Climate change and infectious diseases in Europe

EMERGING, REEMERGING DISEASES IN EU

FACTORS

- Climatic change
- Genetic change of pathogens & vectors
- Increased movements of the population
- Public health problems
- Appearence of „new” pathogens (mostly from animals)

FACTS

- Climate change is indeed tangible: the worldwide mean surface temperature has increased by 0·74 °C (SD 0·18) over the past 100 years, while the worldwide sea level has risen by 1·8 mm per year since 1961, and the Arctic sea ice is retreating by 2.7% per decade.
- In addition, sea surface temperatures are warming, mountain glaciers are shrinking, oceans are becoming more acidic, and extreme weather events are increasing in frequency and intensity.
- These climatic changes have already had noticeable eff ects on many natural systems, including marine and terrestrial ecosystems, such as the timing of seasonal biological events and the distribution of animaland plant species.3

VECTOR-BORNE DISEASES

- Vector-borne diseases are infections transmitted by the bite of infected arthropod species, such as mosquitoes, ticks, triatomine bugs, sandflies, and blackflies
- Arthropod vectors are cold-blooded (ectothermic) and thus especially sensitive to climatic factors
- Weather influences the survival and reproduction rates of the vectors

MOSQUITO-BORNE DISEASES

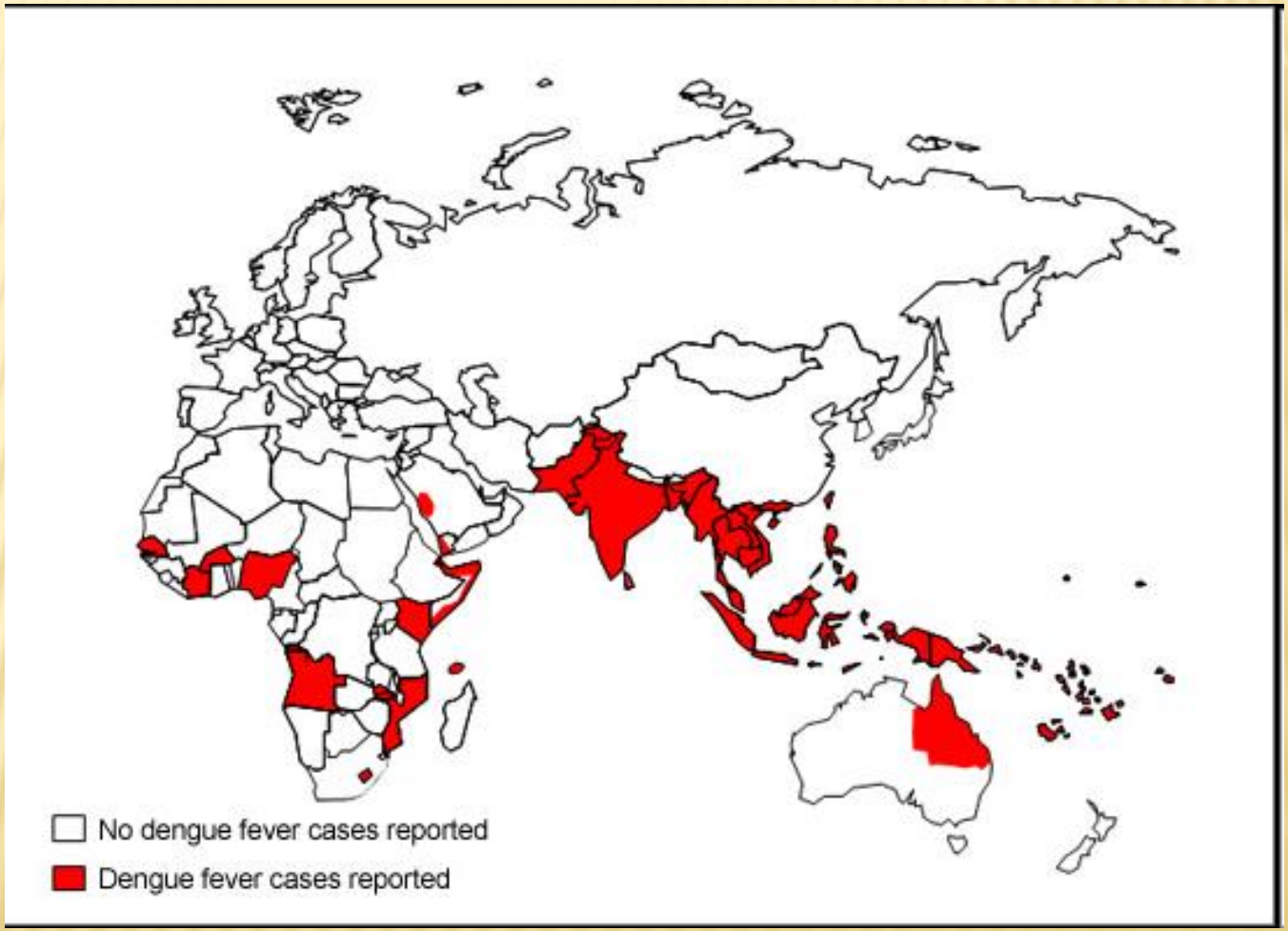
- West Nile fever is caused by the West Nile virus, a virus of the family Flaviviridae that is part of the Japanese encephalitis antigenic group.
- West Nile fever mainly infects birds and infrequently human beings through the bite of an infected *Culex spp mosquito.*
- Since roughly 80% of cases are asymptomatic, the rate of West Nile virus infections in human beings remains largely unknown, and probably only some of the epidemics with tens or hundreds of West Nile fever cases have been documented

