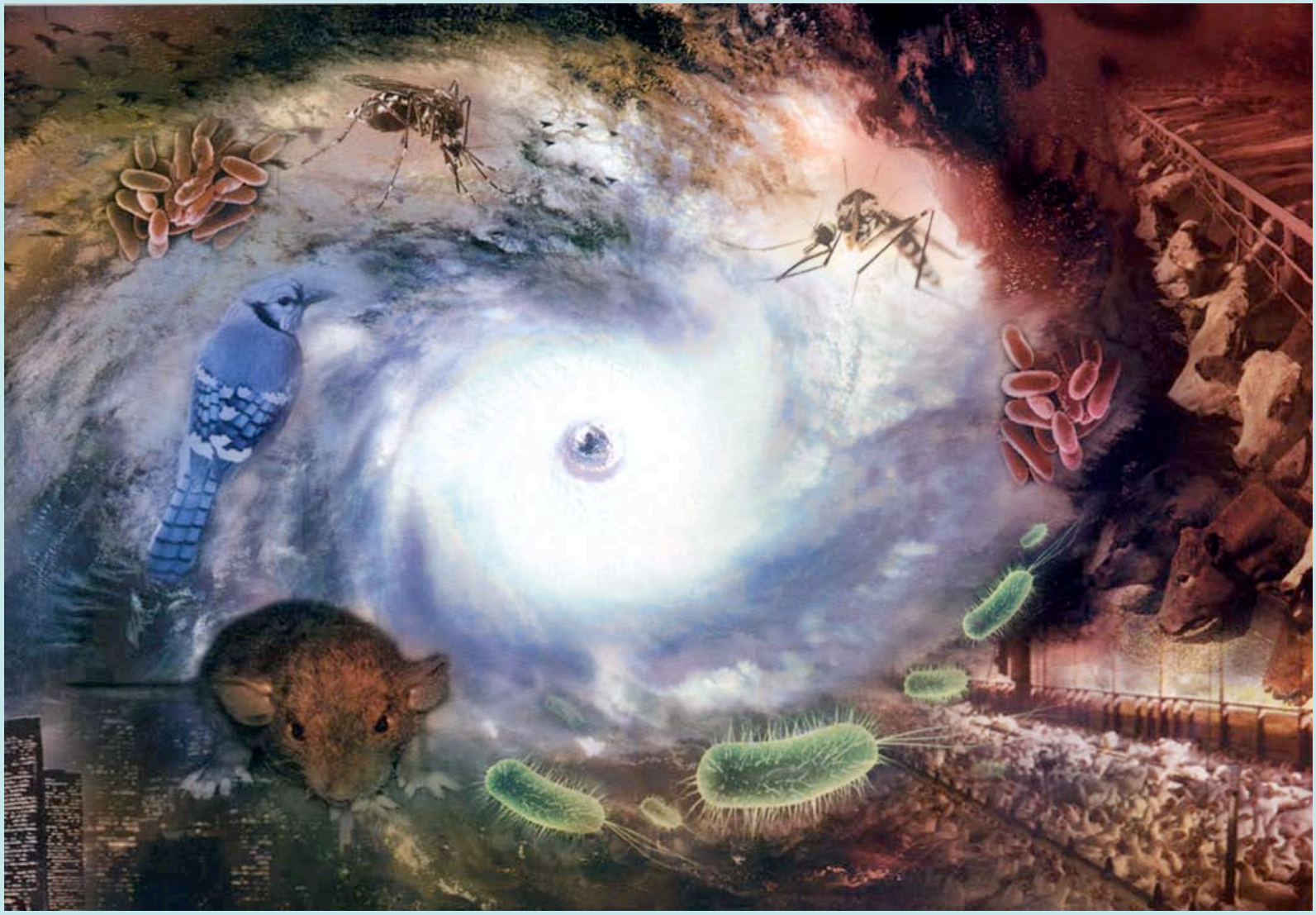
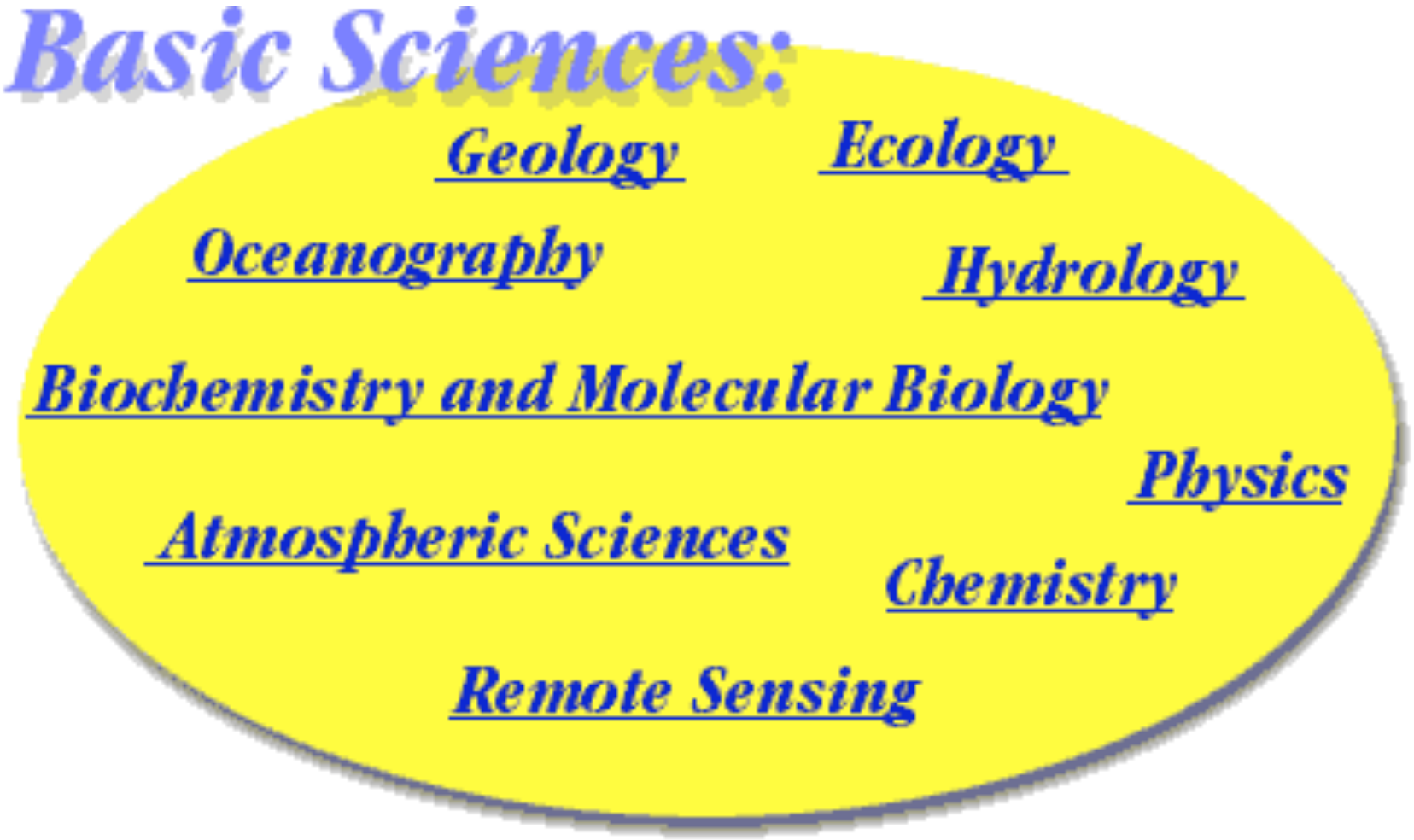
Emerging Infections and the Ecotone

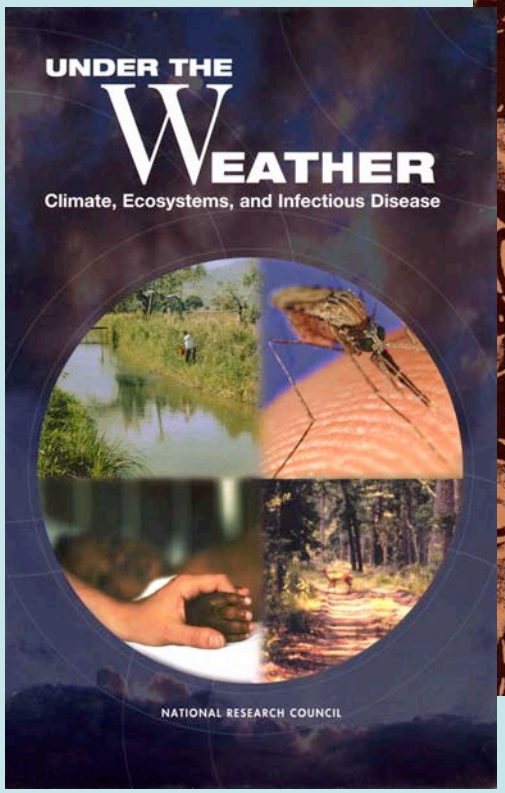


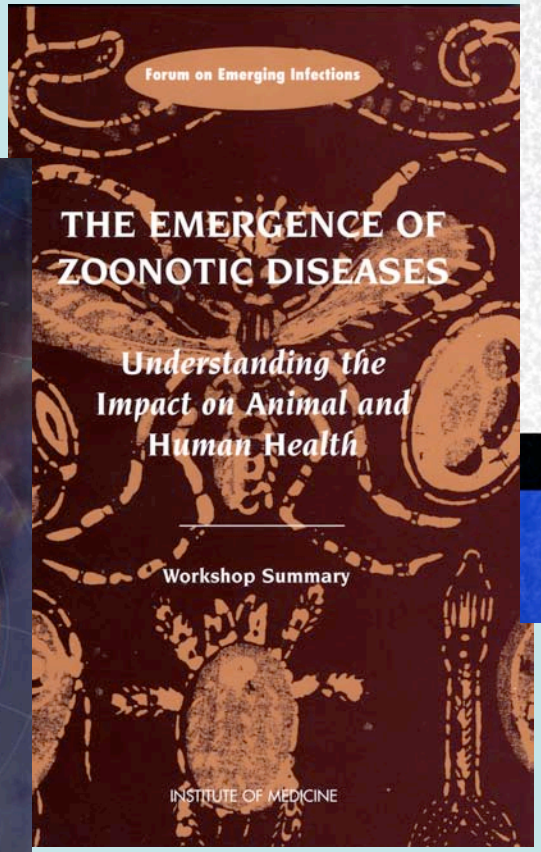
Cover: Emerging Zoonoses and Pathogens of Public Health Concern

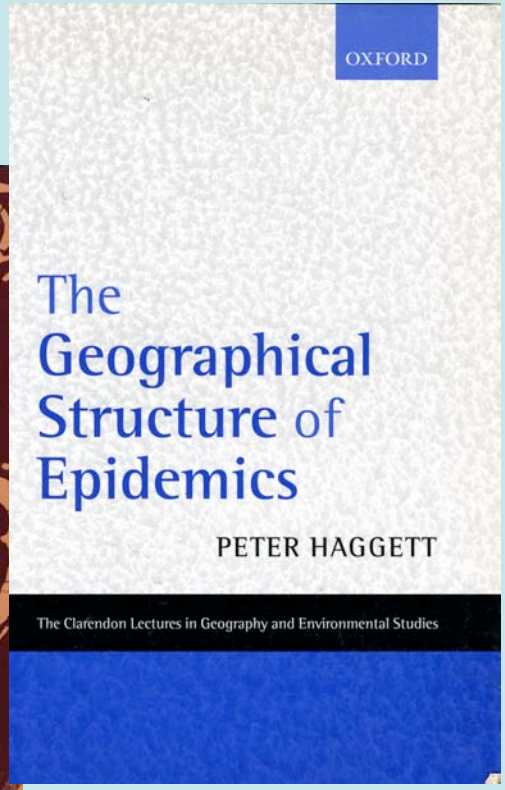

Basic
Science
Medical
Ecology
Applied
Science


Basic Sciences:
Geology
Ecology
Oceanography
Hydrology
Biochemistry and Molecular Biology
Physics
Atmospheric Sciences
Chemistry
Remote Sensing


Applied Sciences:
Biostatistics
Medical Sciences
Epidemiology
Anthropology
Agronomy
Environmental Health Sciences
Socio-Medical Sciences
Toxicology
Medical Geography


UNDER THE
WEATHER
Climate, Ecosystems, and Infectious Disease
NATIONAL RESEARCH COUNCIL

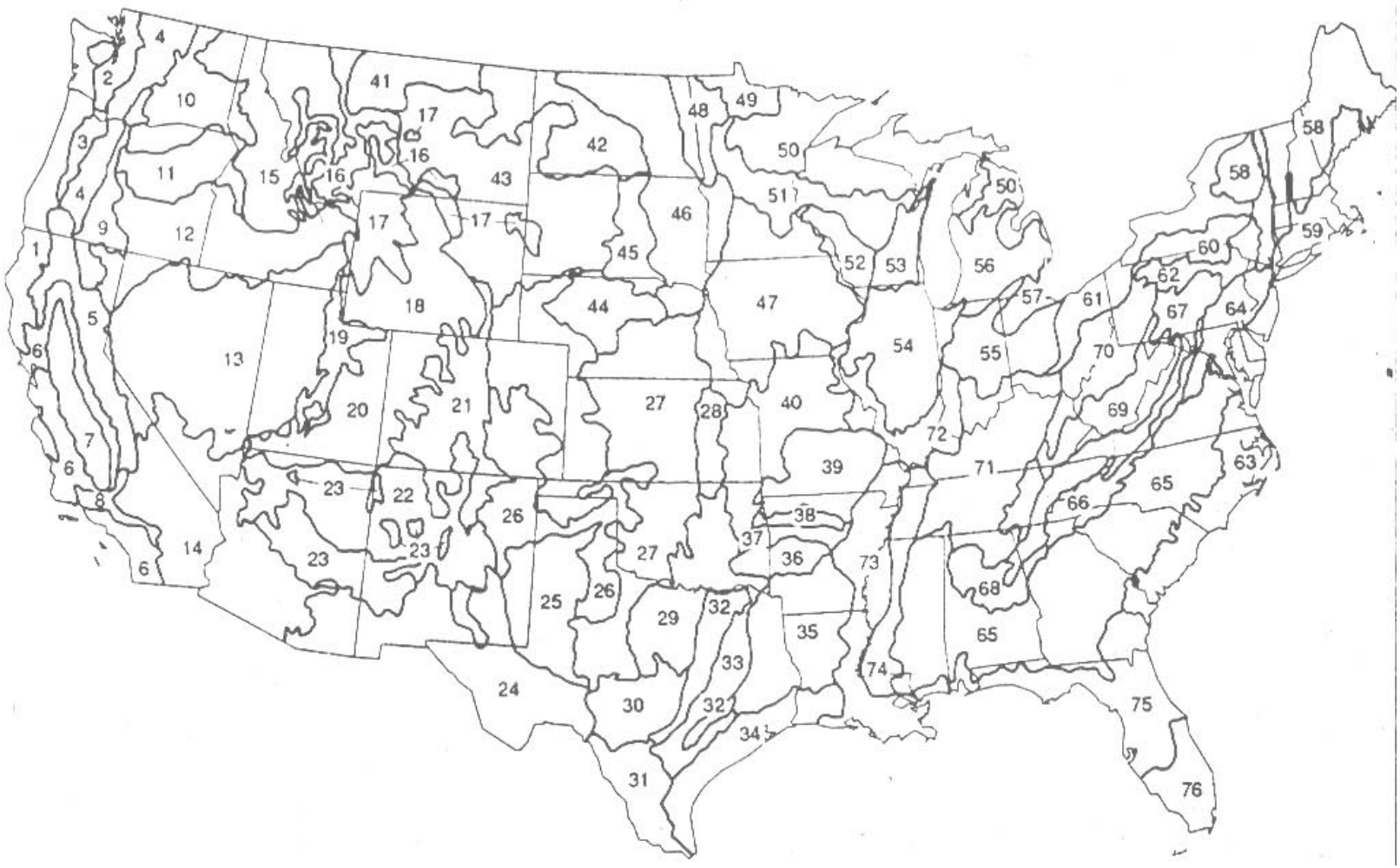

Forum on Emerging Infections
THE EMERGENCE OF ZOONOTIC DISEASES
Understanding the Impact on Animal and Human Health
Workshop Summary
INSTITUTE OF MEDICINE


OXFORD
The Geographical Structure of Epidemics
PETER HAGGETT
The Clarendon Lectures in Geography and Environmental Studies

To learn more, log on to:

www.medicalecology.org

An ecotone is a narrow transition zone between one ecosystem and another.

