The spread of viral and parasitic diseases due to climate change

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Anthropogenic climate change

- Today's life styles are energy dependent and energy intensive.
- For example in 2004 the daily global consumption for petroleum was 82.6 million barrels/ day

Climate change

- The interaction of the atmosphere, oceans, terrestrial and marine biosphere, cryosphere and land surface determine the Earth's surface climate
- Atmospheric concentration of greenhouse gases which include carbon dioxide, methane and nitrous oxides and increasing mainly due to human activity

Global warming

- An increase in green house gases leads to increased warming of the atmosphere and the Earth's surface

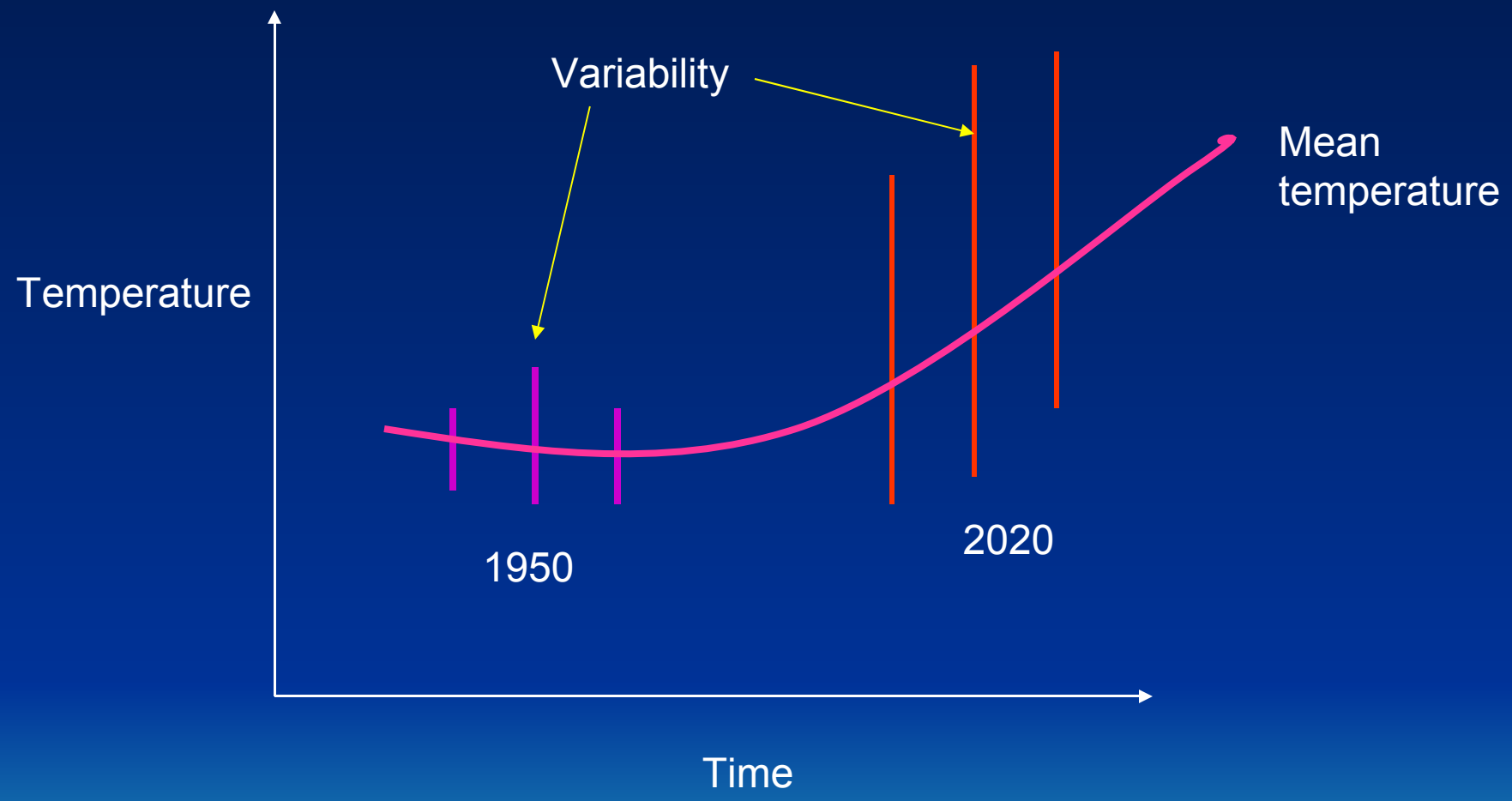
- In the 20th Century the global average temperature increased by 0.6±0.2 ^{o}C.

- 1990's was the warmest decade with 1998 being one of the warmest years in the instrument record since 1861

Characteristics of global warming

- Climate variability is a measure of the departure from the mean climate. The departure from the mean is predicted to increase
- Mean climate change is the persistent increase in the mean values of climate and these can be positive or negative

Climate change and variability



Vectors and climate

- Arthropod vectors cannot regulate their internal temperature.
- Their internal temperature is critically dependent on external temperature
- External changes in temperature has a direct effect on metabolic and development rates of arthropod vectors and pathogens