WEST NILE FEVER

- Past entomological data have been linked to meteorological data to model a West Nile fever outbreak in southern France in 2000.
- The aggressiveness of the vector (*Culex modestus) was positively correlated with temperature and* humidity, and linked to rainfall and sunshine, which were particularly high during the epidemic period.

DENGUE VIRUS INFECTION

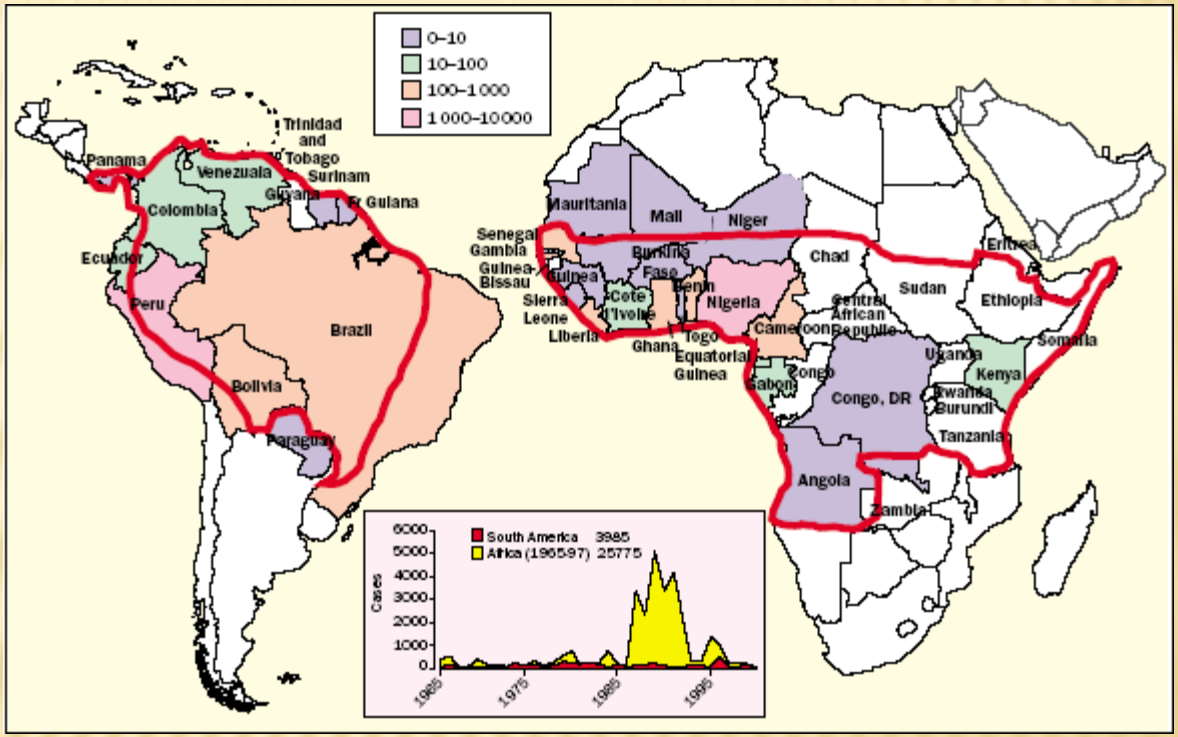
- Dengue is the most important worldwide arboviral human disease; however, mainly due to nearly universal use of piped water, the disease has disappeared from Europe.
- Dengue is frequently introduced into Europe by travellers returning from dengue-endemic countries, but no local transmission has been reported since it would also depend on the reintroduction of its principal vector, the mosquito *Aedes aegypti (also the yellow fever* mosquito), which is adapted to urban environments.
- However, over the past 15 years another competent vector *Aedes albopictus (Asian tiger mosquito) has been* introduced into Europe and expanded into several countries, raising the possibility of dengue transmission.