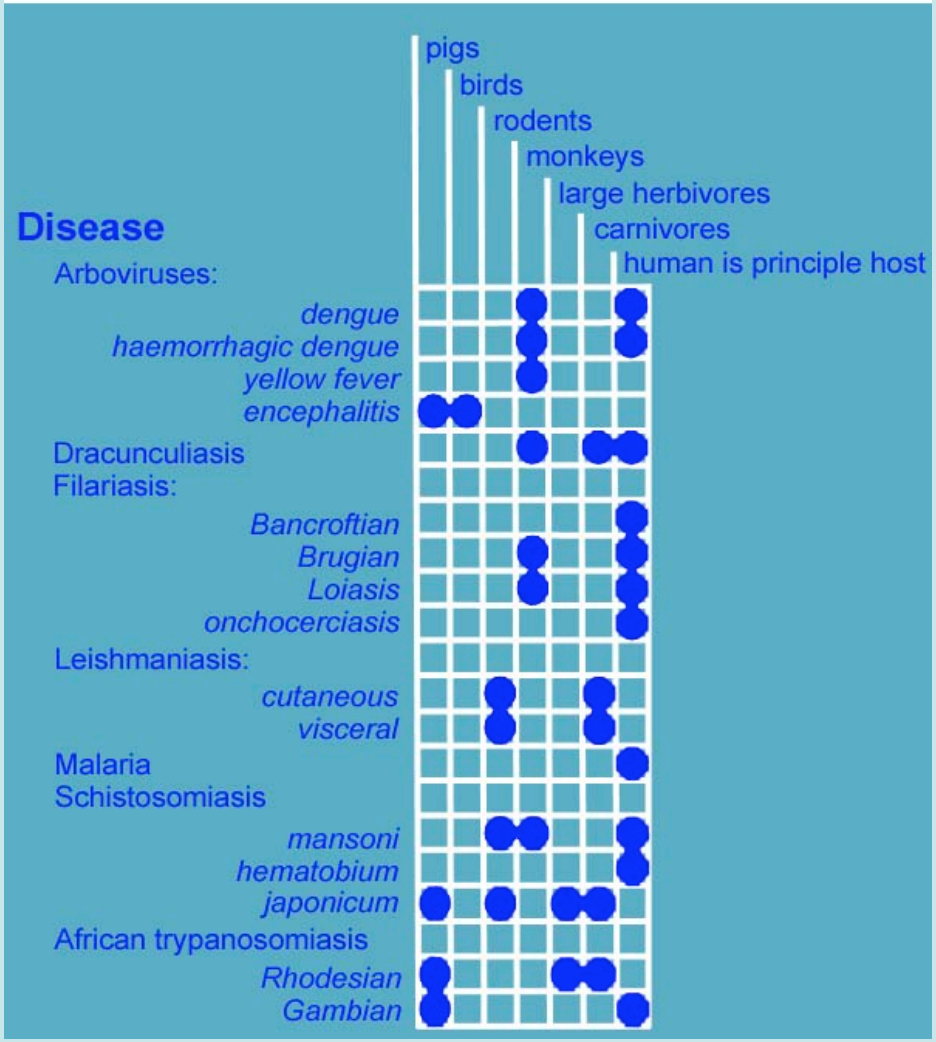


Characteristics reportedly elevated in Ecotones	**Ecological process effected**	**Host-Parasite (pathogen) Consequence**
species richness & density	High frequency of novel species contact	increased opportunity for pathogen host-switch, species jumping
genetic diversity	Intense, diversifying selection pressure	increased opportunity for genetic exchange, genetic novelty
productivity	High population density	opportunity for pathogen persistence
Cross - and along boundary flows of energy, materials, and organisms.	High dispersal and regulation of movement and flows of species, water, and materials	increased opportunity for pathogen spread via host or environmental media (water, air, soil/sediment)
Environmental variability and gradients; habitat heterogeneity	Spatial and temporal environmental variation in biotic and abiotic factors	more rapid microbial, parasite or pathogen adaptation

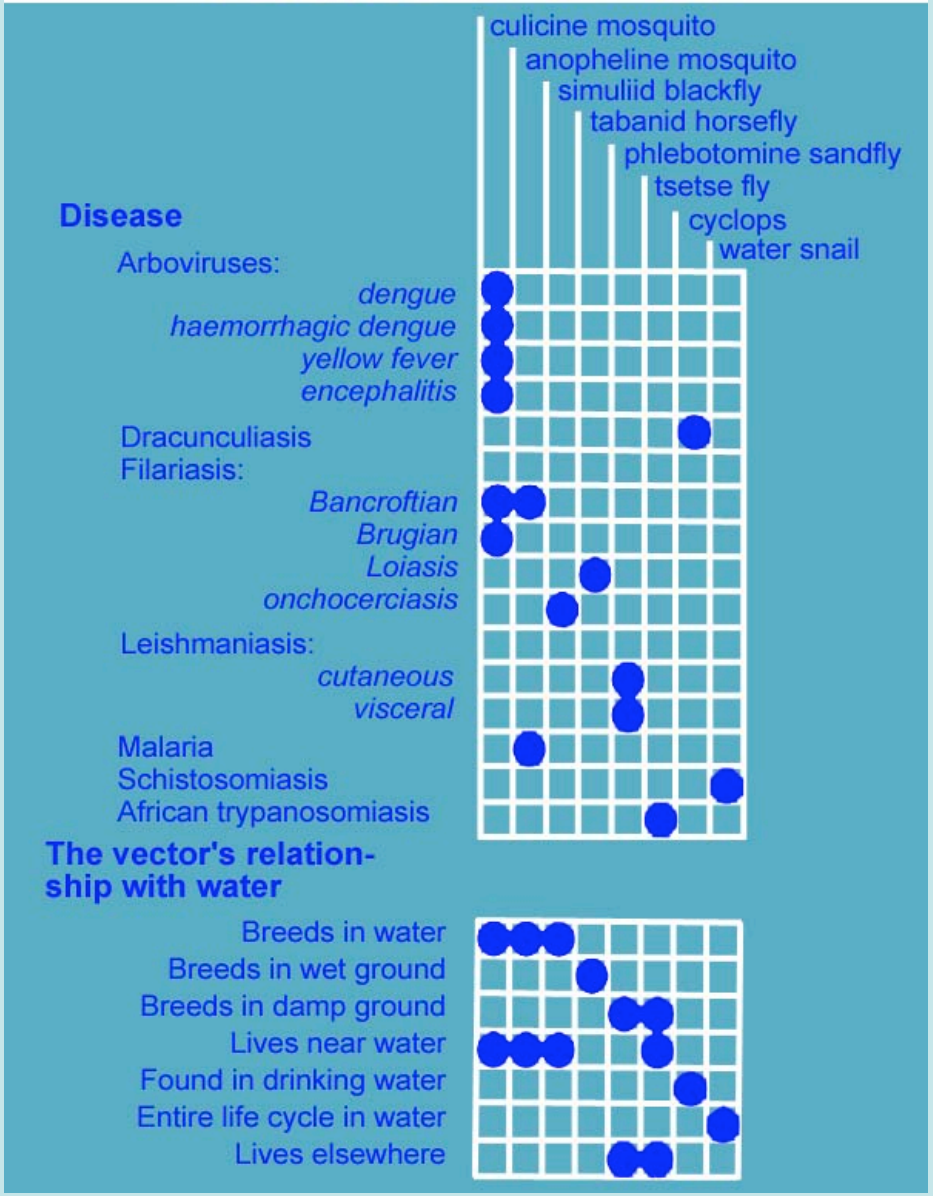
	CDC Master List of Emerging Infectious Diseases				
	Infectious Agents	**Natural Reservoir**	**Source**	**Ecotone involvement**	
1	Cholera	copopods/water	fecal contam	terres-aquatic	Transmission leading to endemic or epidemic disease from shellfish or marine or estuarine water
1	hantavirus pulmonary syndrome	vertebrates	rodents	settlement-nat. ecosys.	Transmission mainly from wild rodents encroaching into homes and farm buildings
1	hendra virus infection	vertebrates	bats	ag-nat. ecosys.	Spillover from Pteros bats to horses (MacKenzie et al 2001)
1	Influenza	vertebrates	birds	terres-aquatic	Spillover from migratory waterfowl, domesic fowl, to pigs; migratory waterfowl
1	Lyme disease	vertebrates	tick	settlement-nat. ecosys.	hosts and vectors proliferate in forest edges
1	Nipah virus infection	vertebrates	bats	ag-nat. ecosys,	Spillover from Pteros bats to pigs
1	rabies	vertebrates	mammals	settlement-nat. ecosys.	Spillover to dogs or direct transmission from wild mammals
1	yellow fever	vertebrates	mammals	settlement-nat. ecosys.	Transmission leading to endemic or epidemic disease from mosquitoes at forest edges
2	African trypanosomiasis	vertebrate	mammals	settlement-nat. ecosys.	Spillover from wild ungulates to pigs
2	Campylobacteriosis	vertebrates/water	Vibrio or fecal contaminated water	terres-aquatic	Spreads via ground and surface water; facilitated by human alteration of natural drainage systems
2	Chagas disease	vertebrates	Reduvuiid bug	settlement-nat. ecosys.	Transmission involves both sylvatic and domestic cycles (Tiexera et al 2001, Beard et al 2003)
					Spreads via ground and surface water; facilitated by human

From: Despommier & Wilcox. 2005 Ecohealth (accepted for publication)

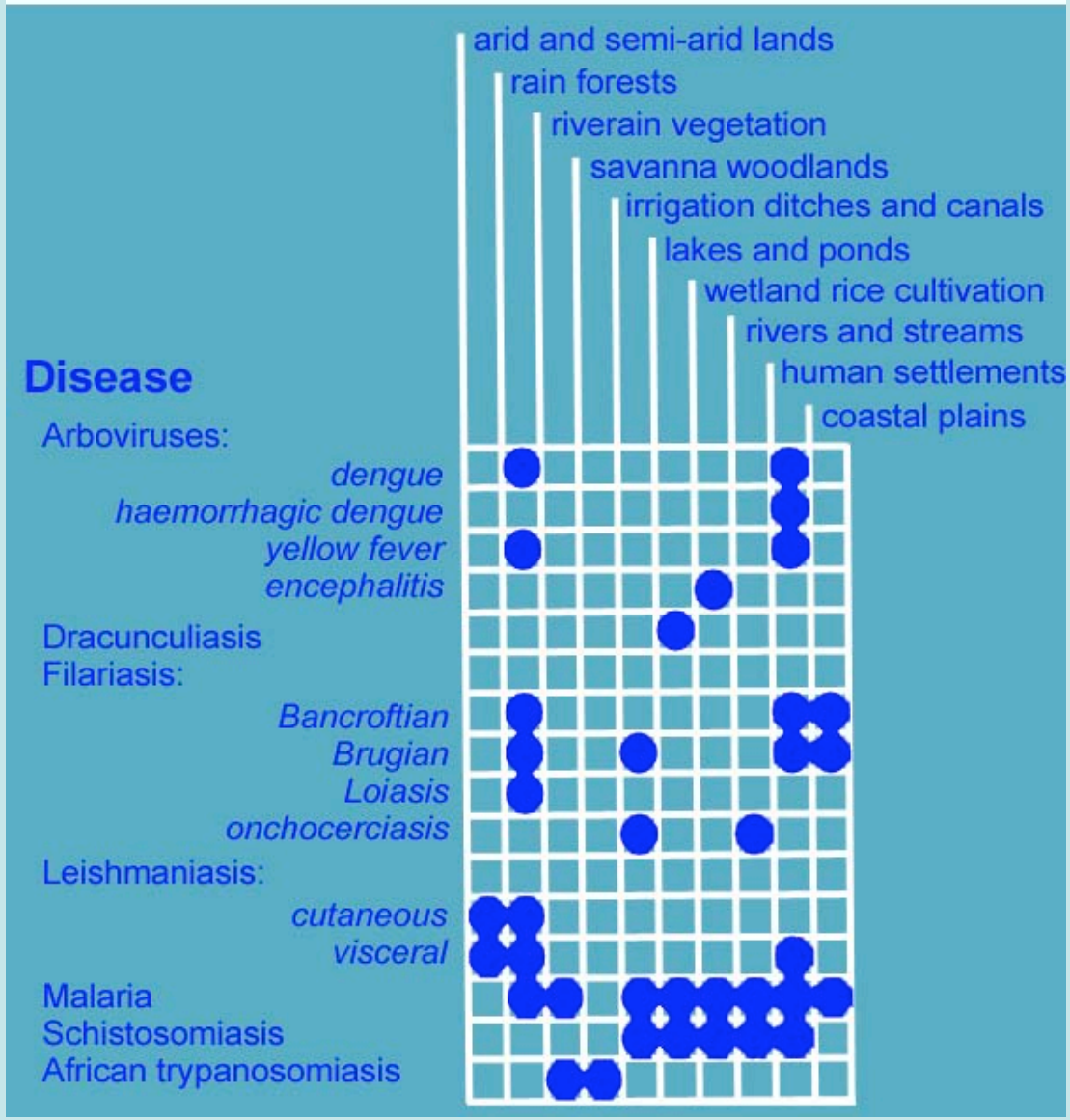
The main animal hosts of vector-borne diseases



Associations between vectors, diseases and water



The principle diseases in relation to the principle habitats of the vectors

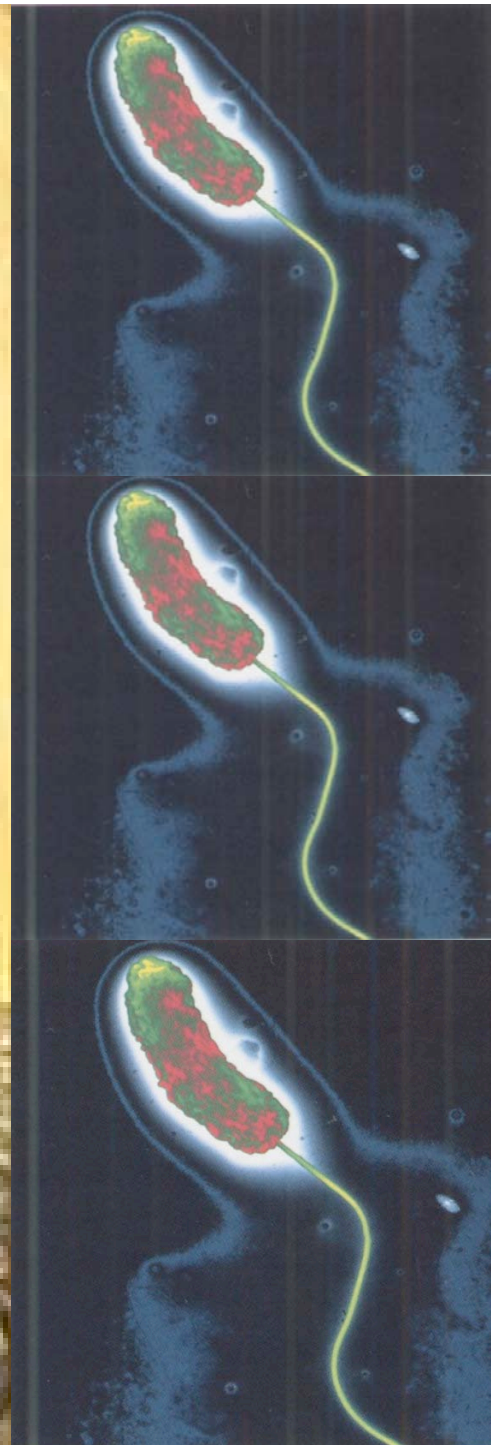


Environmental disturbance leads to emergence or establishment of infectious agents

Urbanization: (encroachment into natural systems)

- Cholera
- Rabies
- Lyme Disease
- Arboviruses - Yellow Fever, Dengue Fever
- Ebola, Lassa, Hanta
- Plague
- African Sleeping Sickness