Pathogens and environmental temperature

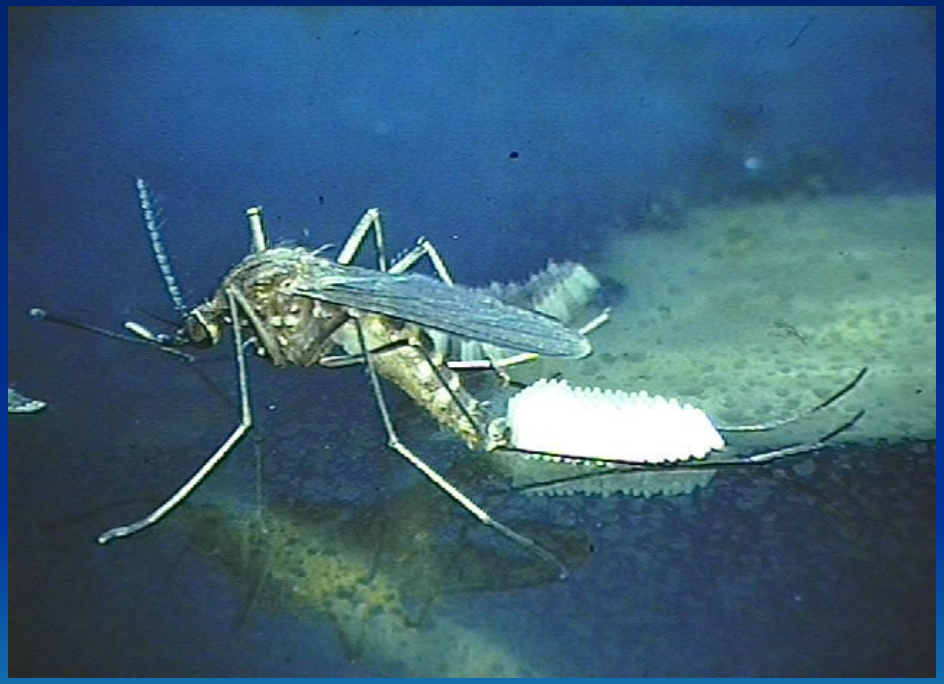
- The rate of parasite and virus development in insects such as mosquitoes and ticks is dependent on environmental temperatures
- The warmer it is the faster the parasites and virus develop.
- This leads to a high populations of infected insects and ticks

Anopheles malaria vector

Sand fly: Leishmania vector

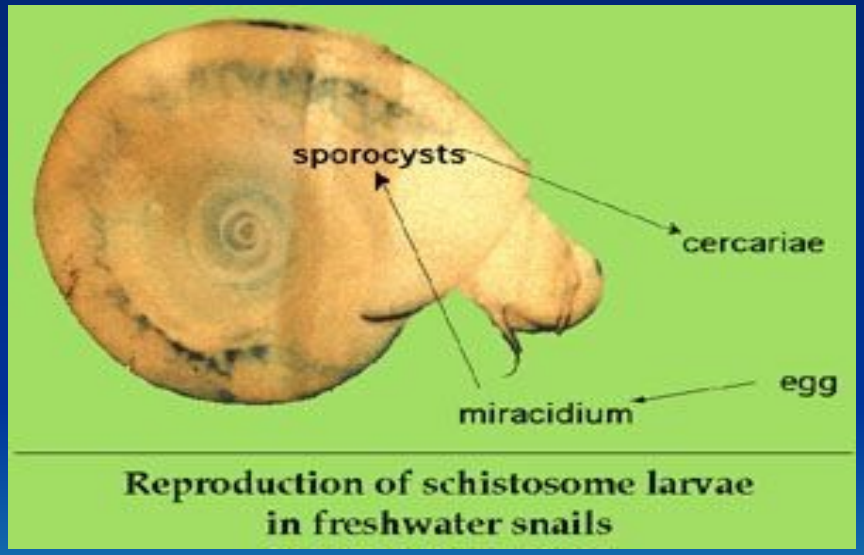
Aedes: dengue, Rift Valley, Yellow fever vector