No dengue fever cases reported
Dengue fever cases reported


No dengue fever cases reported
Dengue fever cases reported

DENGUE RASH AND CONJUNTIVAL HAEMORRHAGE

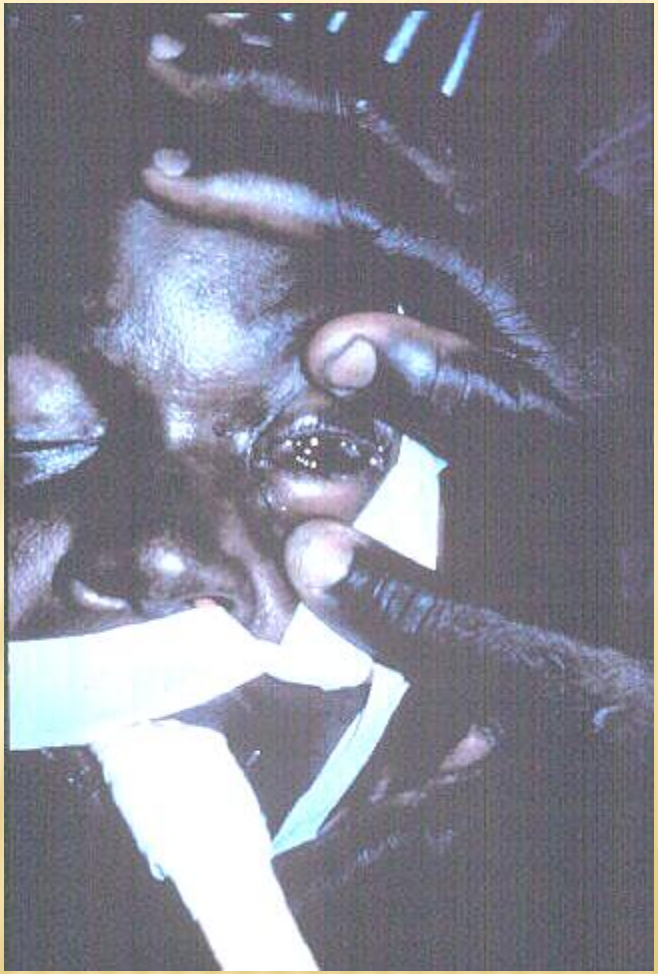
THE DISTRIBUTION OF YF




YELLOW FEVER
Santa Cruz, Bolivia

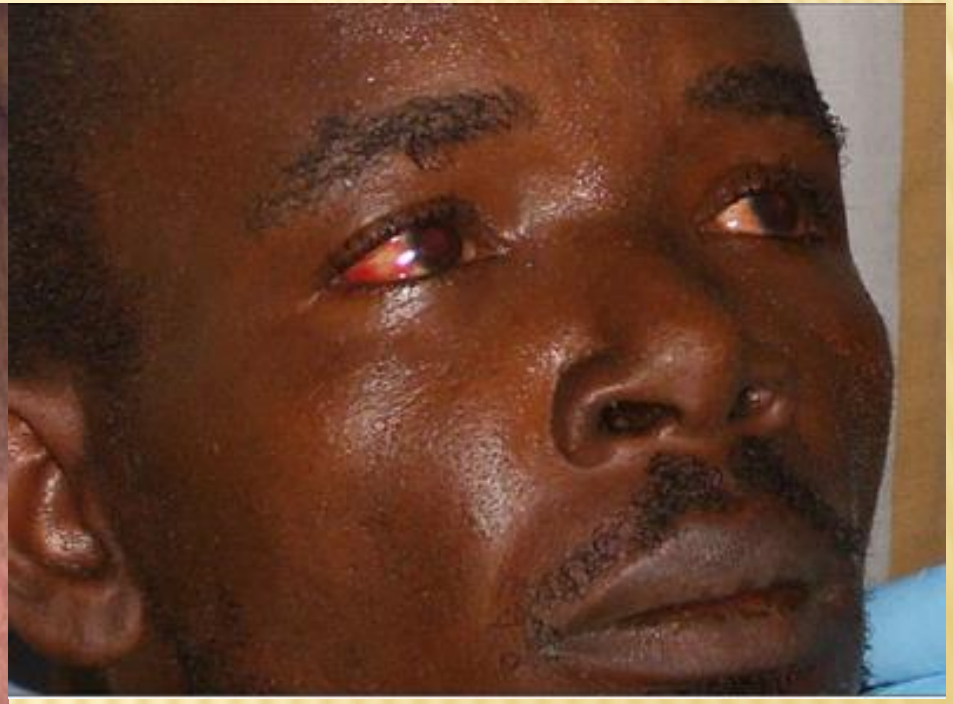
EBOLA VÍRUS

OEDEMA AND CONJUNCTIVITIS (LASSA FEVER)



LASSA FEVER

LASSA FEVER



CHIKUNGUNYA FEVER

- Chikungunya fever is caused by a virus of the genus Alphavirus, in the family Togaviridae, which is transmitted to human beings by the bite of infected mosquitoes such as *A aegypti and A albopictus.*
- A confirmed outbreak of chikungunya fever was reported in August, 2007, in northeastern Italy, the first chikungunya outbreak on the European continent.
- Vector surveillance in the vicinity of the cases identifi ed large numbers of *A albopictus mosquitoes in traps, but* no sandflies or other vectors.