Cholera



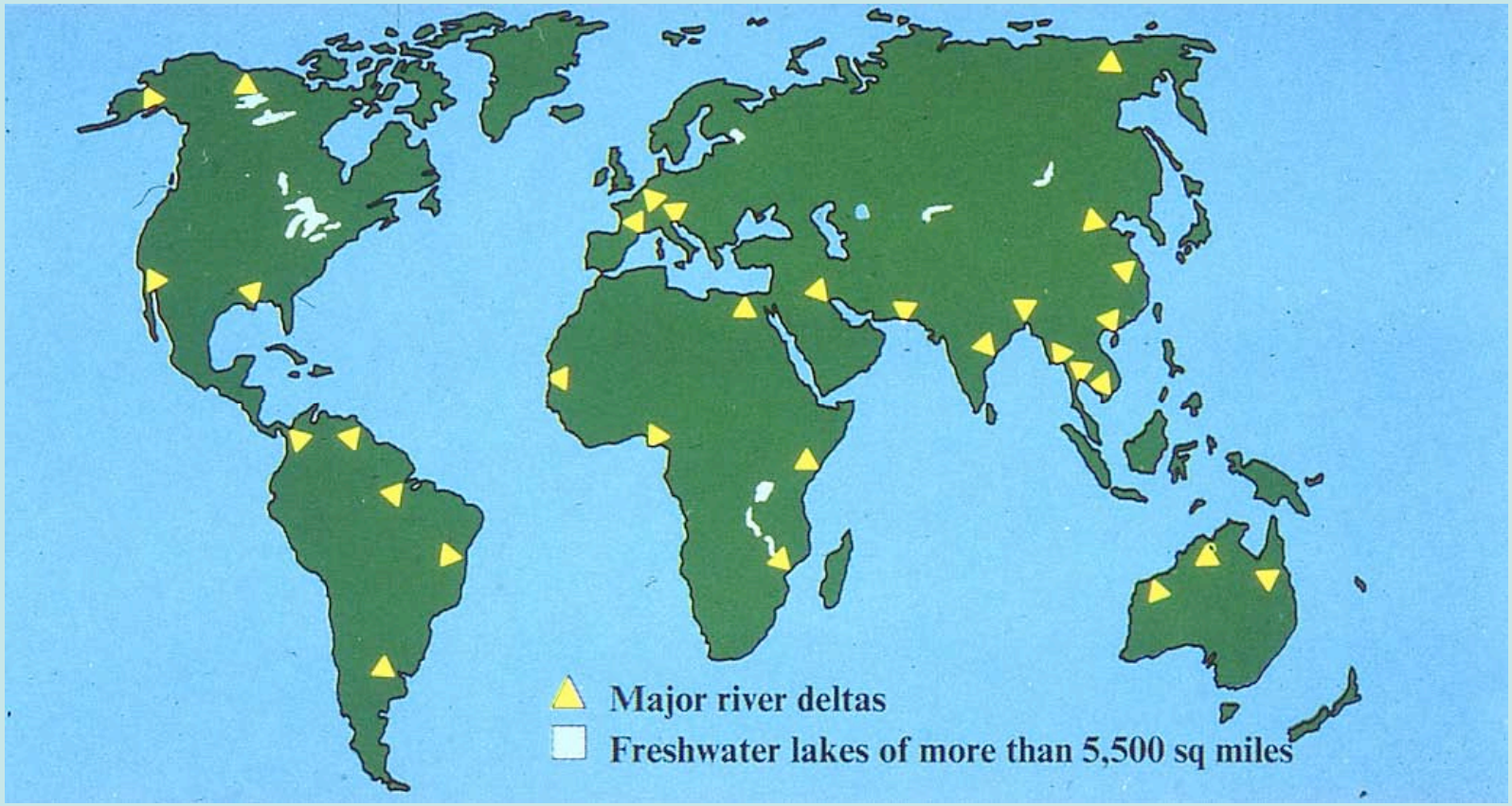
Cholera

Then and Now

John Snow

Rita Colwell

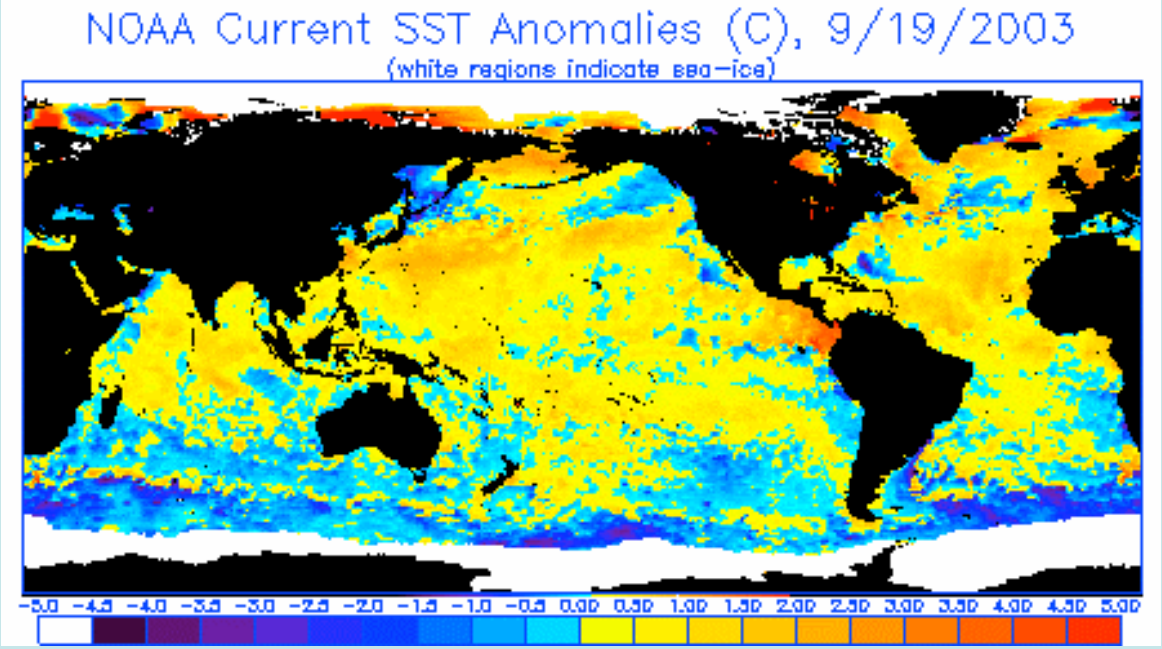
Distribution Of Estuaries



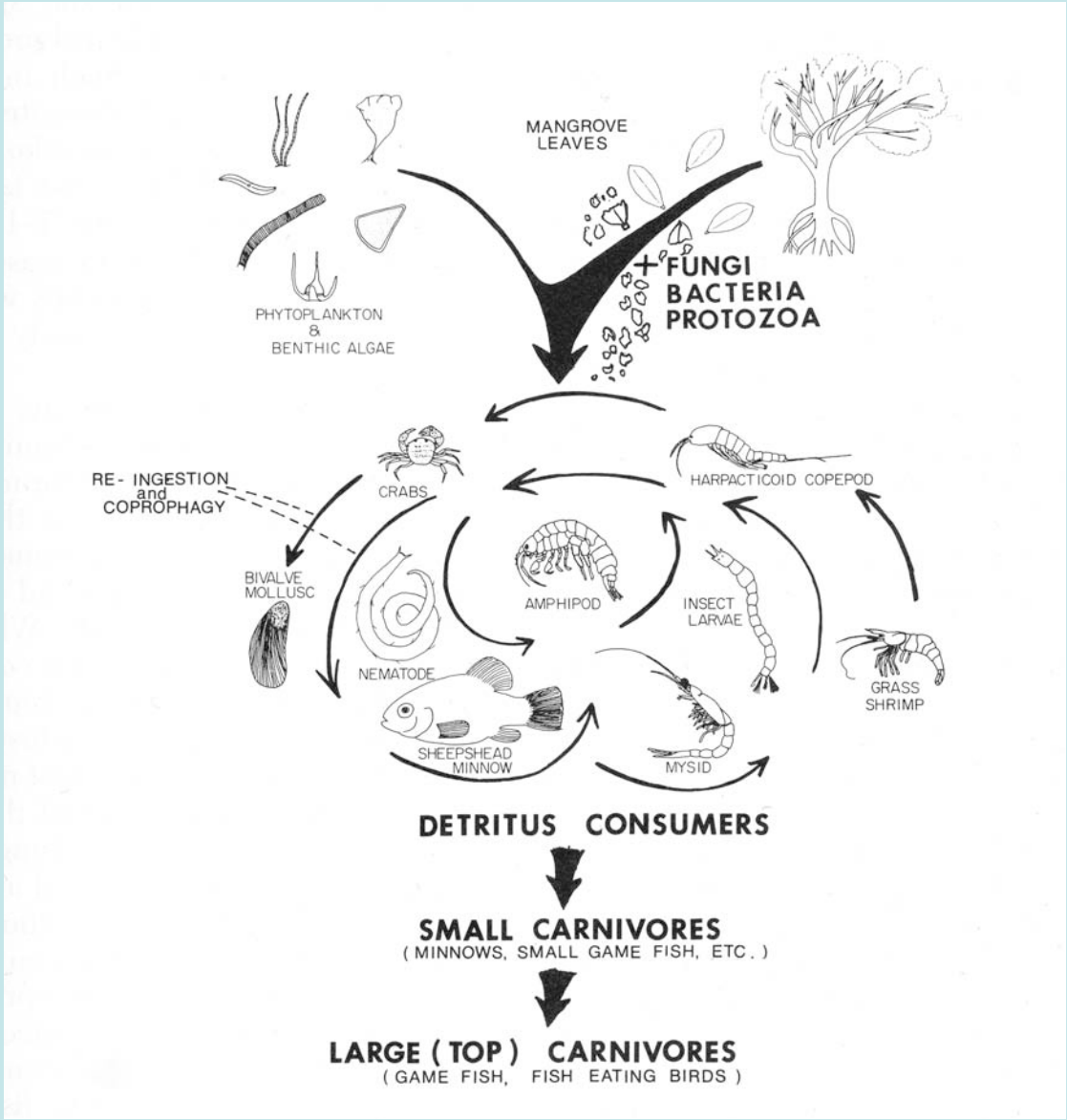
February 3, 2000

El Niño Increases Diarrheal Disease Incidence by 200 Percent

The El Niño phenomenon--the warming of the equatorial Pacific ocean that occurs every two to seven years--has been linked to outbreaks of dengue, malaria, and cholera. Now, researchers from the Johns Hopkins School of Public Health, A.B. Prisma, and the Instituto Nacional de Salud in Lima, Peru, have found that the 1997-1998 El Niño season increased hospitalizations for diarrheal disease by 200 percent, according to a study published in the February 5th issue of *The Lancet*. The results are cause for concern, said the researchers, since diarrhea already causes one billion episodes and three million deaths annually in children under five worldwide.



Trophic Relationships Of The Mangrove Estuary

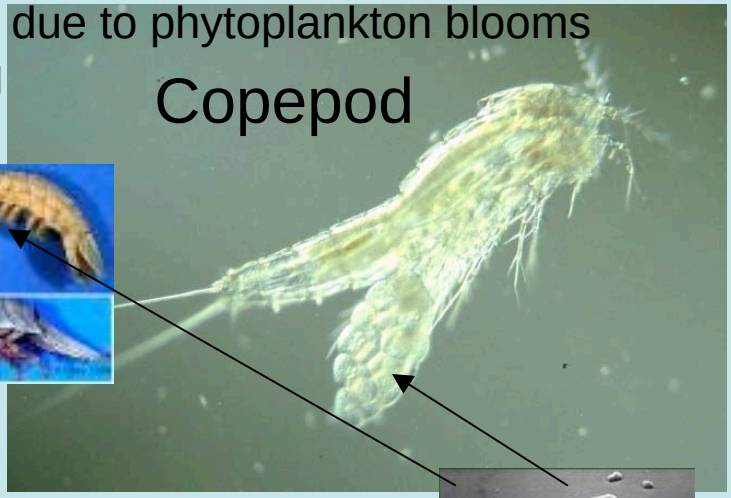


From: E. Odum *Fundamentals Of Ecology*

Ecology of Cholera Epidemics

Numbers increase during monsoons due to phytoplankton blooms

Filter-feeding crustacea



Throw net fishing for crustacea after the monsoons in Bay of Bengal

Fecal contamination of freshwater and human activities

Vibrio cholerae *and its relatives are marine microbes, fully integrated into their respective food webs.*

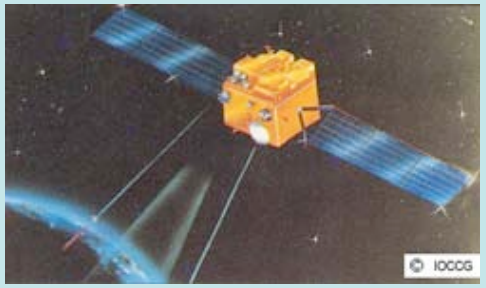
Environmental conditions favoring growth of vibrio:

1. *Low salt*
2. *High Nutrient Load*
3. *20^{O}C*
4. *Triggers phytoplankton bloom*
5. *Followed by zooplankton bloom*
6. *Followed by a cholera outbreak*

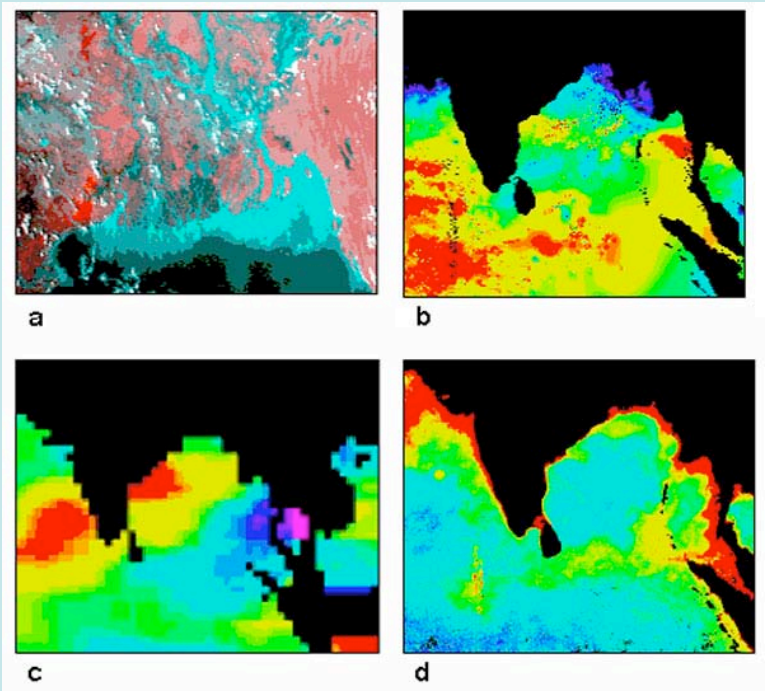
Marine copepod with *Vibrio cholerae* *attached to egg cases.*

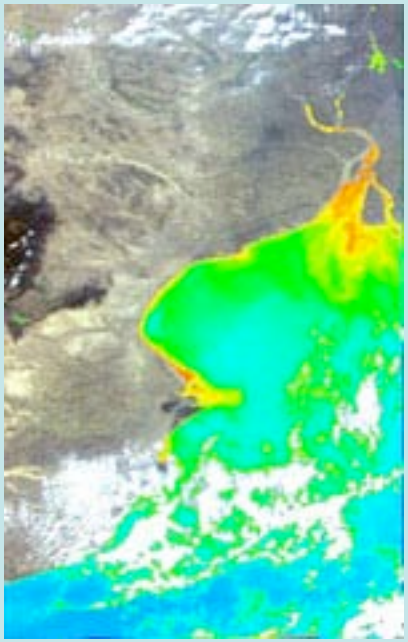
Phytoplankton Bloom

Monsoons

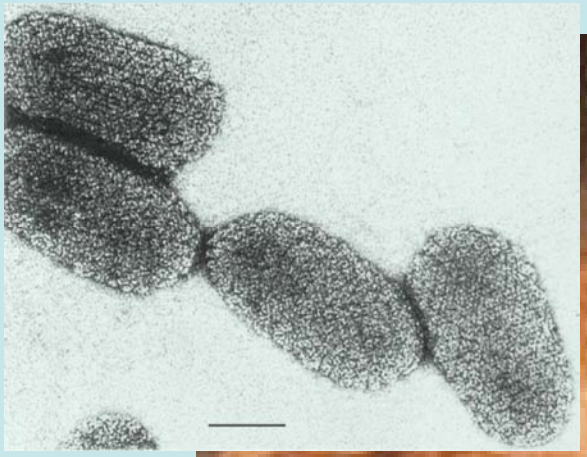


1. lower the salinity of the estuary
2. bring nutrients to the estuary
3. raise the ambient water temperature of the estuary





Rabies



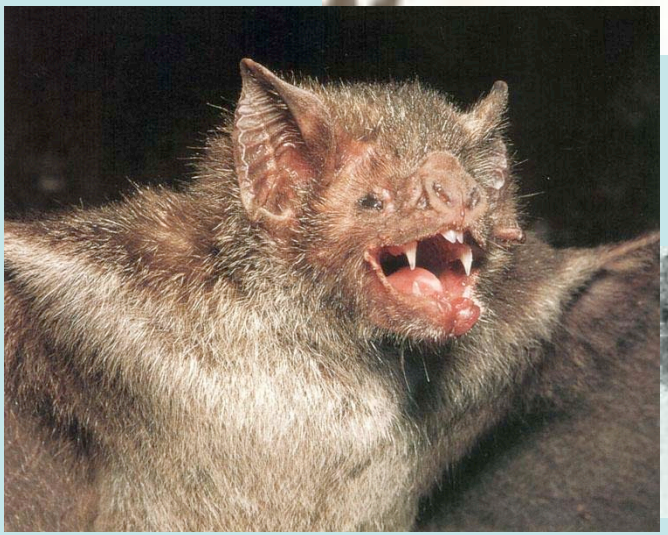
Cross Sectional
RNA
Envelope
(Membrane
bilayer)
Matrix
Protein
Ribonucleoprotein

