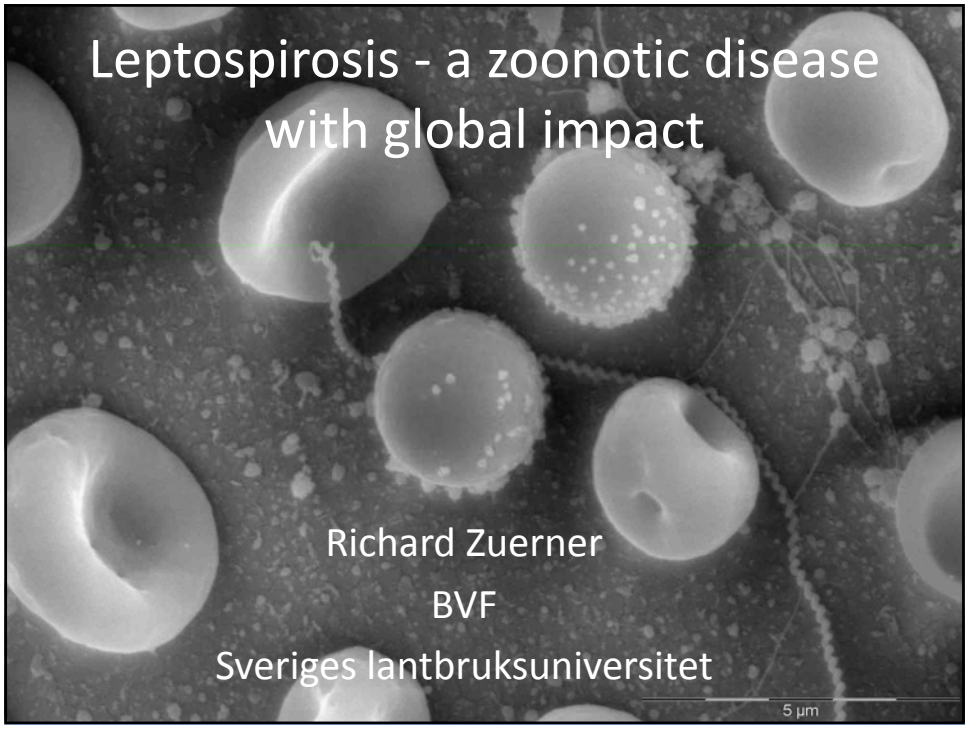
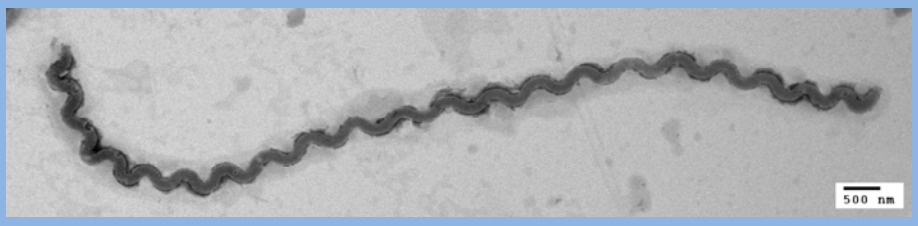


Leptospirosis

- One of the most common zoonotic diseases known
- World-wide distribution
- Disease incidence is significantly underestimated
  - Broad diversity of symptoms
  - Limited diagnostics
  - Need for improved health education
- High incidence of mortality in humans
- Many animal species become chronic carriers of disease

Pappas et al 2007 Int. J. Infect. Dis. 12: 351.