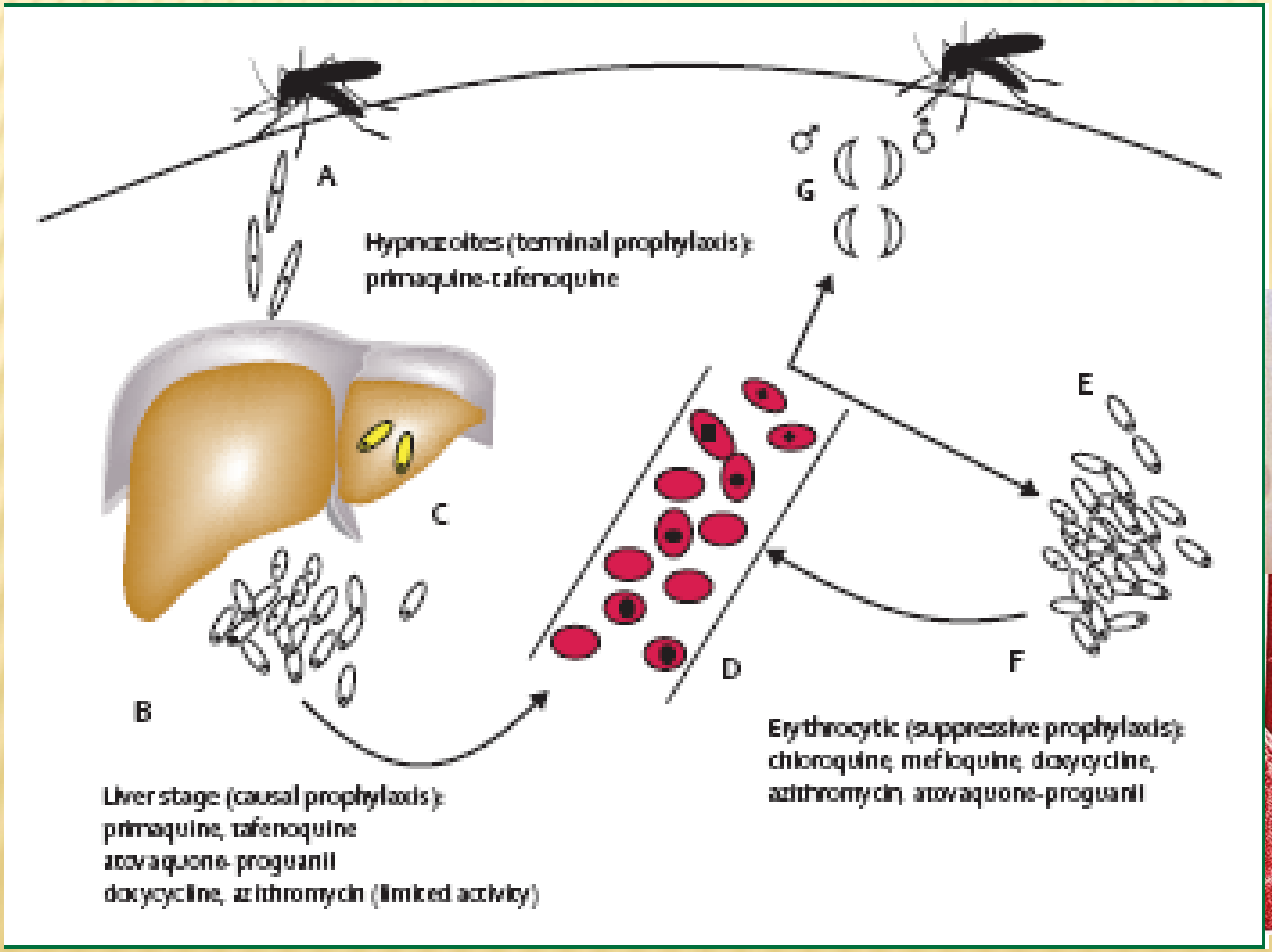
MALARIA

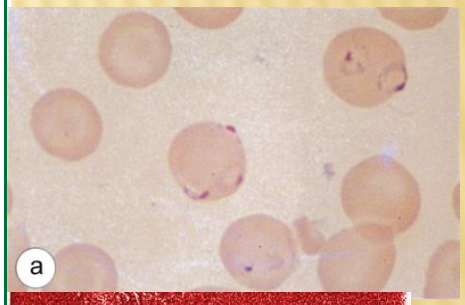
- Malaria is caused by one of five species of the *Plasmodium parasite transmitted by female Anopheles spp* mosquitoes.
- Historically malaria was endemic in Europe, including Scandinavia, but it was eventually eliminated in 1975 through a number of factors related to socioeconomic development.
- Any role that climate played in malaria reduction would have been small.
- Nevertheless, the potential for malaria transmission is intricately connected to meteorological conditions such as temperature and precipitation.
- For example, conditions for transmission in Europe have remained favourable as documented by sporadic autochthonous transmission of a tropical malaria strain by local vectors to a susceptible person.