World Distribution of Rabies

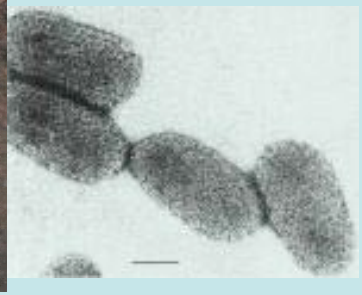
Rabies vectors and carriers

Fruit Bats

Nipah virus



Vampire Bat



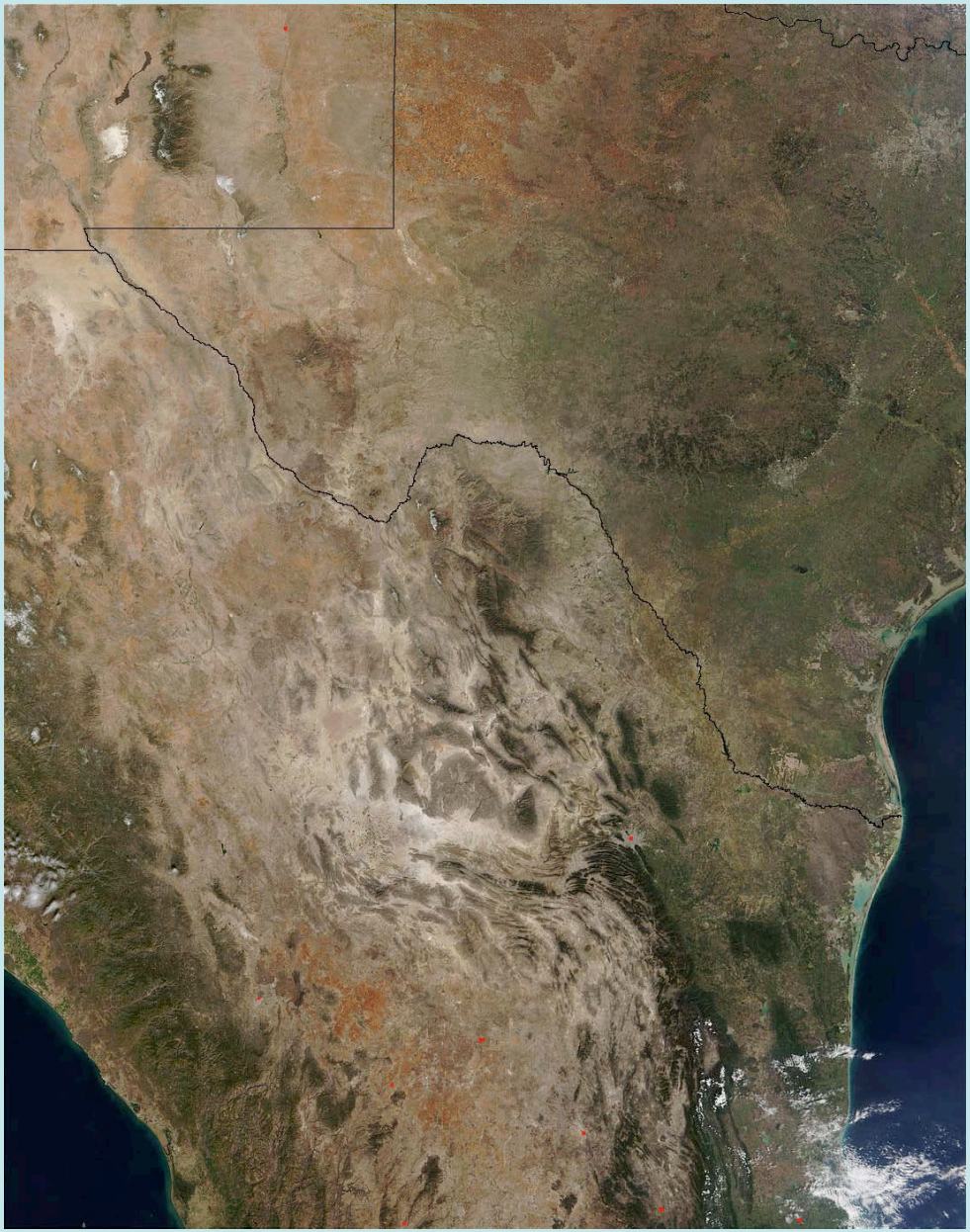
rabies virus

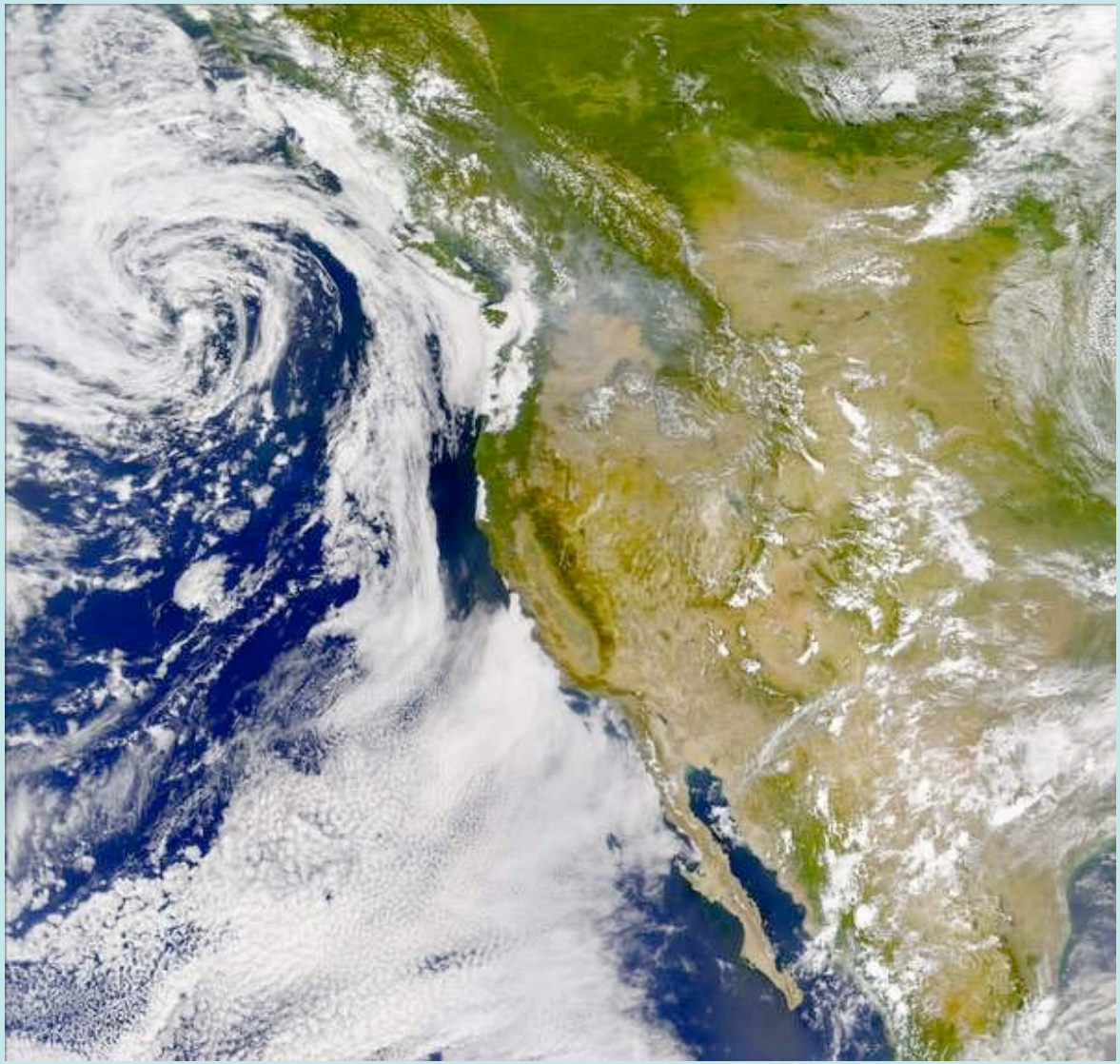
Did you know?
30% of all mammalian species are bats

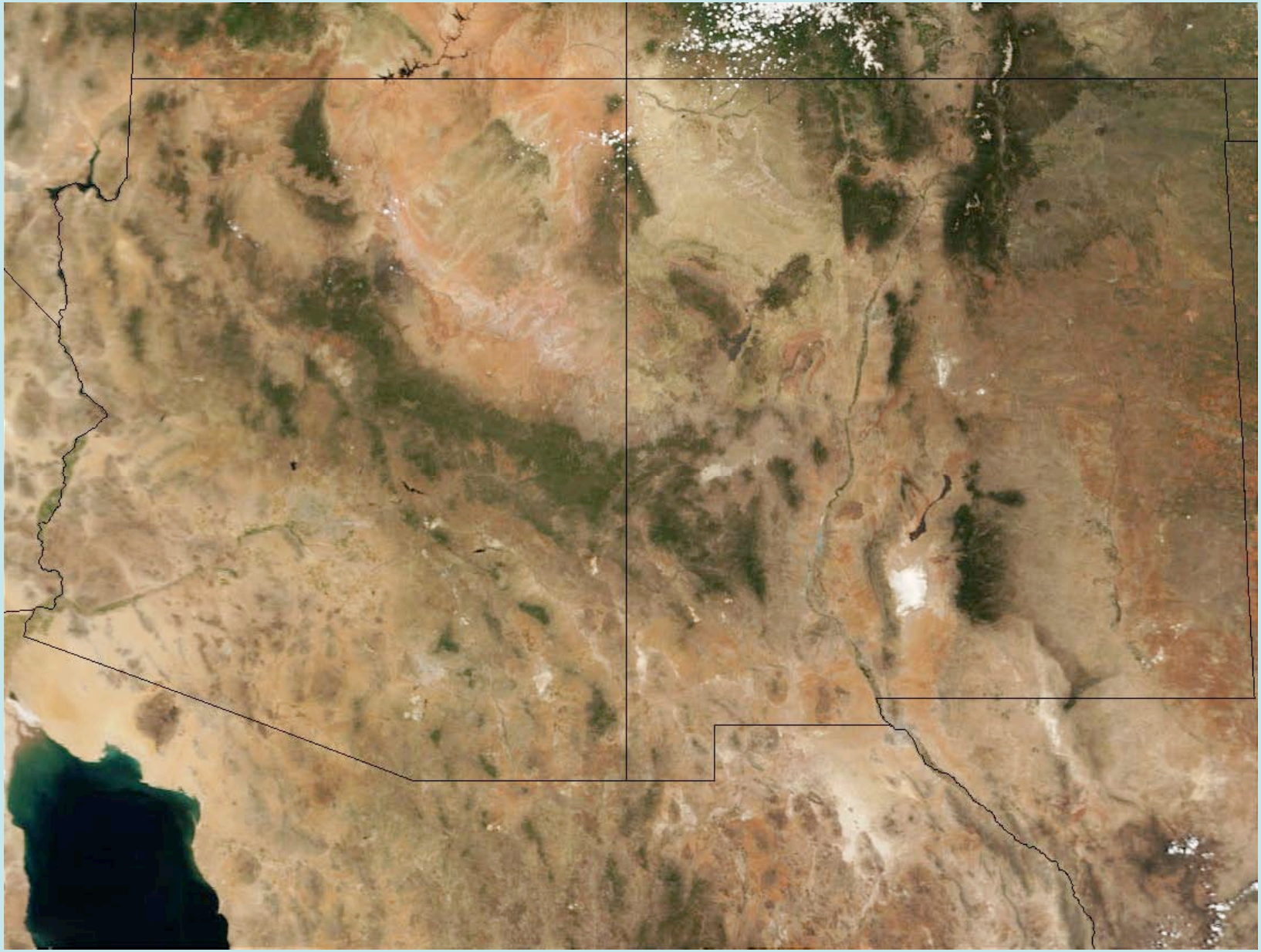
ProMed: Oct 27th, 2005
From: Luciano Goldani <rsf4805@via-rs.net>

Hematophagous (vampire) bats are proliferating because of forest devastation in the state of Maranhao, northeastern Brazil. 20 cases of fatal rabies have been clinically documented. The population in the area is protecting their houses with wire nets to prevent bat bites.

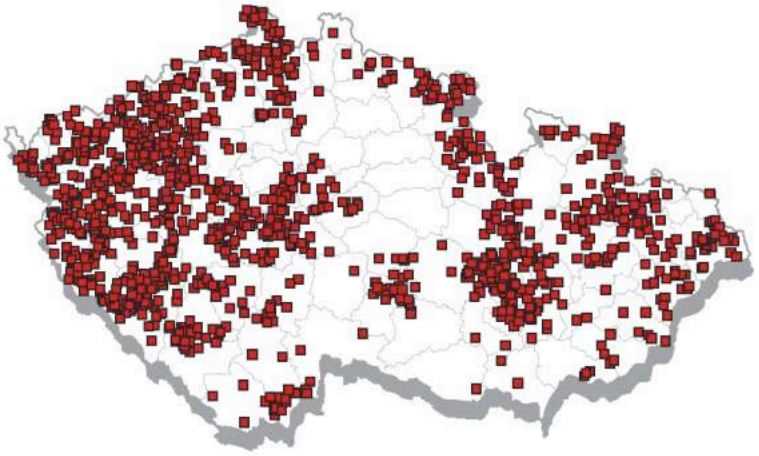
Dr. Luciano Goldani
Infectious Diseases Unit
Universidade Federal do Rio Grande do Sul
Brazil







Rabies Cases in the Czech Republic in 1989



Rabies Cases in the Czech Republic in 2002

Control of rabies by oral bait-vaccine

3.1 Rabies Situation and Rabies Controlin the Czech Republic 2000 – 2002

by O. Matouch[1] and J.Vitásek[2]
[1]State Veterinary Institute, Liberec 30, CZ
[2]State Veterinary Administration, Prague, CZ

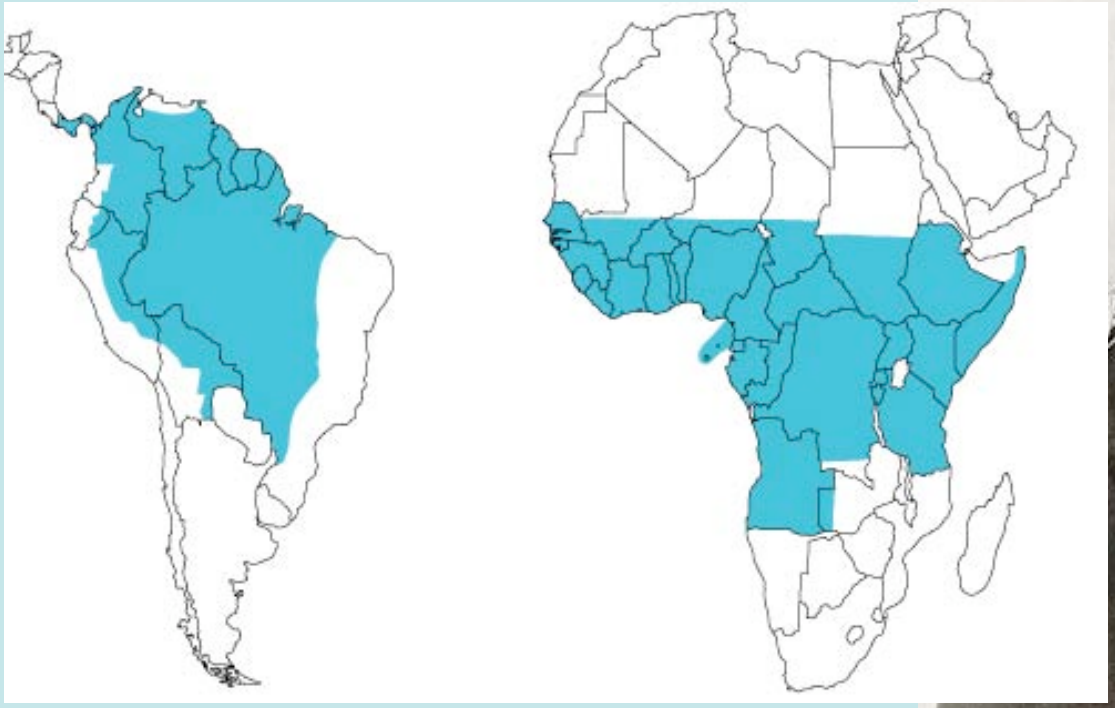
1. Oral vaccination of foxes

The field trial of oral immunization of foxes was started in the Czech Republic in spring 1989. The first application of the oral rabies vaccine (SAD B19-Tübingen) was carried out in the districts Klatovy, Domazlice, Tachov adjacent to the German border in spring 1989. During the course of the next campaigns the treated area was extended covering 44 districts in autumn 1992. In the autumn 1993 the whole territory of the Czech Republic, with exception of rabies free districts bordering Germany, was included.
Since 1992 only the Czech made vaccine LYSVULPEN manufactured by BIOVETA Ivanovice with the SAD Bern vaccine virus strain has been used in the Czech Republic.
The "Bavarian model" was applied during all vaccination campaigns. Voluntary hunters distributed the vaccine baits by hand in their hunting preserves. The strategy of two vaccination campaigns per year, one in spring and one in autumn, was applied. From 1996 aerial distribution of the vaccine baits was selectively used on a restricted territory (4 - 6 districts). In the last years, the aerial vaccination was extended to 50% of the treated territory (29 districts) in 2002 (See Map). More than nineteen million of vaccine baits were used from 1989 till the autumn 2002.