Culex: Filariasis, West Nile virus vector



Ticks: Lyme disease vector

Snail: Schistosomiasis vector



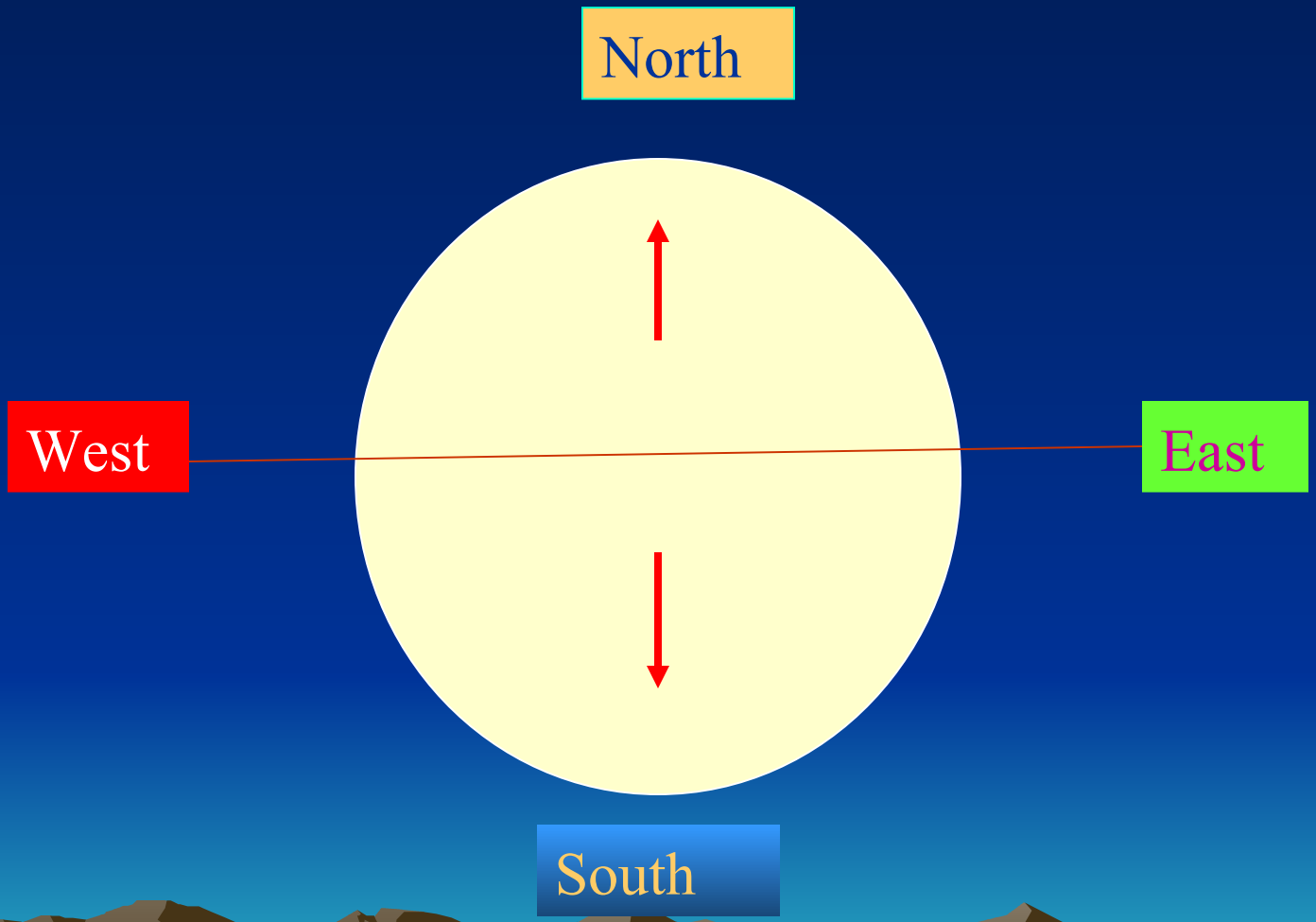
Effects of temperature on disease transmission

- For many diseases the lower range of transmission is 14-18 ^{o}C
- The upper limit is 35-40 ^{o}C
- Warming above the lower limit can increases disease transmission
- Warming above the upper limit can decrease transmission