Typical spirochete morphology



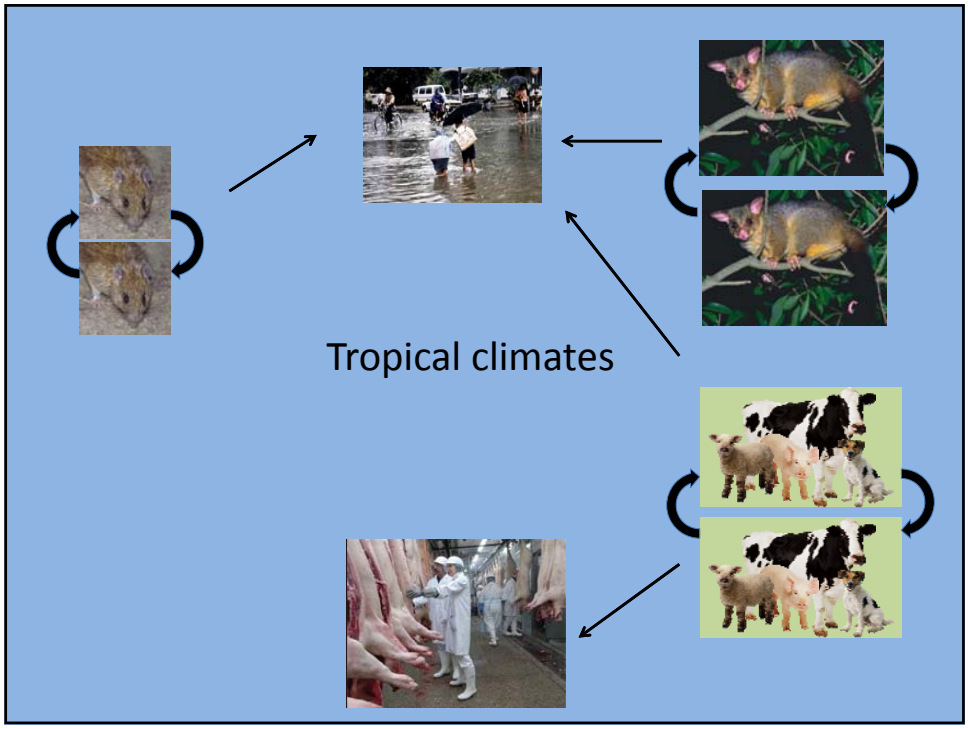
- EM of *Leptospira*
  - Note hooked and spiral ends
  - Morphology and cellular structure enable unique mode of motility
    - Penetrate large variety of tissues

Disease maintenance and transmission

- Pathogenic *Leptospira* reside in maintenance hosts
- Humans are accidental hosts
- Animals may also be accidental hosts
- Transmission is often a result of exposure to urine contaminated water or by direct contact with blood

Disease

- Gain entry through mucous membranes or abraded skin
- Localize in kidney
- Pass to bladder then urine
- Enter water to potentially infect new hosts
- Colonization of liver may indicate potential for severe infection
- Not all species tolerate water (host to host)



Specific maintenance host relationships

- >200 serovars
- Specific host-serovar relationship
  - Difficult to identify source of infection in areas rich with diversity
- Maintenance hosts have chronic infection with little sign of disease
- Accidental hosts (humans other non-maintenance hosts) often suffer acute infection with significant mortality rates

Emerging problem in urban slums

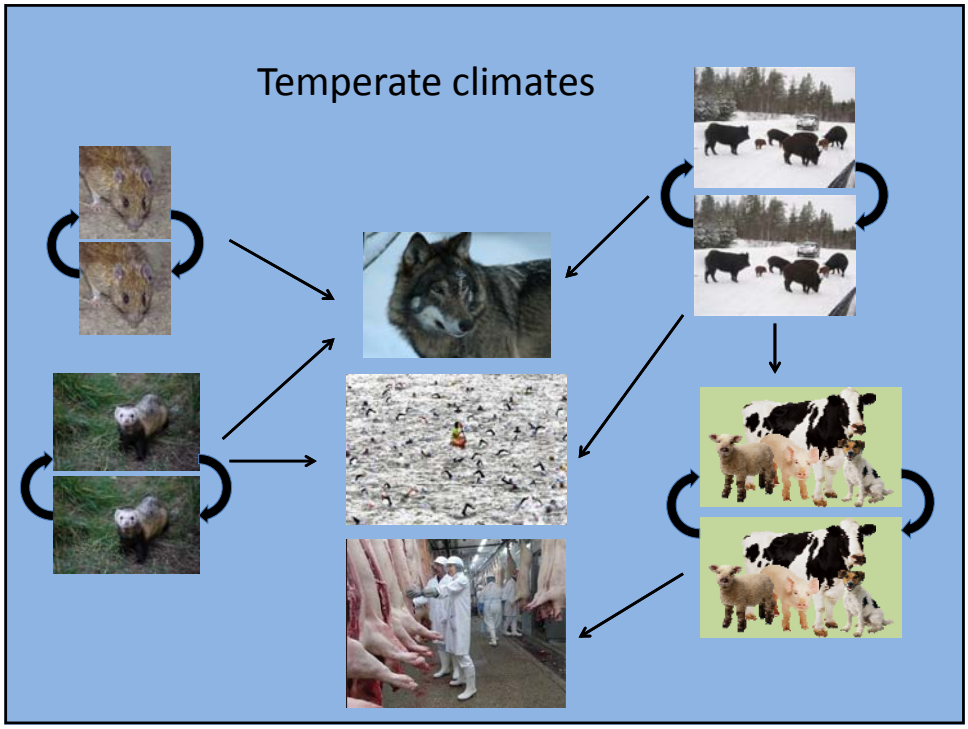
- Sharp increase in annual epidemics in urban slums
- Epidemics correspond with annual rainfall
  - Heavy rainfall = urban flooding = human infection
- Common sources of infection are domestic rat (#1) and dogs
- "The only epidemic-prone infection which can be transmitted directly from contaminated water is leptospirosis, a zoonotic bacterial disease."*