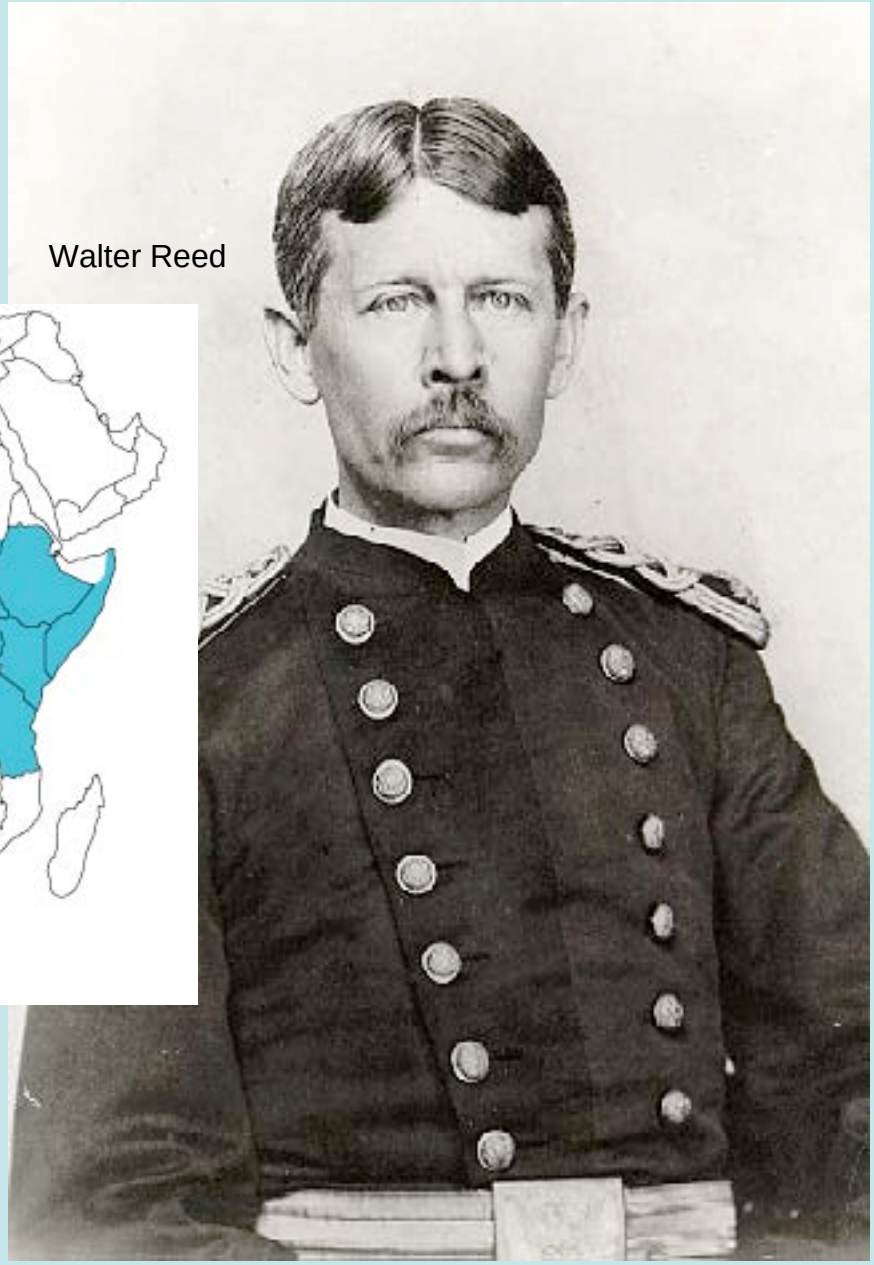
Thanks, Louie!

Yellow Fever

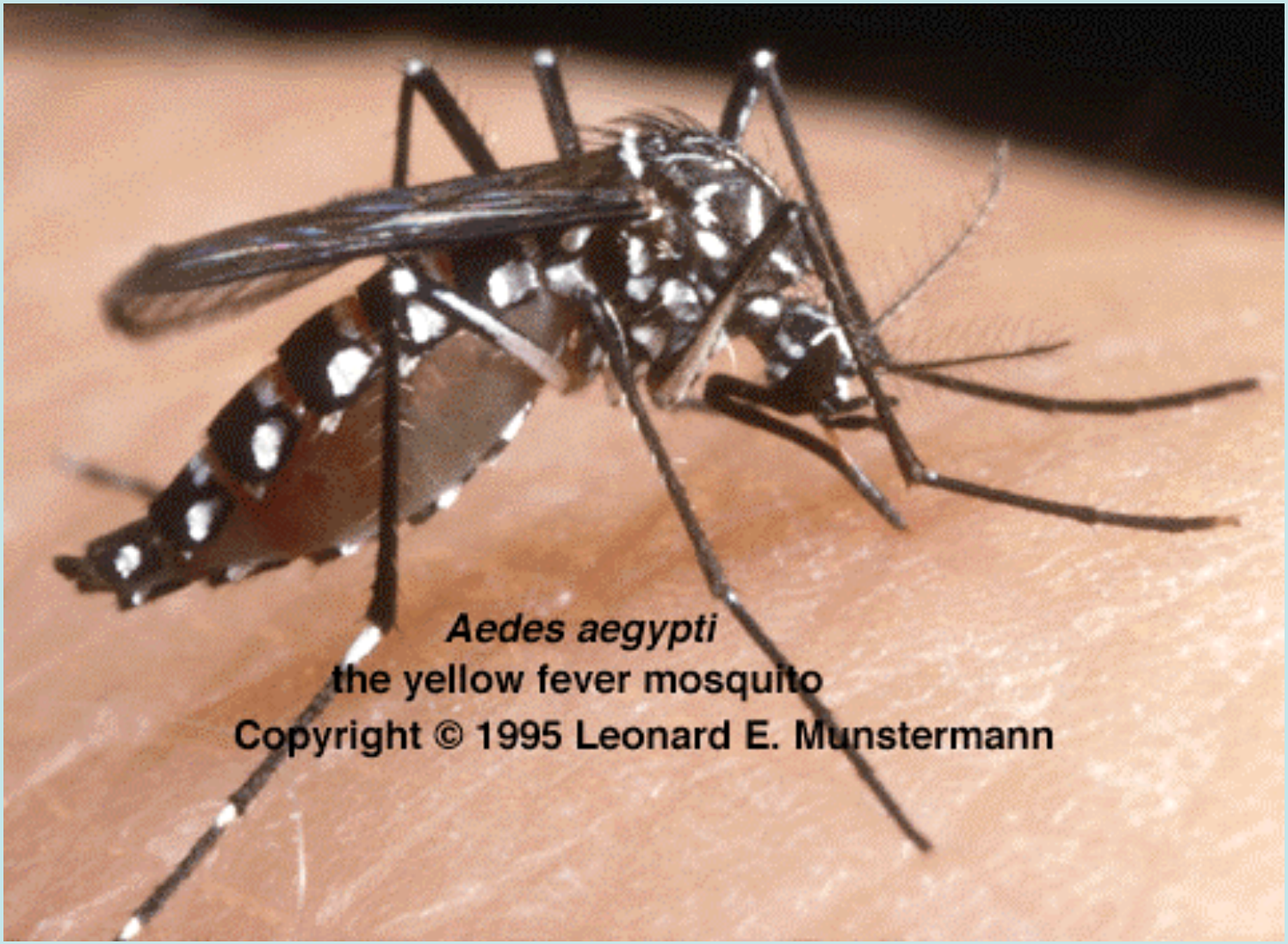
Distribution of Yellow Fever



Walter Reed

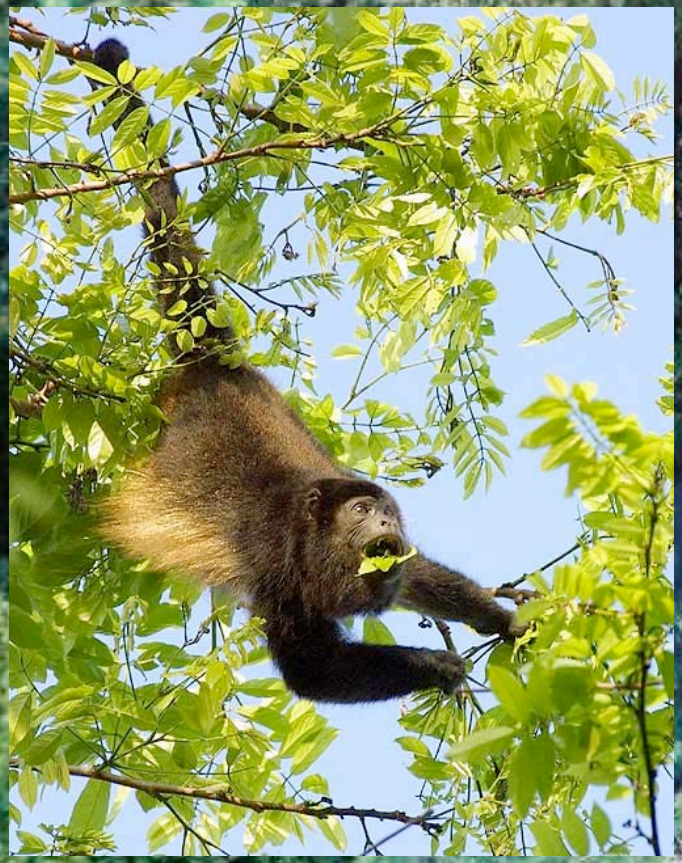


“A man, a plan, a canal. Panama”