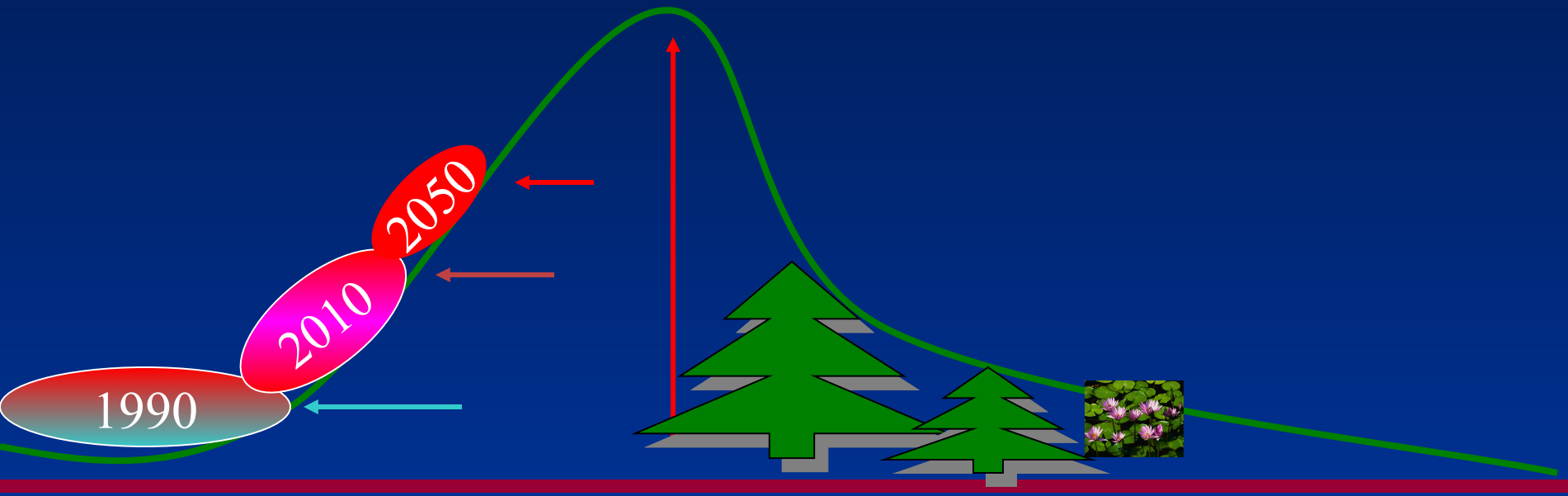
Effects of climate change of VBDs

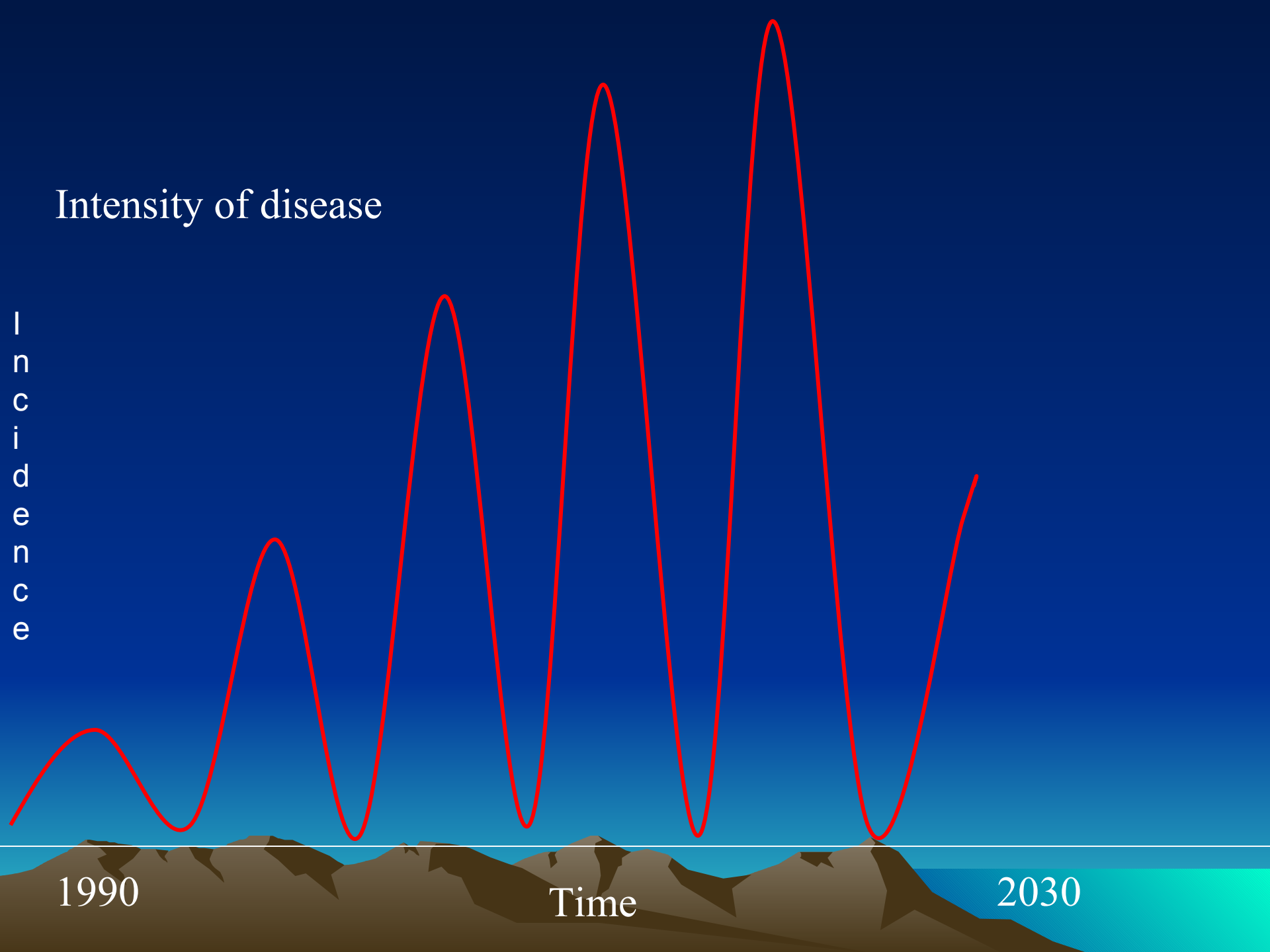
- Increased latitudinal range
- Increased altitudinal range
- Intensified transmission at the fringe areas (areas close to the outer boundary of transmission)

Latitudinal shift in disease and vectors



Latitudinal shift in vectors and diseases




Intensity of disease
Incidence
1990
Time
2030

Regional distribution of climate sensitive VBDs: Africa

Very climate sensitive

Malaria

Rift Valley Fever

Less climate sensitive

Leishmaniasis

Typanosomiasis

Filariasis

Plague

Yellow Fever

Schistosomiasis

Tick borne fevers

Current effect of climate change in Africa

Malaria epidemics in the African highlands are associated with El Nino

Shift of malaria transmission to new sites at high altitude in the highlands

Rift Valley Fever epidemic associated with El Nino

North America

Wide spread

- Lyme disease
- West Nile Fever

Restricted

- Rocky Mountain Spotted Fever
- Dengue
- Pulmonary hantavirus syndrome
- St. Louis encephalitis
- La Cross encephalitis
- Western eastern and Venezuelan encephalitis

Current effect of climate change in North America

- West Nile Fever epidemics associated with very warm Summers
- St. Louis encephalitis outbreaks correlates with extended periods above 30^{o}C
- Pulmonary hantavirus epidemic associated El Nino events (heavy precipitation)

Europe

Widespread

- Lyme disease

Restricted

- Malaria

- Leishmaniasis

Current effect of climate change in Europe

- Northward movement of the tick *ixodes ricinus* in Sweden
- Several cases of co-infection of HIV and Leishmaniasis reported in France, Spain and Portugal
- Sporadic cases of local malaria transmission in Eastern Europe

Asia, Australia and the Islands West of the Pacific

Asia

Dengue

Malaria

Australia

Ross river virus

Barmah Forest Virus

Murray Valley Virus

Current effect of climate change in Asia and Australia

- Dengue and malaria incidence associated with El Nino Southern Oscillation index, which is correlated with wet and hot weather

- Arbovirus infections in Australia associated with heavy rains and flooding

South America

- Malaria
- Leishmaniasis
- Dengue Fever
- Chaga's diseases
- Schistosomiasis
- Plague
- Arboviruses (Yellow Fever, Oropouche Fever)