*WHO Health action in crises fact sheet
http://www.who.int/hac/techguidance/ems/flood_cds/en/#

Comparison of human leptospirosis, dengue, and hantavirus infections (2002)

Disease	Leptospirosis	Dengue	Hantavirus
Total cases	Unknown	~50,000,000	Unknown
Severe infection	300,000 – 500,000	400,000	150,000 – 200,000
Mortality rate	5-20%	5-15%	3-10%

Source: Rudy Hartskeerl
WHO Collaborative Laboratory
Royal Tropical Institute
Amsterdam, The Netherlands

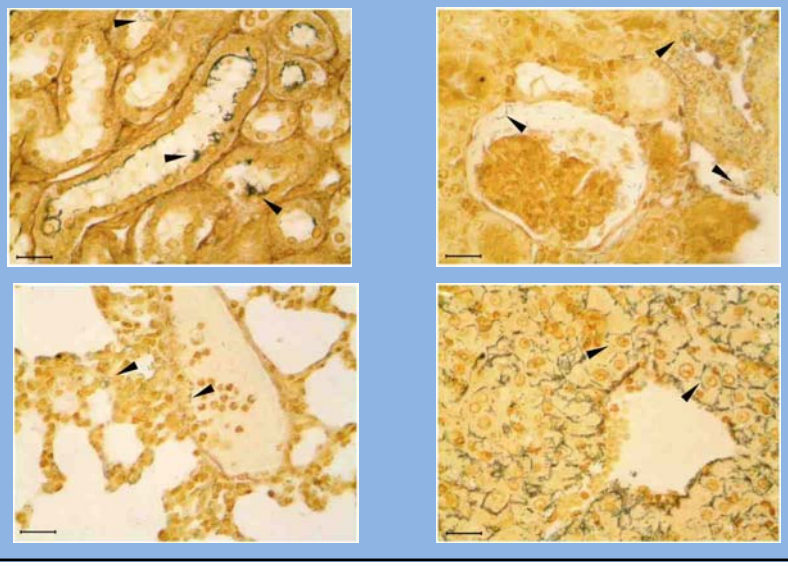


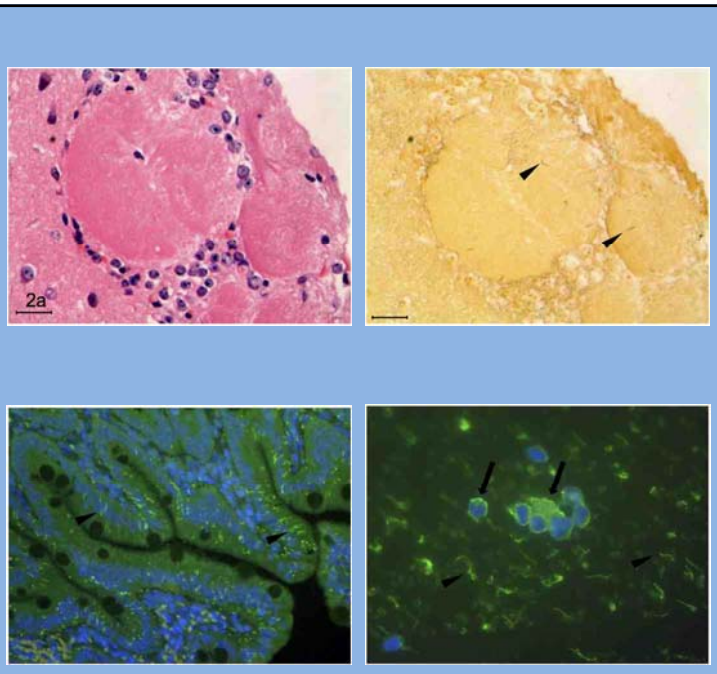
Pattern of infection – temperate regions