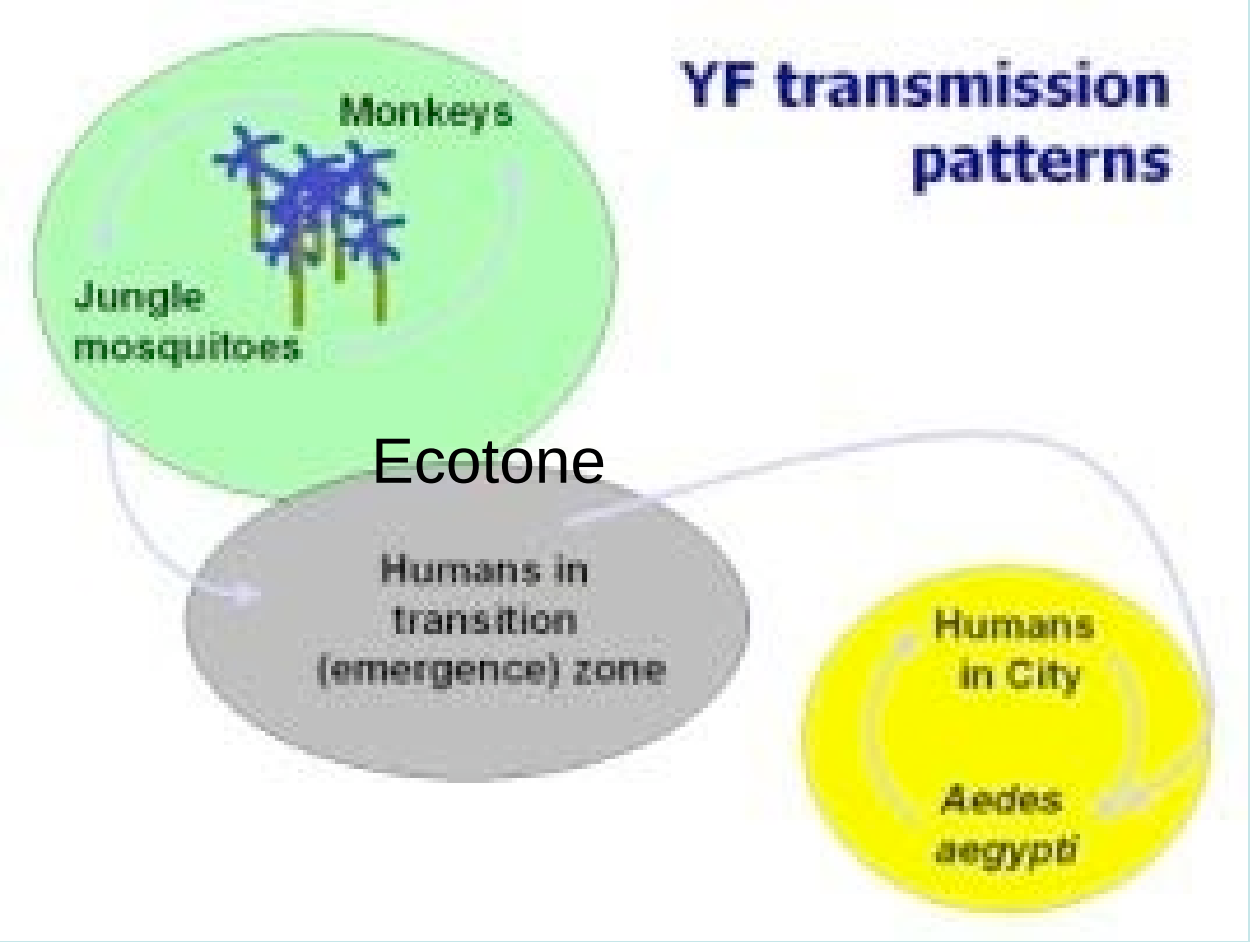

Aedes aegypti
the yellow fever mosquito
Copyright © 1995 Leonard E. Munstermann

Panama Canal: The Early days

Canopy Transmission
By *Haemogogus sp.*

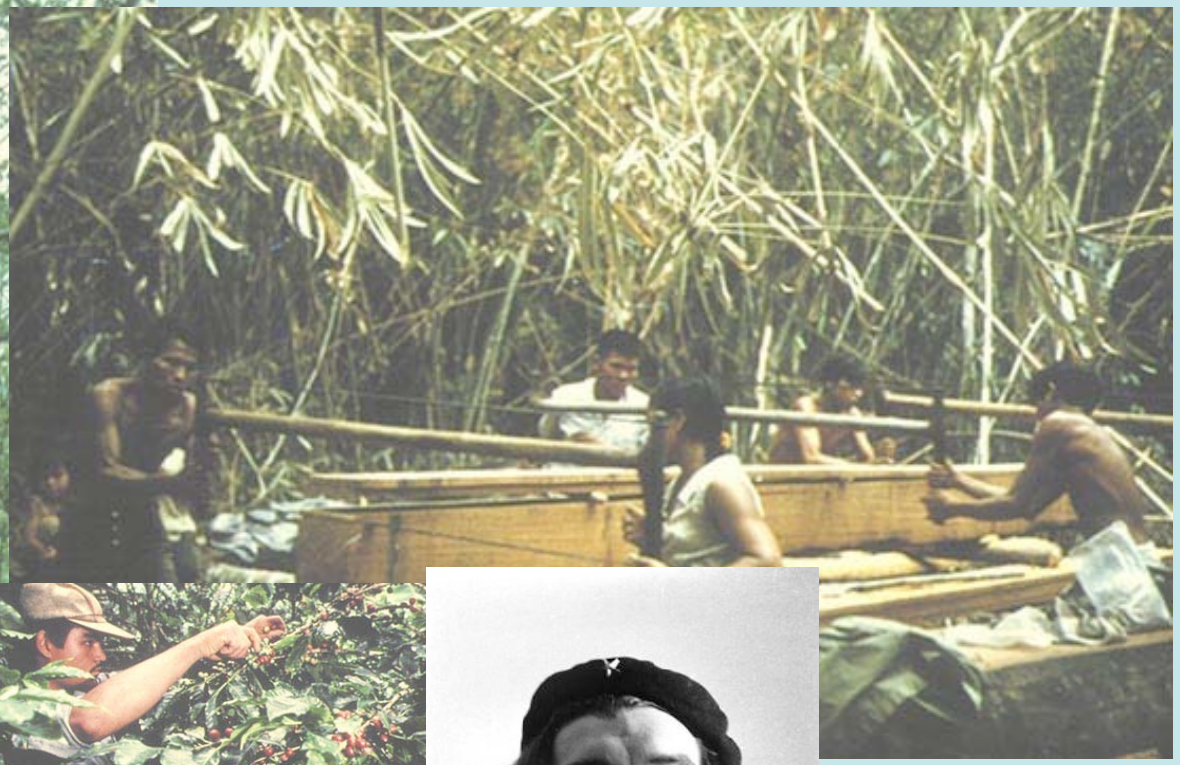


Ecology of Transmission Of Yellow Fever



Occupations at High Risk

Rubber

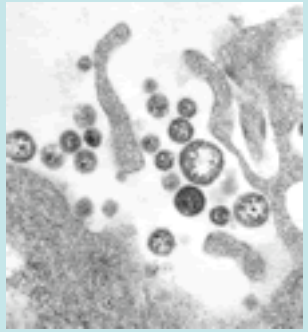


Sugar cane

Coffee

Insurgent

Lassa fever




0 100 200 300 400 mi
0 200 400 600 km
MAURITANIA
Sénégal
MALI
NIGER
SENEGAL
THE GAMBIA
Gambia
Niger
Lake Chad
GUINEA-BISSAU
BURKINA FASO
White Volta
NIGERIA
Black Volta
BENIN
Niger
GUINEA
TEMNE
SIERRA LEONE
KPELLE
MENDE
MANO
GOLA
LIBERIA
CÔTE D'IVOIRE
Bandama
GHANA
Lake Volta
TOGO
FON
EWE
NUPE
Benue
YORUBA
NORTHEAST IGBO
MBEMBE
CAMEROON
EDO
IGBO
YAKO
Cross
EFIK
KALABARI
BIOKO
ASHANTI
AVIKAM
ALAGYA
FANTI
Gulf of Guinea
Average annual rainfall
mm in
500 20
1,500 60
3,000 120
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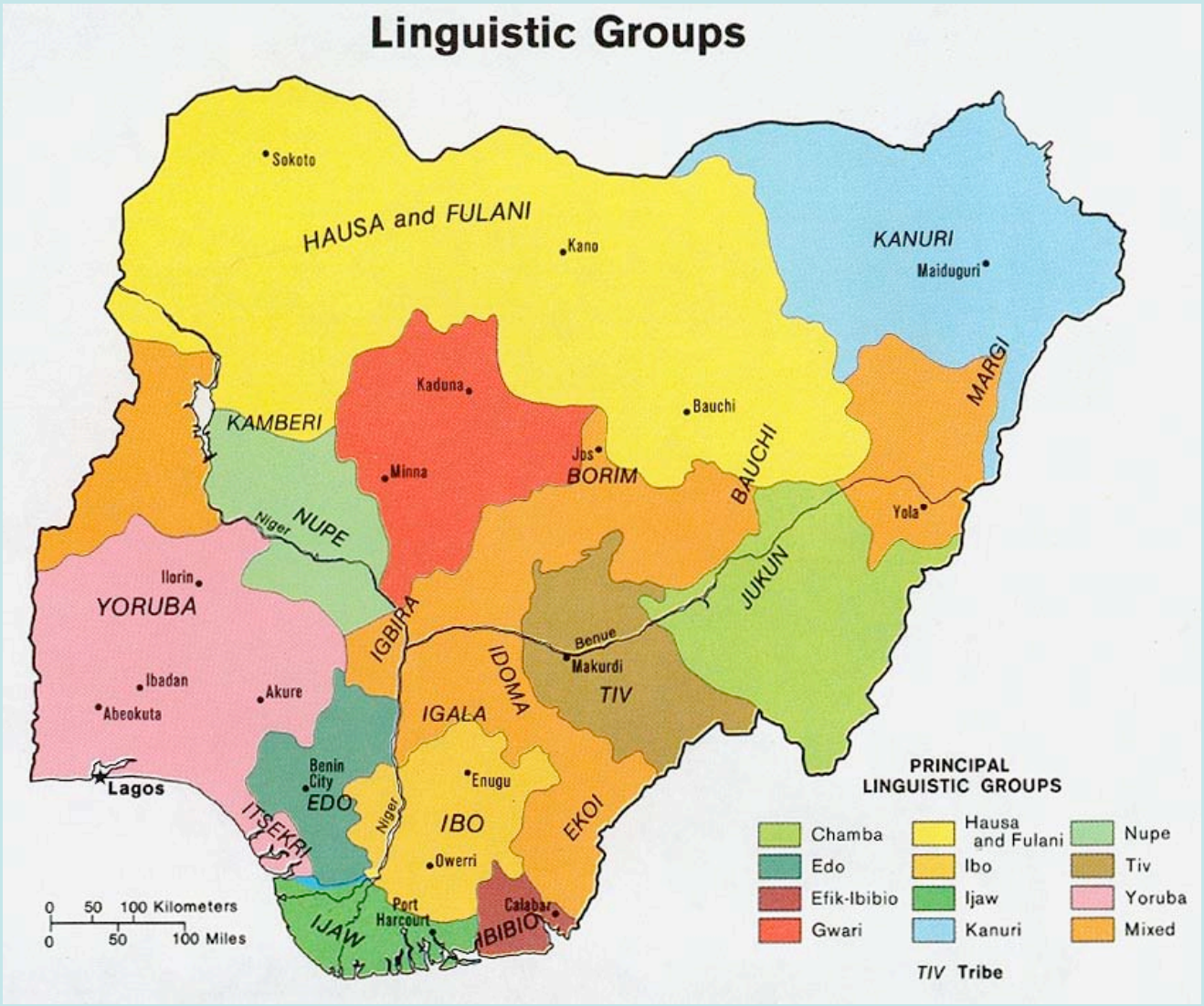
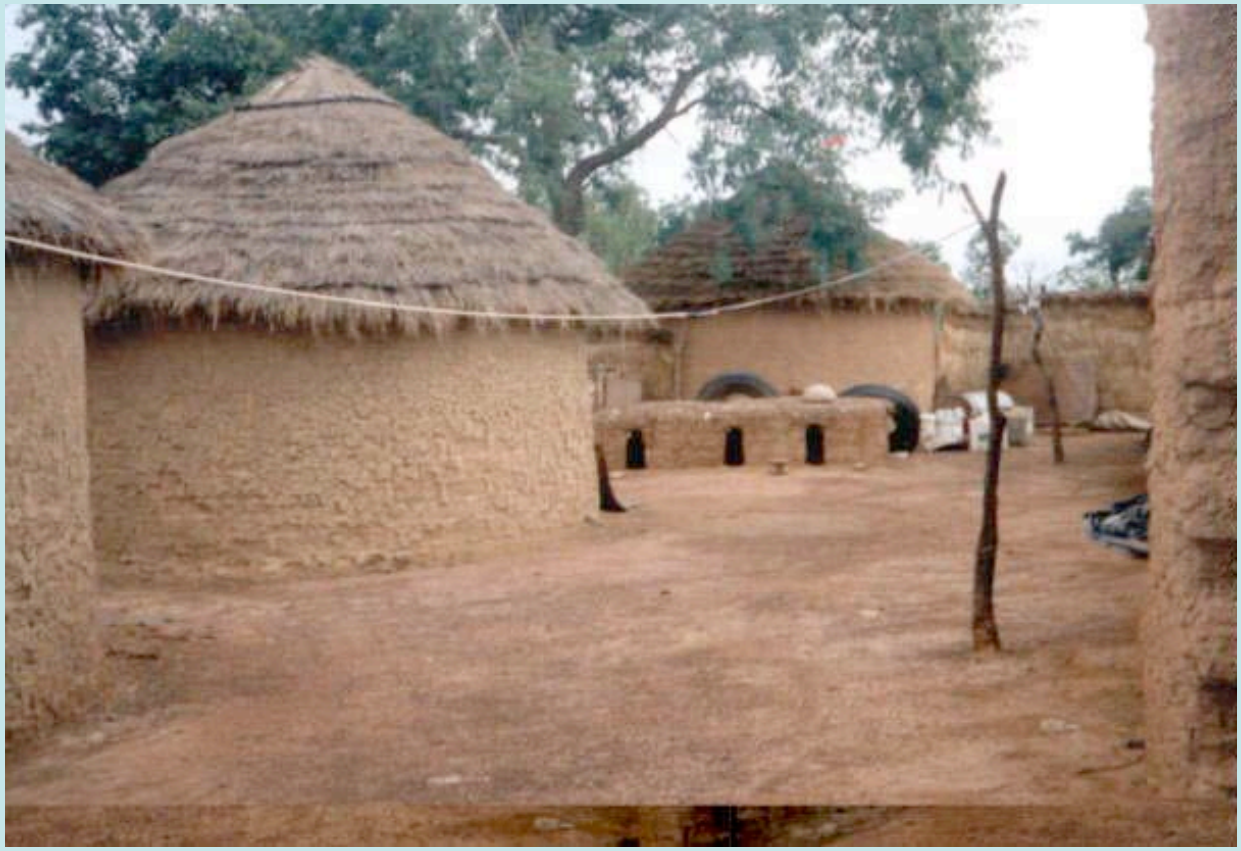
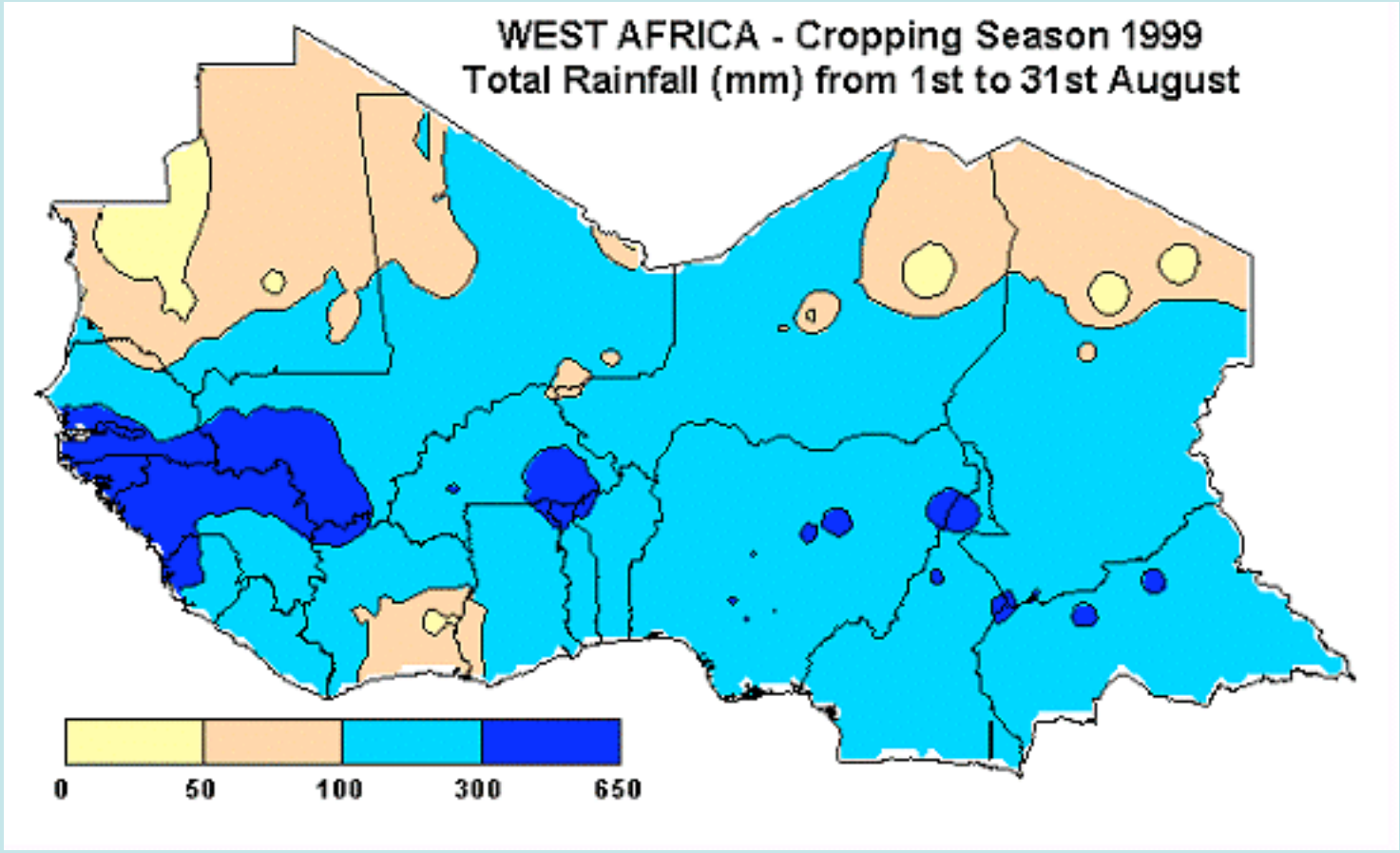
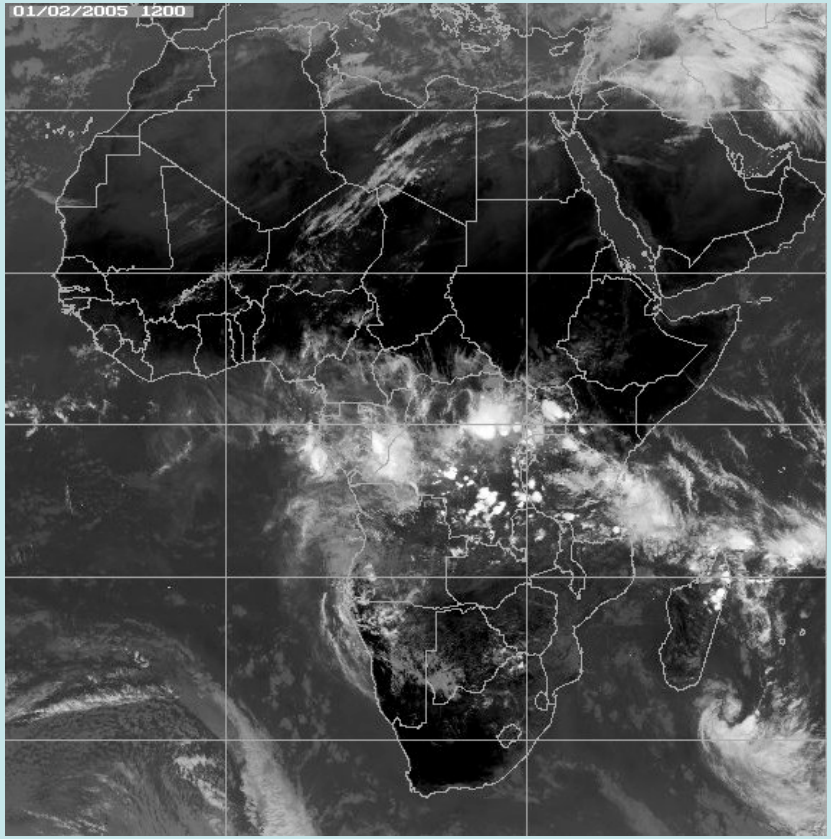
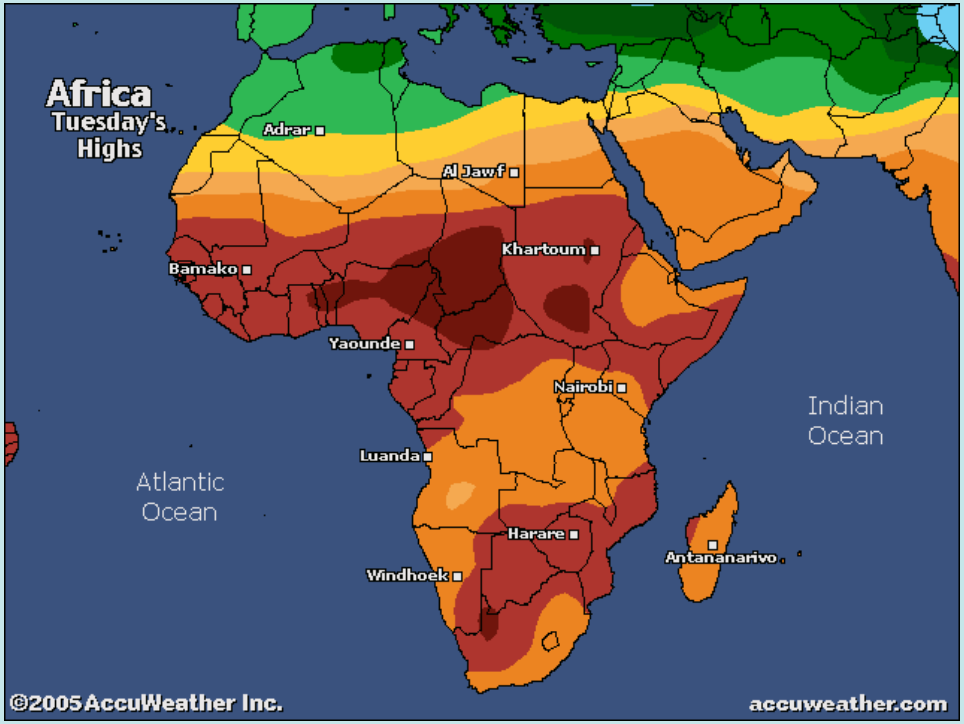

Linguistic Groups
Sokoto
HAUSA and FULANI
Kano
KANURI
Maiduguri
MARGI
Kaduna
Bauchi
KAMBERI
Jos
BORIM
BAUCHI
Minna
Yola
Niger
NUPE
Ilorin
YORUBA
JUKUN
IGBIRA
Benue
Makurdi
IDOMA
TIV
Ibadan
Akure
Abeokuta
IGALA
Benin City
Enugu
Lagos
EDO
IBO
EKOI
ITSEKIRI
Niger
Owerri
Port Harcourt
Calabar
IJAW
IBIBIO
0 50 100 Kilometers
0 50 100 Miles
PRINCIPAL LINGUISTIC GROUPS
Chamba
Hausa and Fulani
Nupe
Edo
Ibo
Tiv
Efik-Ibibio
Ijaw
Yoruba
Gwari
Kanuri
Mixed
TIV Tribe




WEST AFRICA - Cropping Season 1999
Total Rainfall (mm) from 1st to 31st August
0
50
100
300
650