Current effect of climate change in South America

- The El Nino phenomenon intensifies the annual cycle of malaria cases for *Plasmodium vivax* and *Plasmodium falciparum* in endemic areas of Colombia

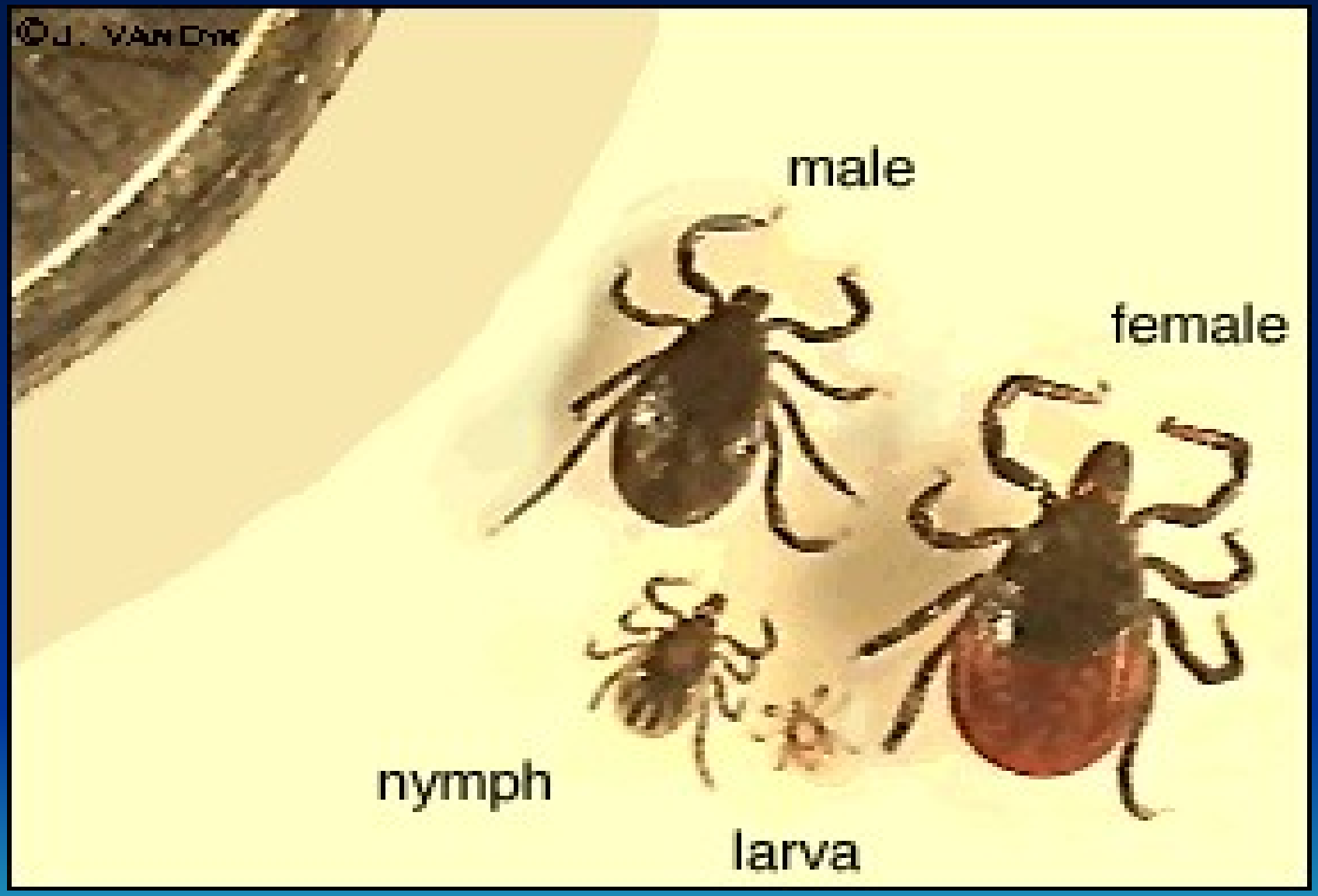
- The El Nino phenomenon increases the number of Leishmaniasis in Colombia