- Veterinarians, abattoir workers, animal workers
- Recreational exposure
  - Swimming, kayaking
- Travel
- Pets

THE ASSOCIATED PRESS
Participants in the Iron Horse Triathlon begin the swimming portion of the event in Lake Springfield in this June 21 photo.

Leptospira colonize many tissues during severe infection



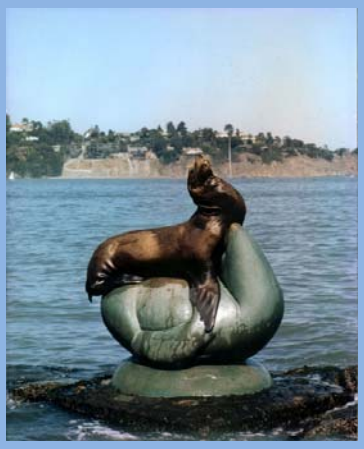


Innate vs. Adaptive Immunity

- In maintenance hosts (cattle as a model) interaction with cells associated with innate immunity or that bridge innate and adaptive immune systems may be critical for establishing chronic infections
  - Neutrophils
  - NK cells*
  - Gamma delta T cells*

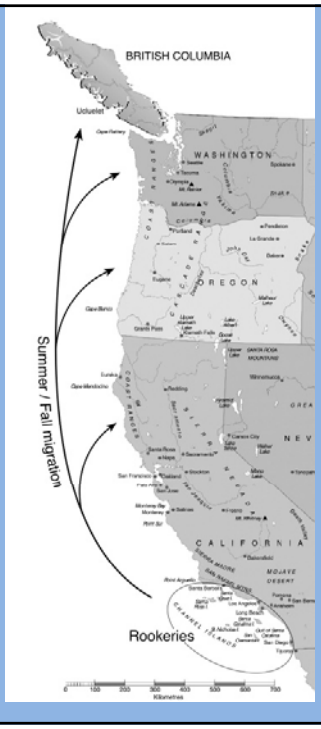
Animal migration and leptospirosis

Impact on protected animal species



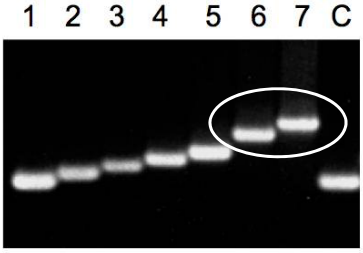
- California sea lion
  - Rookeries on islands off the So. California coast
  - Hunted to near extinction
  - Now protected and numbers rebounded
  - 1970 severe leptospirosis epidemic
  - Continued every few years
  - *L. interrogans* serovar Pomona
  - Current season is one of the worst on record

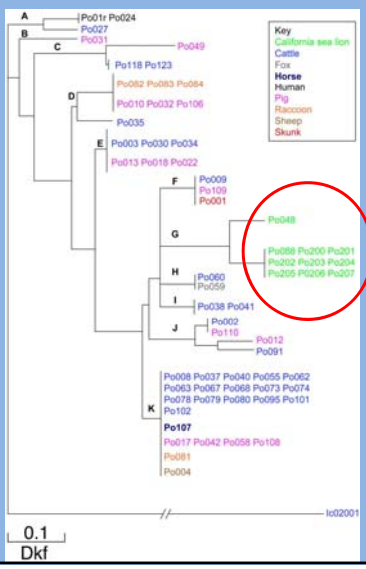
- 2004 outbreak
- Sick animals (males) found as far north as British Columbia and Puget Sound
- Infection was dispersed over 2000 km north
  - Potential for equivalent dispersal south to Gulf of California (females)