01/02/2005 1200


Africa
Tuesday's
Highs
Adrar
Al Jawf
Khartoum
Bamako
Yaounde
Nairobi
Luanda
Harare
Windhoek
Antananarivo
Atlantic
Ocean
Indian
Ocean
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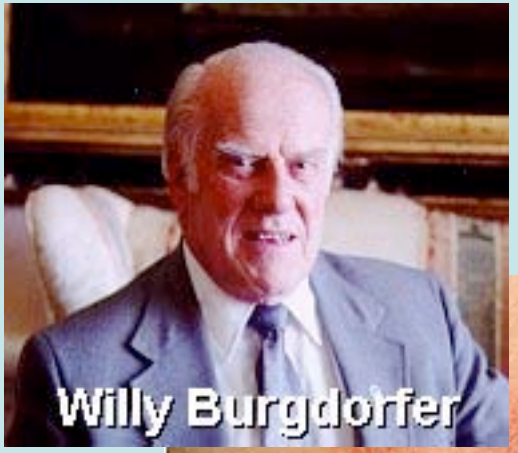
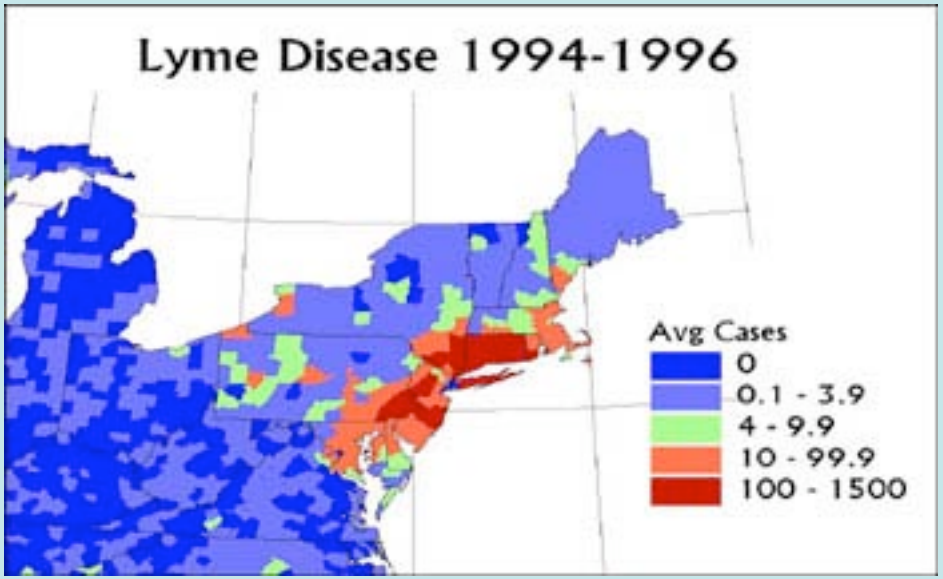
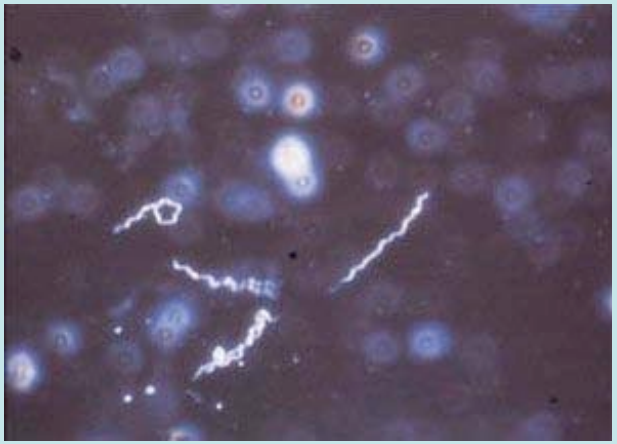
Lyme Disease



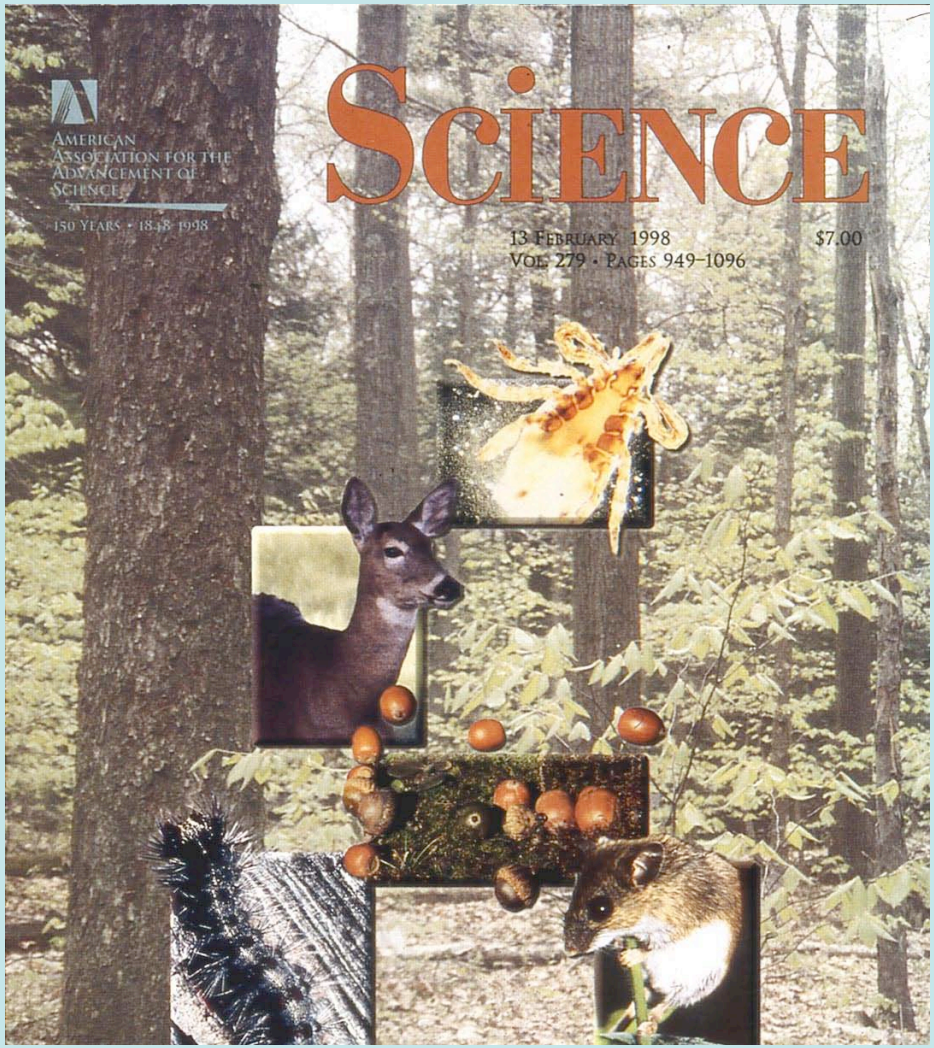
Ixodes scapularis



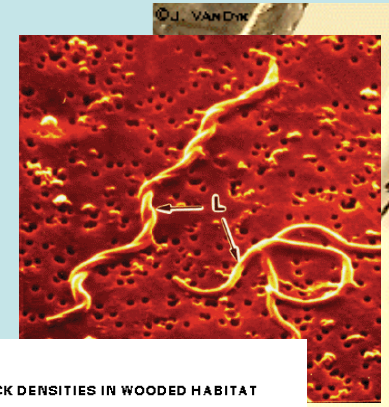


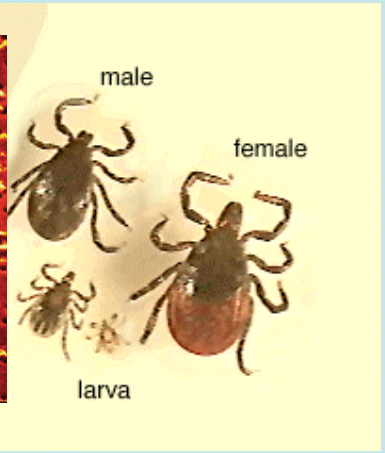
Borrelia burgdorferi

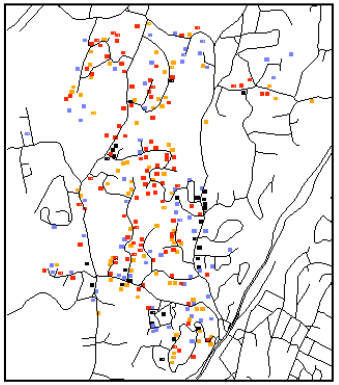
Lyme Disease Maintenance: Urbanization and De-forestation



Westchester County, NY



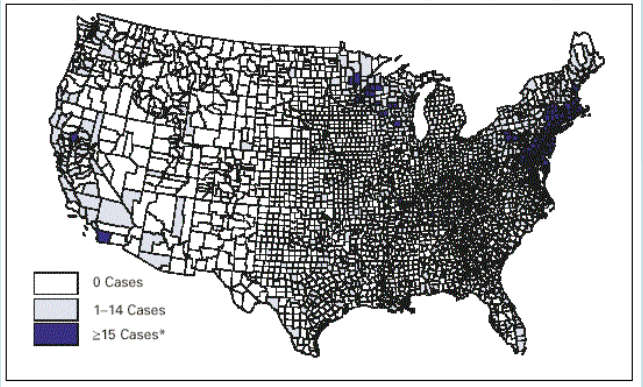




TICK DENSITIES IN WOODED HABITAT
ON RESIDENTIAL PROPERTIES (N = 274)
IN CHAPPAQUA, NEW YORK

HIGH (>5 TICKS/50M2)
LOW (>0, <=5 TICKS/50M2)
NO TICKS
NO WOODS

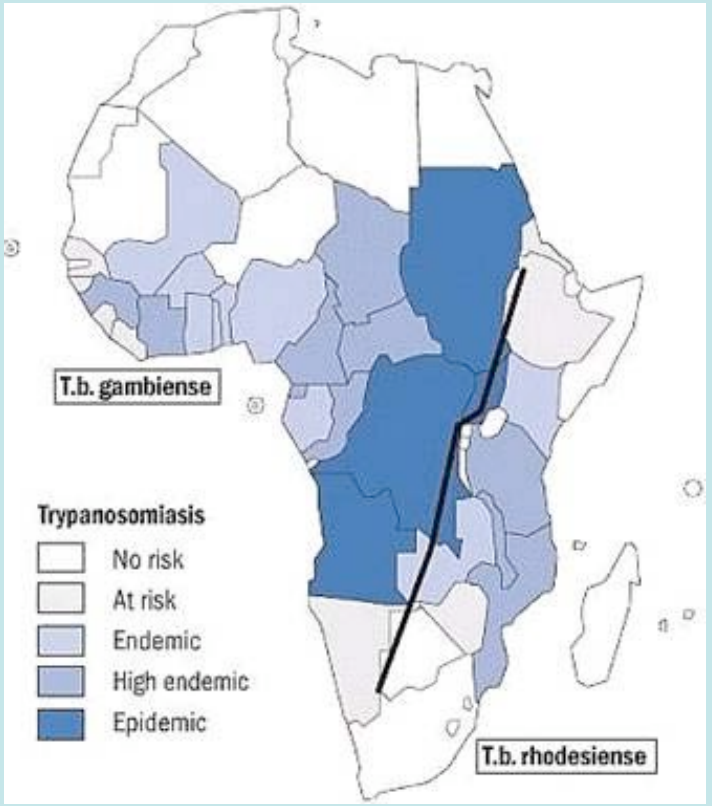
Field data provided by D. Frank (NYMC)
and D. Fish (Yale School of Medicine)

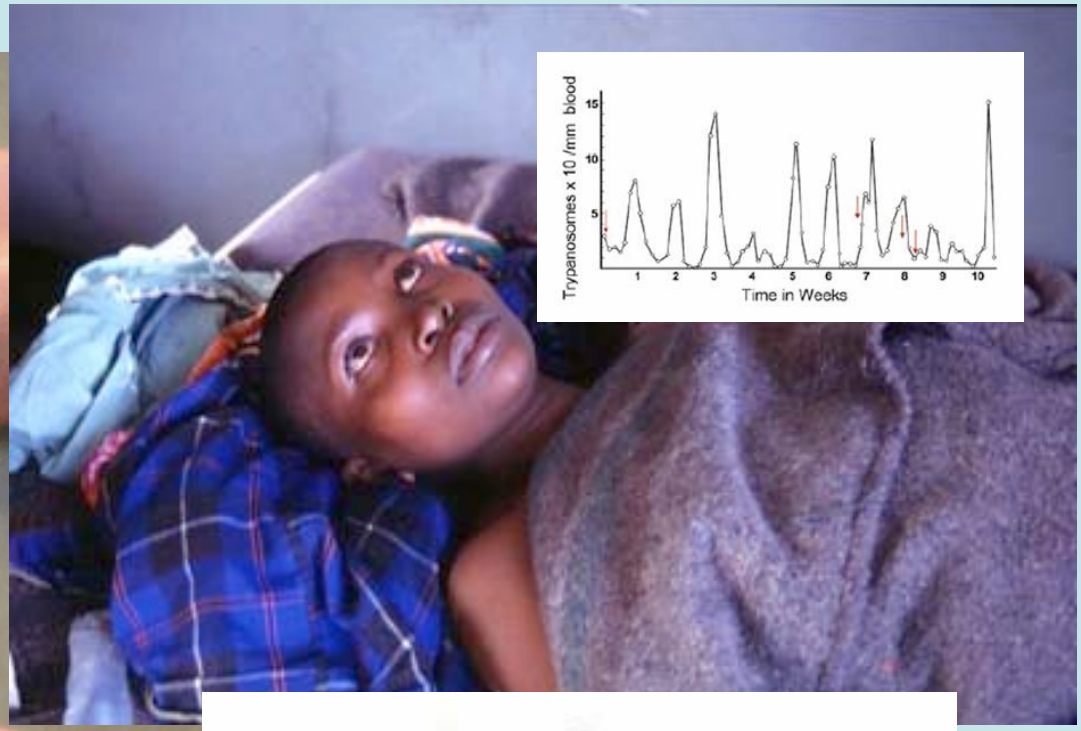


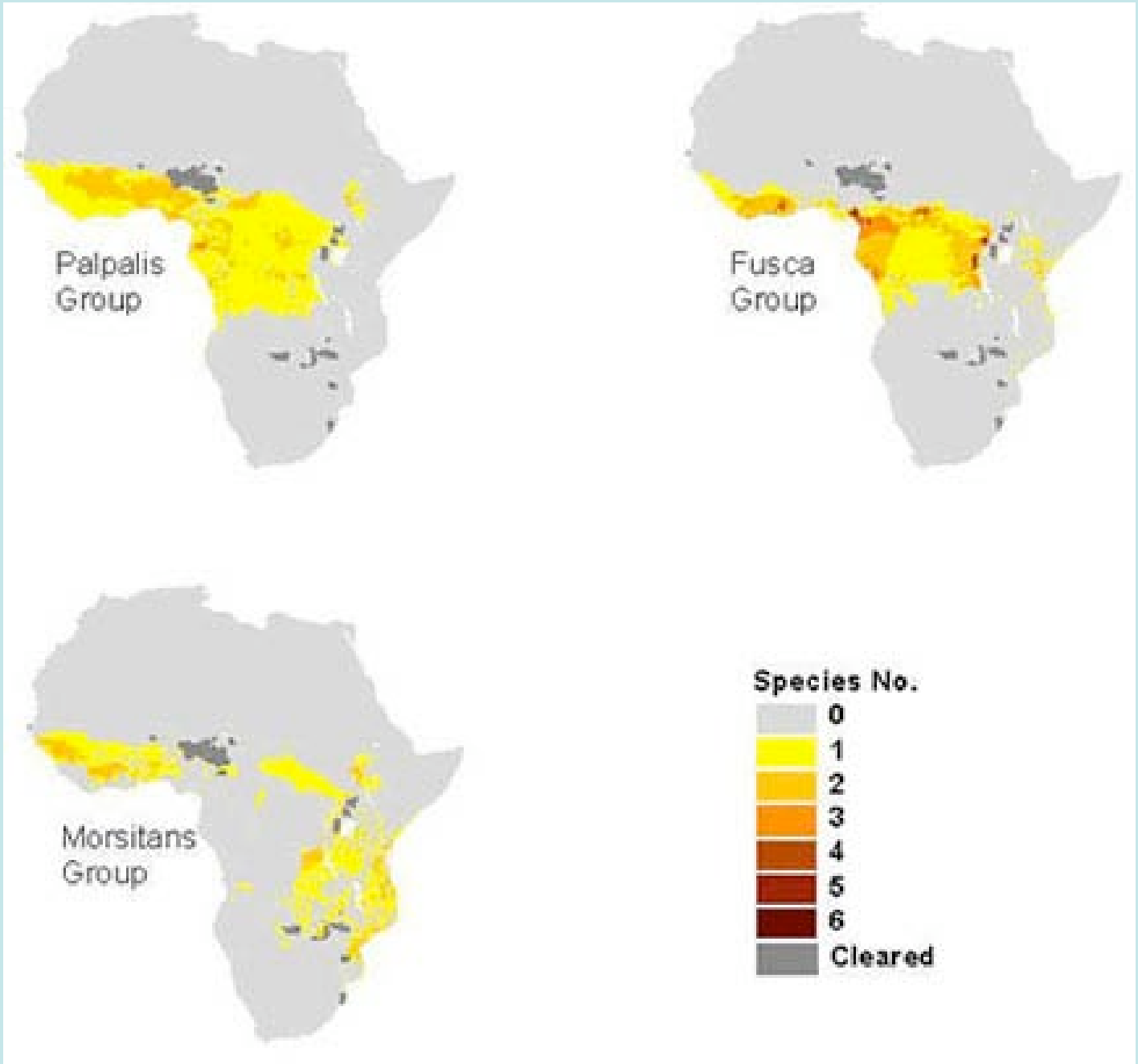
*Total number of cases from these counties represented 90% of all cases reported in 1999.