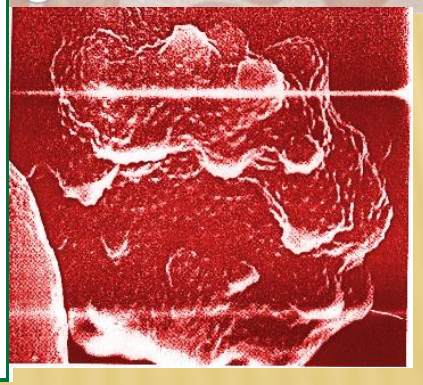
MALARIA

- Thus, while climatic factors may favour autochthonous transmission, increased vector density, and accelerated parasite development, other factors (socioeconomic, building codes, land use, treatment, capacity of health-care system, etc) limit the likelihood of climate-related re-emergence of malaria in Europe.

MALARIA (CONT)







SANDFLY-BORNE DISEASES

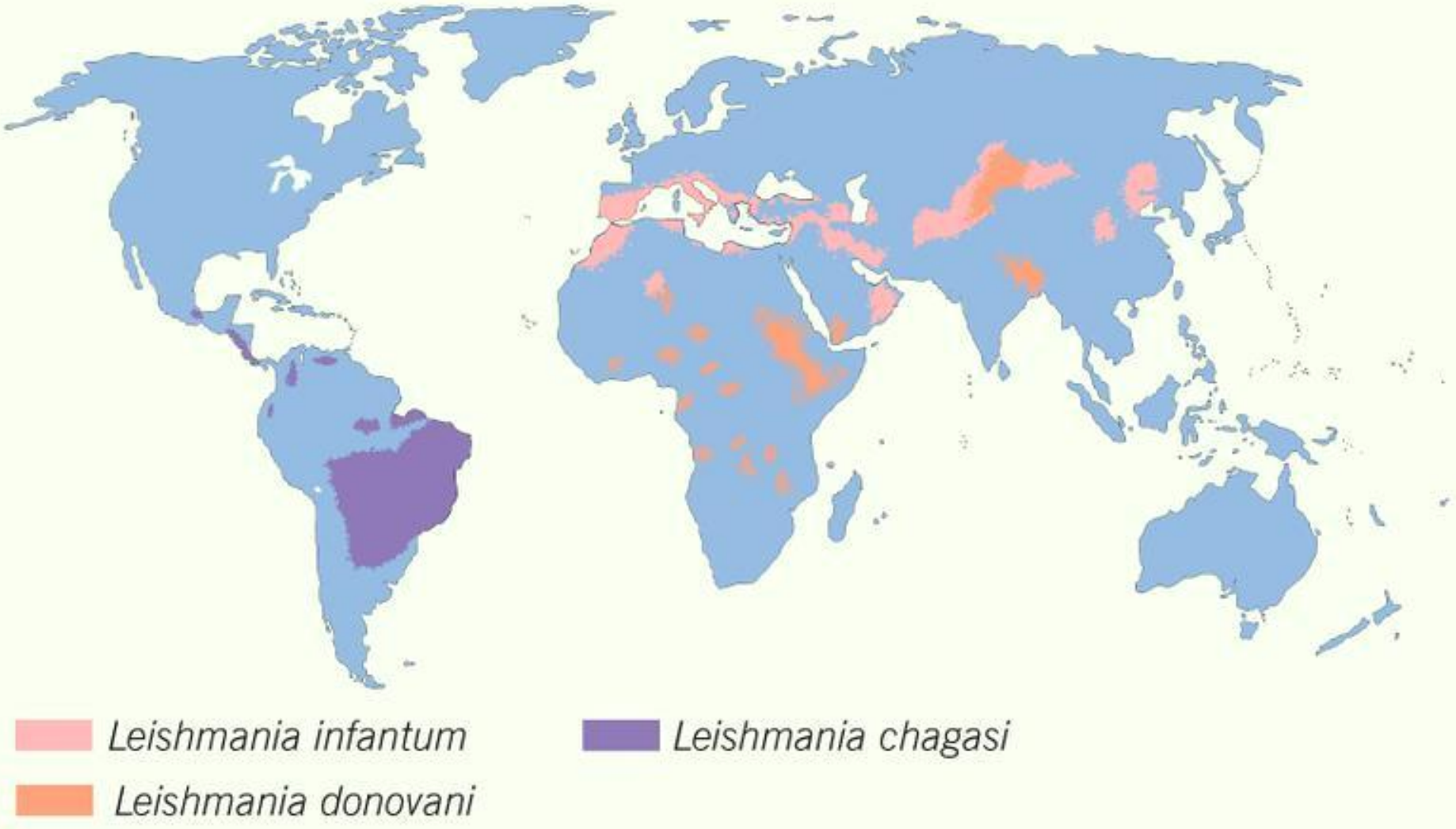
- Leishmaniasis is a protozoan parasitic infection caused by *Leishmania infantum that is transmitted to human* beings through the bite of an infected female sandfly.
- Temperature infl uences the biting activity rates of the vector, diapause, and maturation of the protozoan parasite in the vector.38,39 Sandfly distribution in Europe is south of latitude 45°N and less than 800 m above sea level, although it has recently shifted to a latitude of 49°N