Sea lion isolates form a unique group

- VNTR analysis
  - PCR regions that differ in the number of repeats
  - Run samples on gel and compare sizes



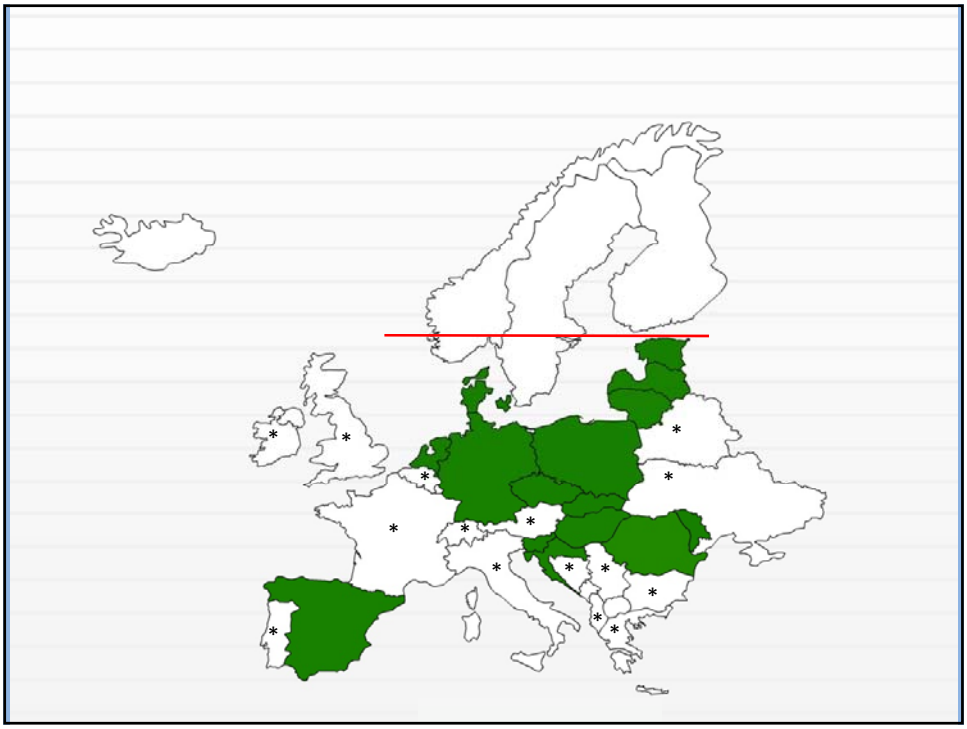


Changes in relationship

- New studies suggest that a maintenance host relationship is developing between serovar Pomona and California sea lions
- Broader impact
  - Sick animals haul out near freshwater outlets
    - Interaction between terrestrial and marine mammals
      - Potential for transmission to humans
  - The same genetic subgroup of Pomona has been isolated from terrestrial animals on the islands in the rookeries

Impact of human encroachment

- Channel Islands
  - Rookeries for California sea lions
  - Previously used for swine production
    - Introduced pigs destroyed normal flora
      - Affected ground cover of small mammals (e.g. Channel island foxes and spotted skunks)
  - DDT use impacted bald eagle population
    - Golden eagles replaced bald eagles in region
      - Hunt small mammals
  - Channel island foxes and spotted skunks are now maintenance hosts for leptospirosis
    - These animals are under pressure from new predator, lack adequate protection from flora, and now have chronic infections affecting reproduction
    - Both species are either listed as endangered or of special concern



Bacterial genera with potential for zoonotic diseases – migratory animals

Marine Mammals

- *Brucella*
- *Clostridia*
- *Coxiella*
- *Leptospira*
- *Mycobacteria*
- *Vibrio*

Birds

- *Anaplasma*
- *Borrelia*
- *Brachyspira*
- *Campylobacter*
- *Rickettsia*
- *Salmonella*

Future concerns

- The role of environmental contaminants, e.g. PCB's, can have an immunosuppressive affect on wildlife
- Changing climate may
  - Alter migration patterns of animal species
  - May alter northern environments to assure pathogen survival

A better understanding of human activity and impact on the environment combined with disease surveillance are essential to limit encroachment of diseases into new regions.