CHAART

African Trypanosomiasis




Trypanosomes x 10 /mm blood
15
10
5
1
2
3
4
5
6
7
8
9
10
Time in Weeks


Palpalis
Group
Fusca
Group
Morsitans
Group
Species No.
0
1
2
3
4
5
6
Cleared

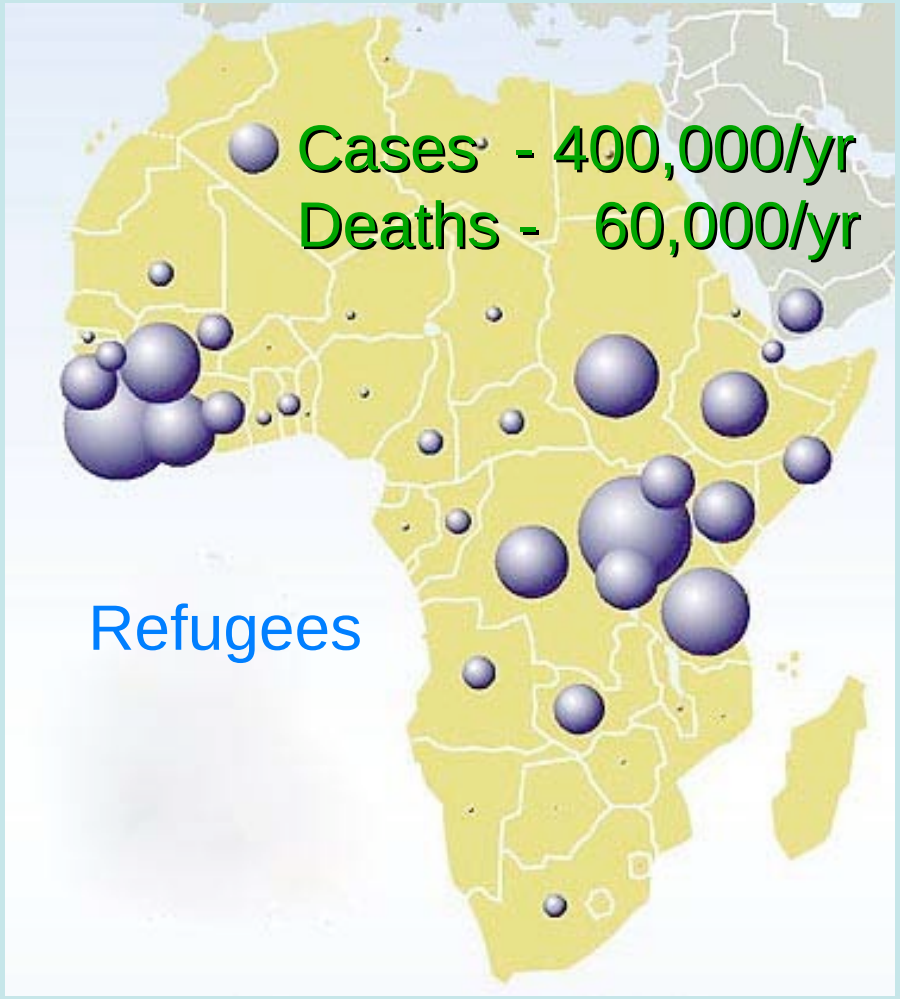
East African Savanna

West African River

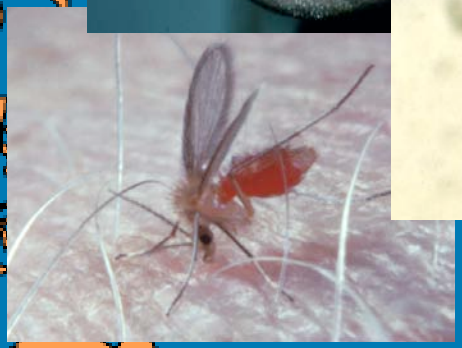
Riverine Tsetse and agriculture

Civil Unrest and War - 2005

Liberia
Côte-d'Ivoire
Sudan
Ethiopia
Nigeria
Sierra Leone
Guinea
Ghana
Burundi
Burkina Faso
Cameroon
Gambia
Rwanda
Swaziland
Mauritania
Zambia
Central African Republic
Namibia
Democratic Republic of Congo



Leishmaniasis

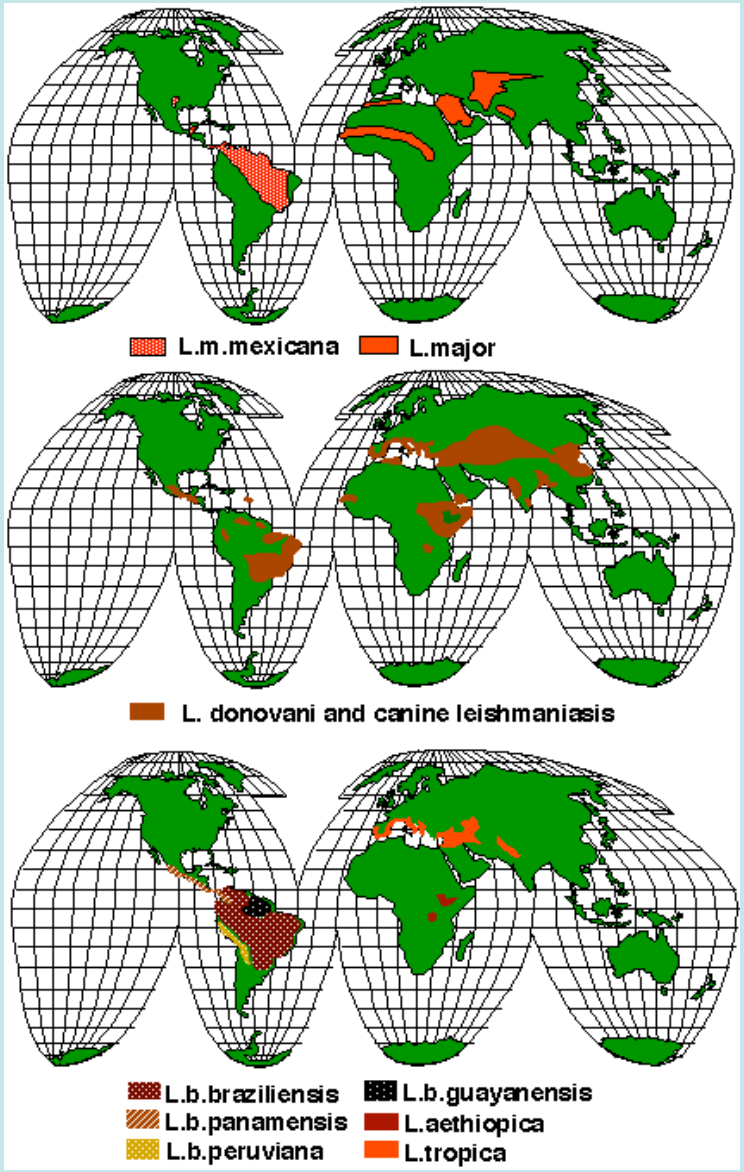


12 million people infected

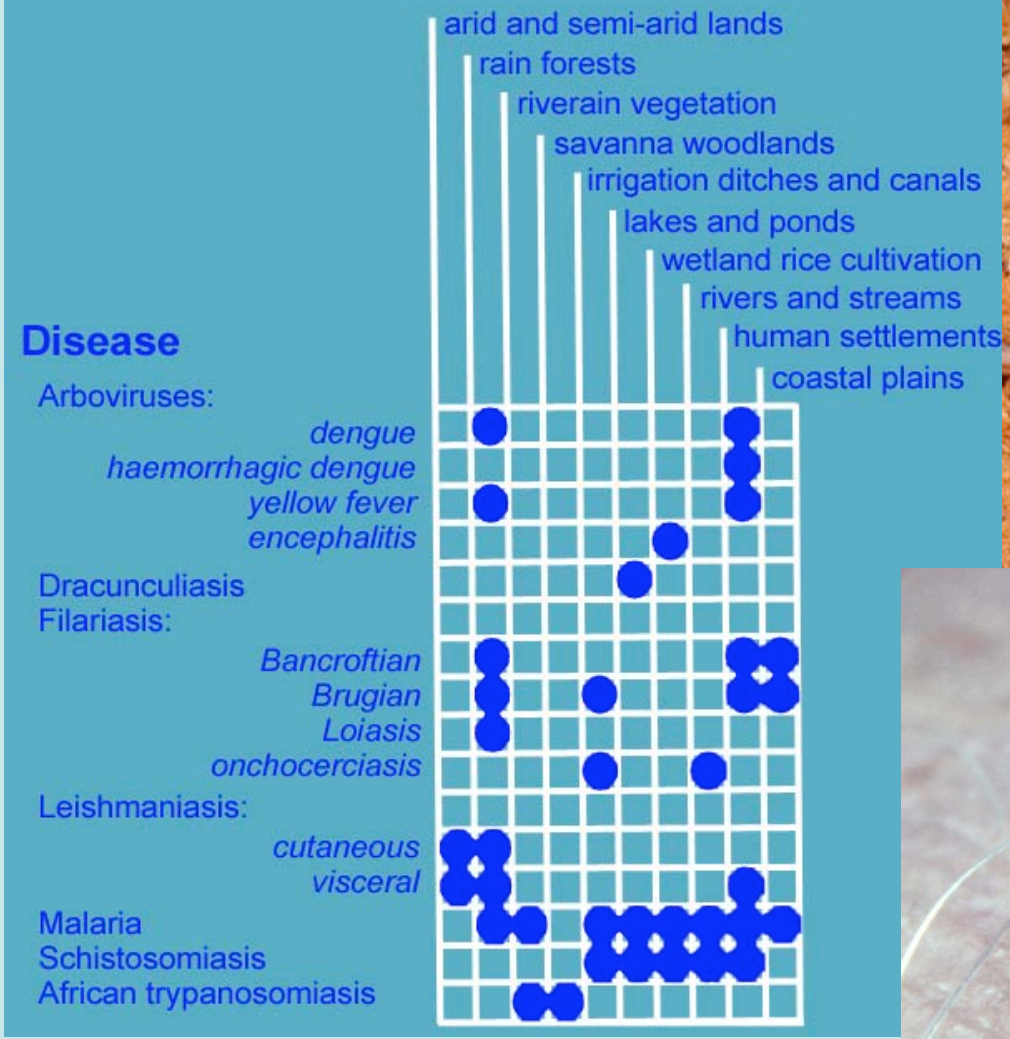
350 million people at risk

Visceral

Cutaneous / Mucocutaneous


L.m.mexicana
L.major
L. donovani and canine leishmaniasis
L.b.braziliensis
L.b.panamensis
L.b.peruviana
L.b.guayanensis
L.aethiopica
L.tropica

The principle diseases in relation to the principle habitats of the vectors

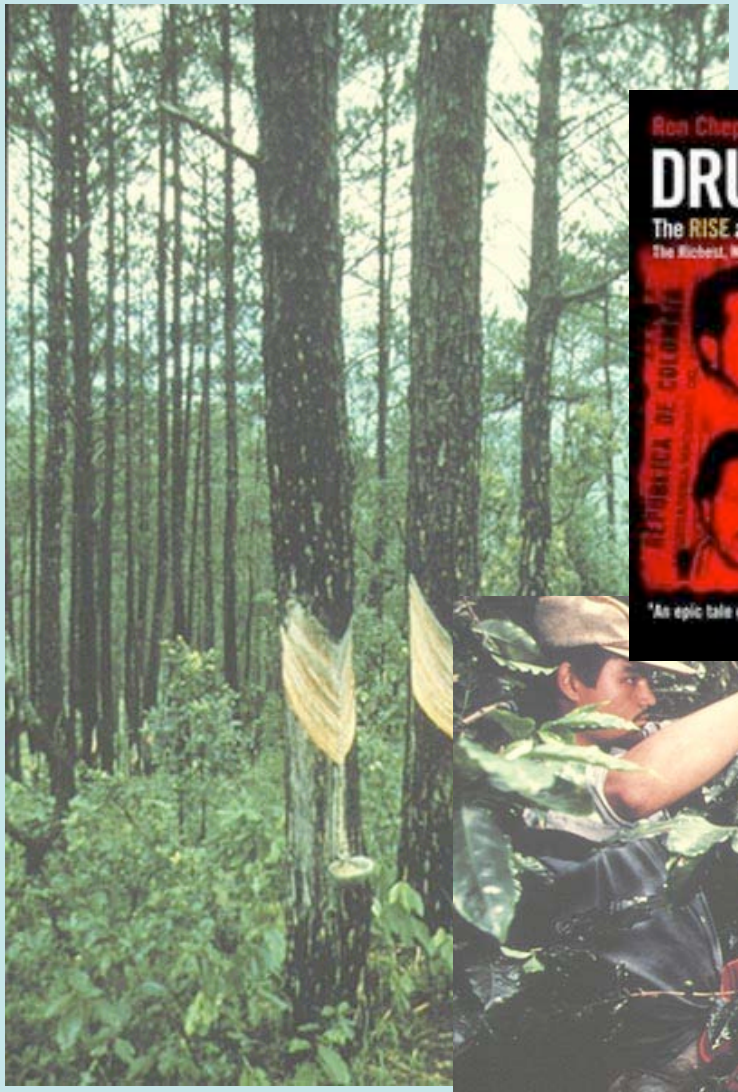


Rodent Holes and Sandfly Habitat

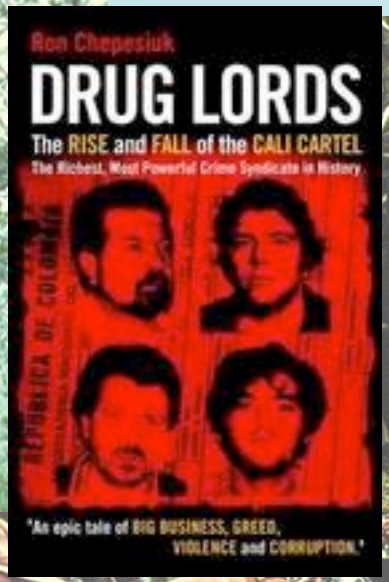
Reservoir Hosts

Encroachment and Vector-borne Diseases

Occupations at Risk



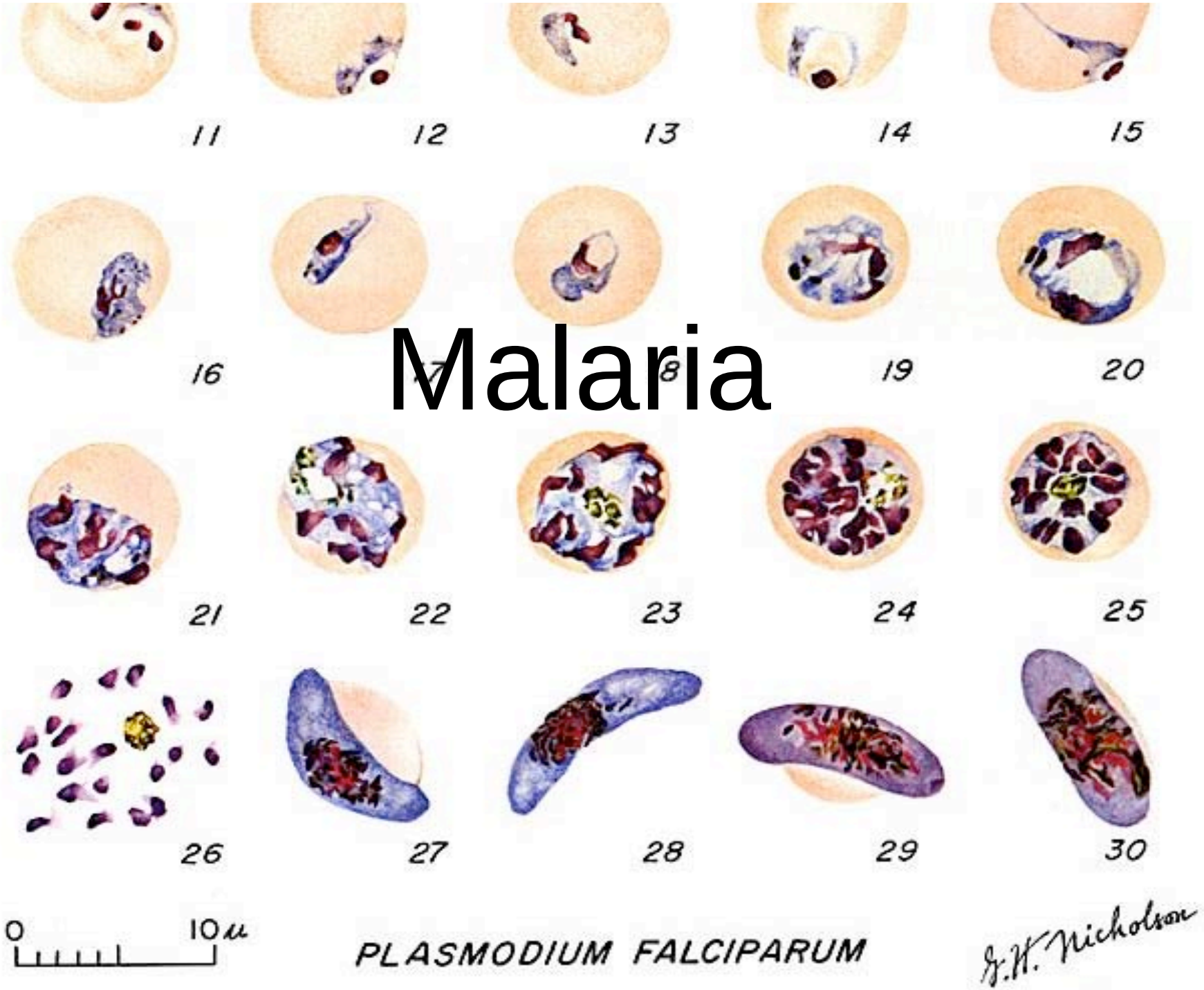
Rubber



Sugar cane

Coffee

Malaria


11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
0
10 μ
PLASMODIUM FALCIPARUM
J. H. Nicholson


80%

Some Important Vectors

Anopheles gambia

Anopheles dirus

Anopheles balabacensis

Oasis habitat

Marsh habitat

Irrigation Canal Habitat

Swampland Habitat

Rice Paddy Habitat

What’s Next?

Without an ecological perspective
on infectious disease transmission,
its anyone's guess!