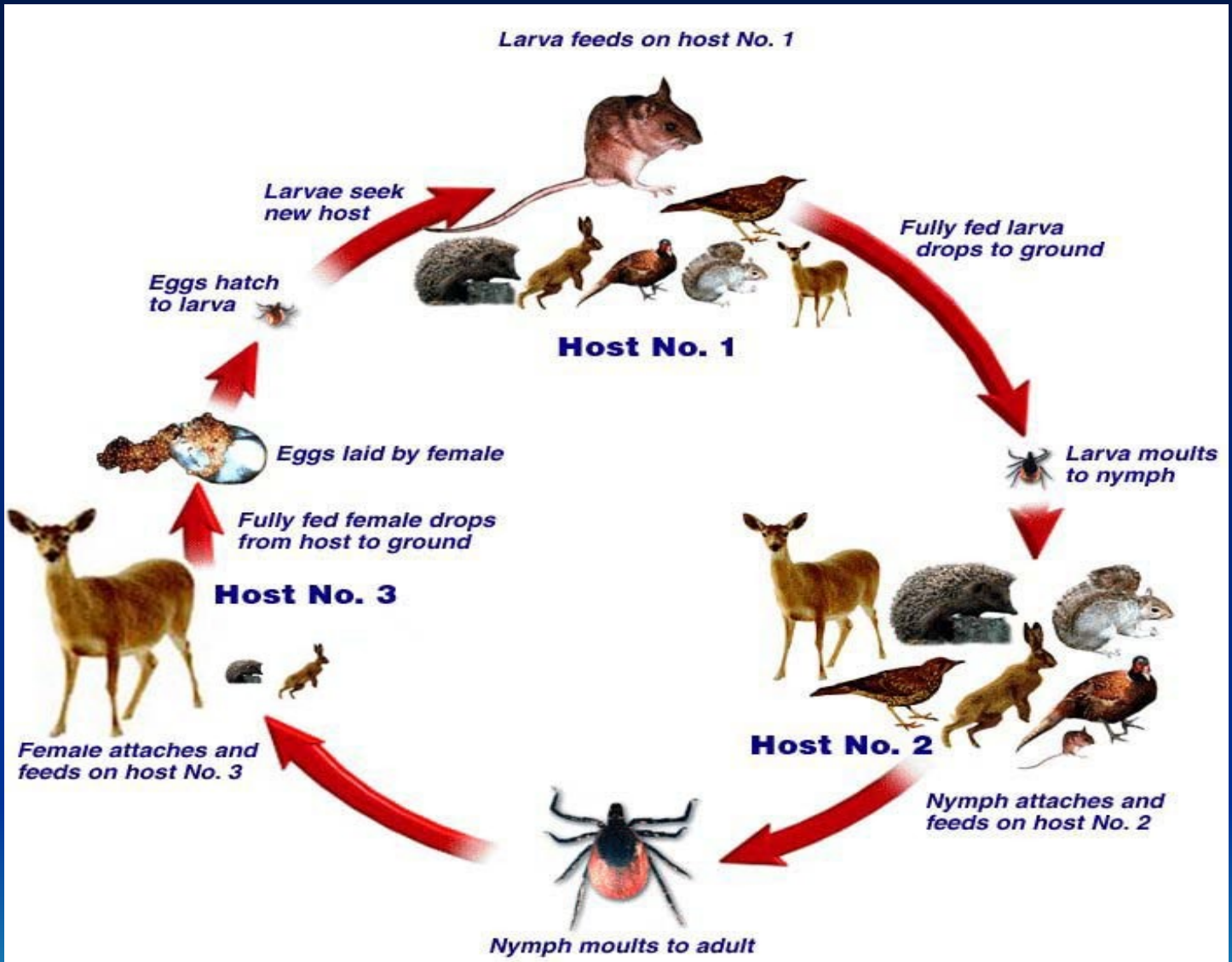
Case studies

Lyme disease

West Nile Fever

Malaria


male
female
nymph
larva



The relative size of the animals approximates their significance as hosts for the different tick life cycle stages in a typical woodland habitat.

Courtesy of Dr Jeremy Gray and Bernard Kaye

Lyme disease

- ***Lyme borreliosis*** is the most common vector-borne zoonotic disease in the Northern Hemisphere. The infection is caused by the spirochetes ***Borrelia burgdorferi***
- ***Lyme borreliosis*** occurs throughout Europe and is particularly prevalent in the east.

Lyme disease

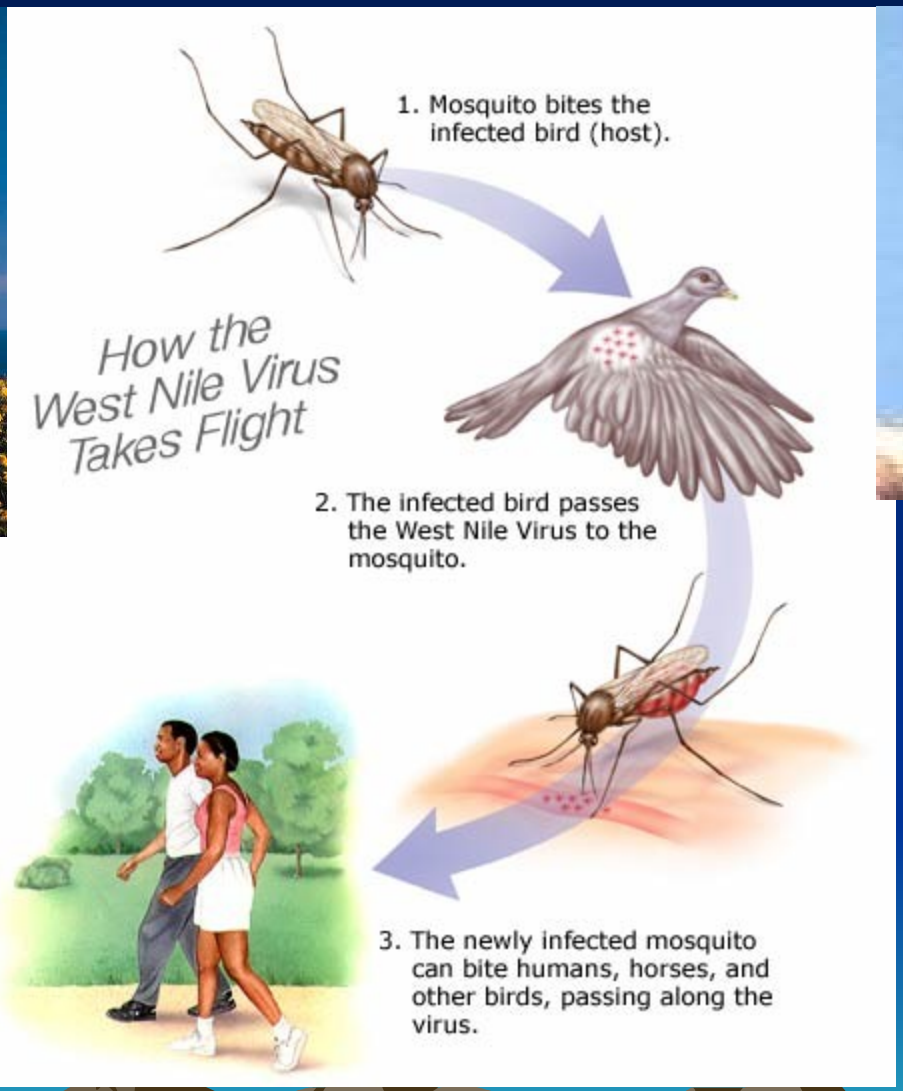
- The risk of ***Lyme borreliosis*** in Canada may be but more geographically widespread than previously suspected.

- ***Lyme borreliosis is*** an emerging bacterial zoonotic and vector-borne disease in the United States

Lyme disease

- In Northeastern USA, significant correlations were observed between warmer and wetter winters, 2 years prior to disease incidence
- This may have been due to higher survival of the white-footed mouse, the main host for Lyme disease-infected ticks and enhanced nymph tick survival in wetter conditions

WEST NILE FEVER



West Nile Fever

- Previous to1996 West Nile Fiver was sporadic infection that occurred in Europe Africa and Asia
- This has now changed
- In 1996, the first major West Nile Fever epidemic in Europe occurred in Romania, with a high rate of neurological infections

West Nile Fever

- In 1999 the biggest numbers of clinical cases of West Nile Fever were registered in Volgograd and Astrakhan regions of Russia
- In 1999 West Nile (WN) virus was detected in the metropolitan New York City (NYC) area during the summer and fall. Sixty-two human cases, 7 fatal, were documented.

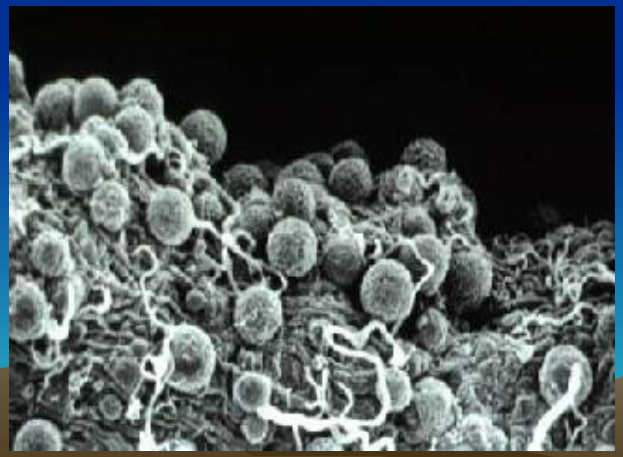
West Nile Fever

- By 2002 surveillance reports indicated that the virus had spread south and west USA affecting 42 States and the District of Colombia
- In 2002 the West Nile Virus outbreak in Israel appeared after a climatic warning signs.
- Viral outbreaks have been associated with unusually **warm summers**

MALARIA

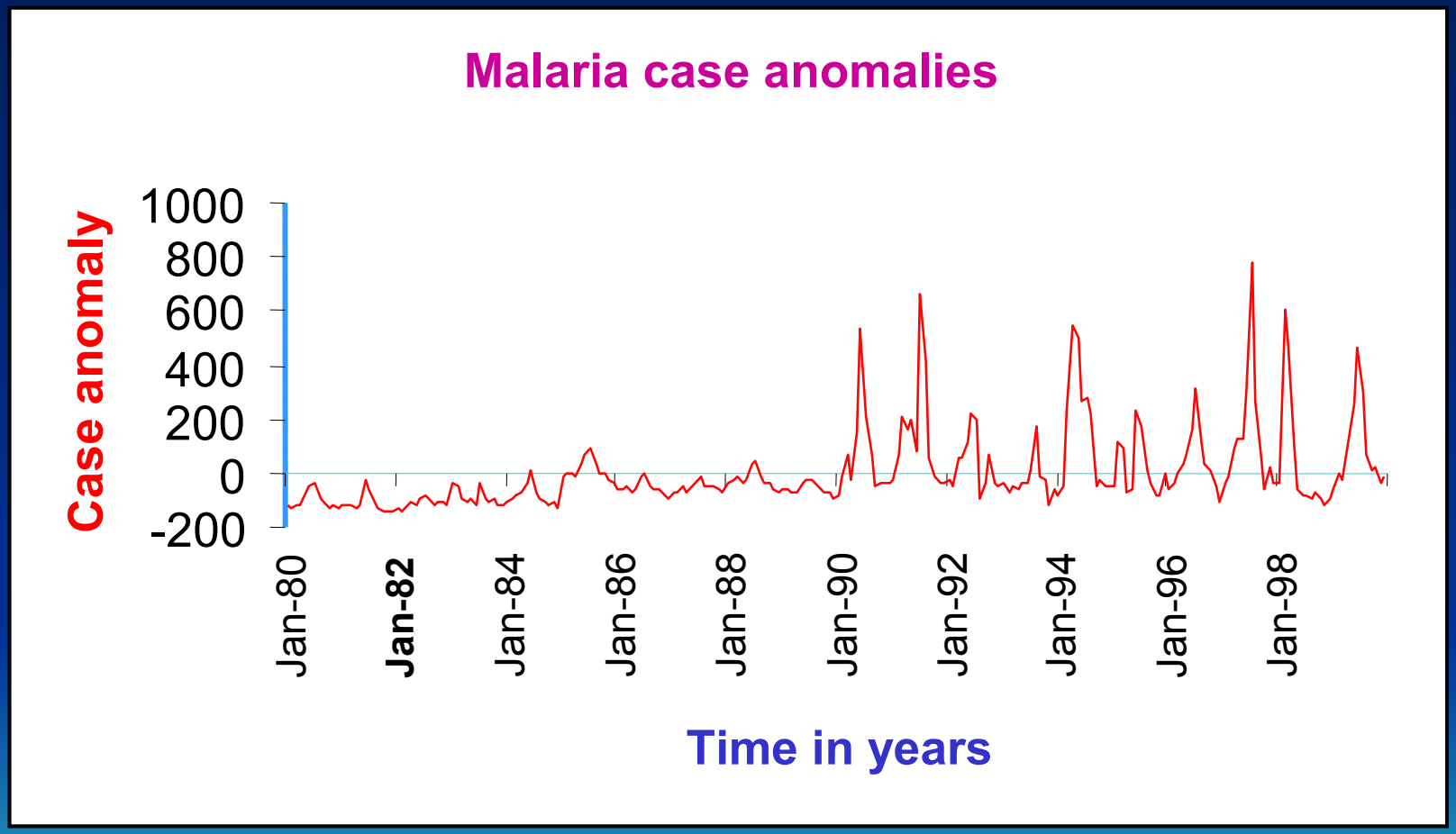
Larvae mature faster

Adults feed more frequently

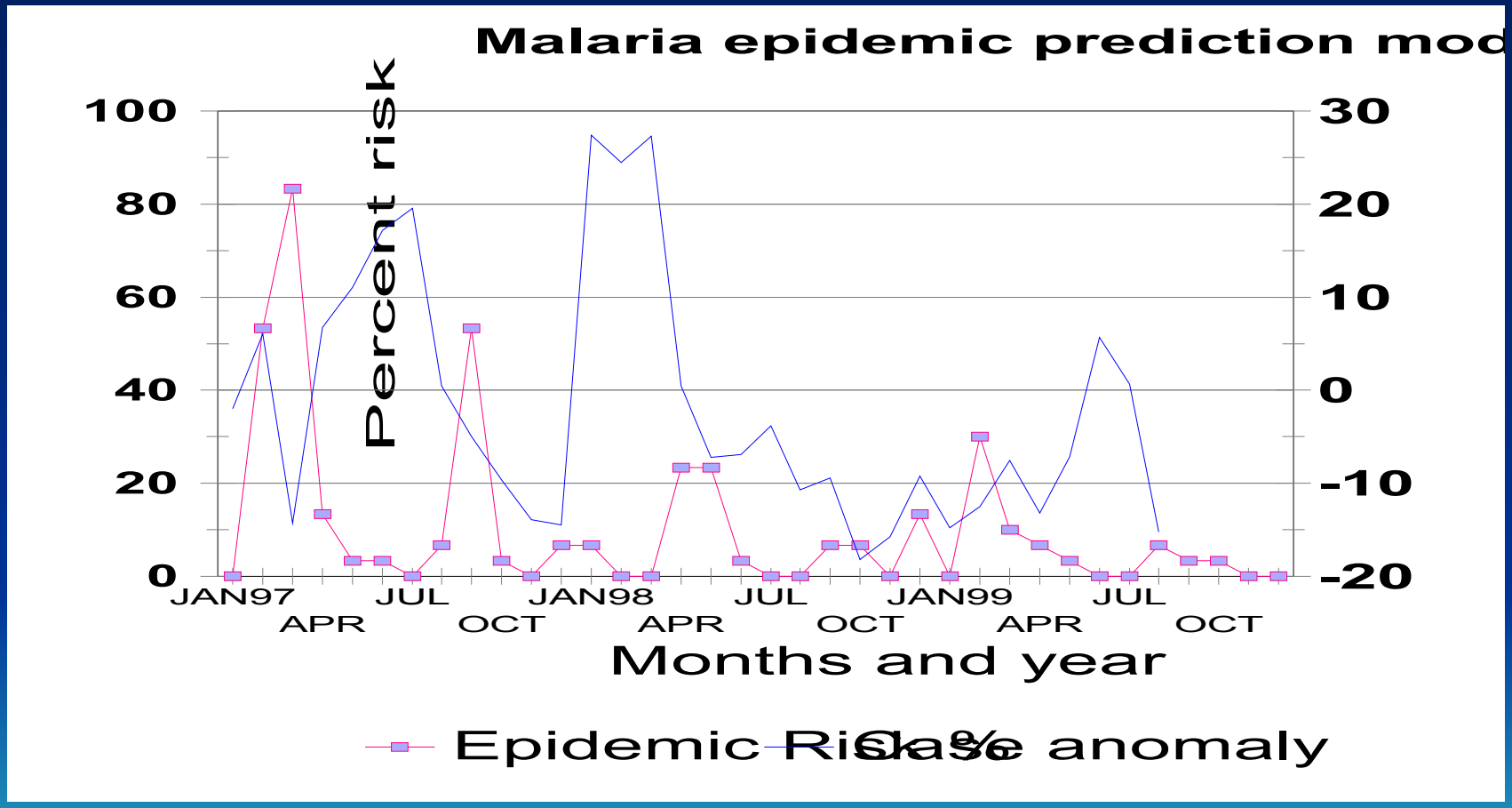


Parasites in mosquitoes develop faster

Malaria case anomalies in Mandy district western Kenya



Malaria epidemics after anomalous temperatures



In Kenya Malaria moves to new areas in Central Highlands

Malaria endemic Western Highlands

Central Highlands

New records of malaria

Acknowledgement

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THANK YOU