SANDFLY-BORNE DISEASES

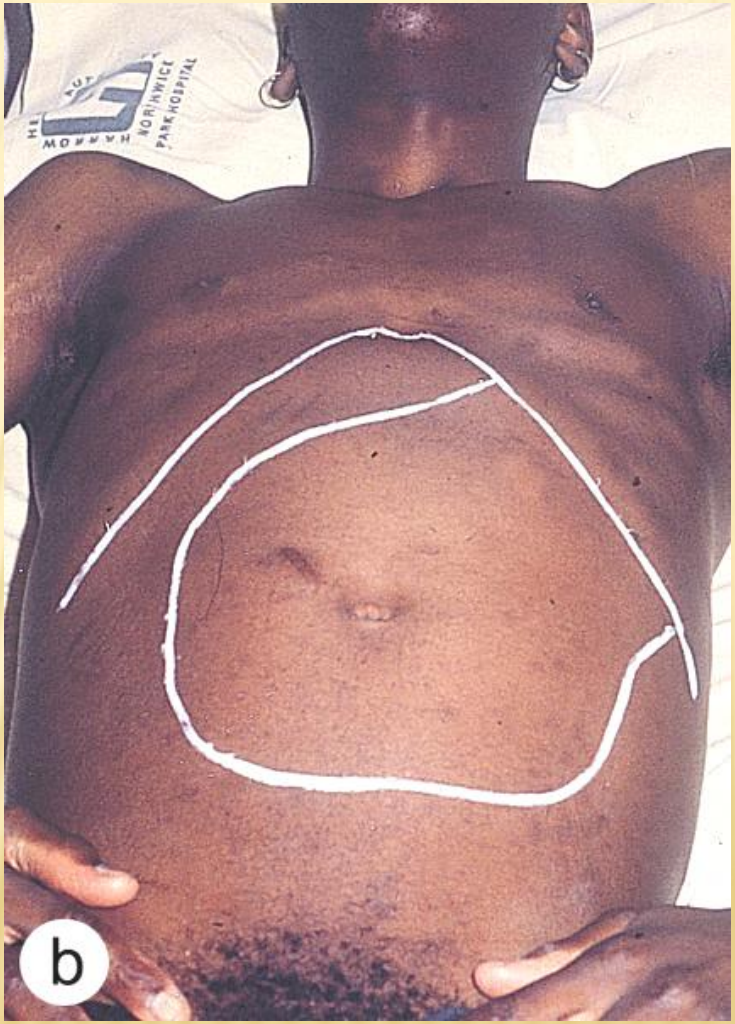
- The biting activity of European sandflies is strongly seasonal, and in most areas is restricted to summer months.
- Currently, sandfly vectors have a substantially wider range than that of *L infantum, and imported cases of infected dogs are* common in central and northern Europe.
- Once conditions make transmission suitable in northern latitudes, these imported cases could act as plentiful sources of infections, permitting the development of new endemic foci.

SANDFLY

DISTRIBUTION OF VISCERAL LEISHMANIASIS

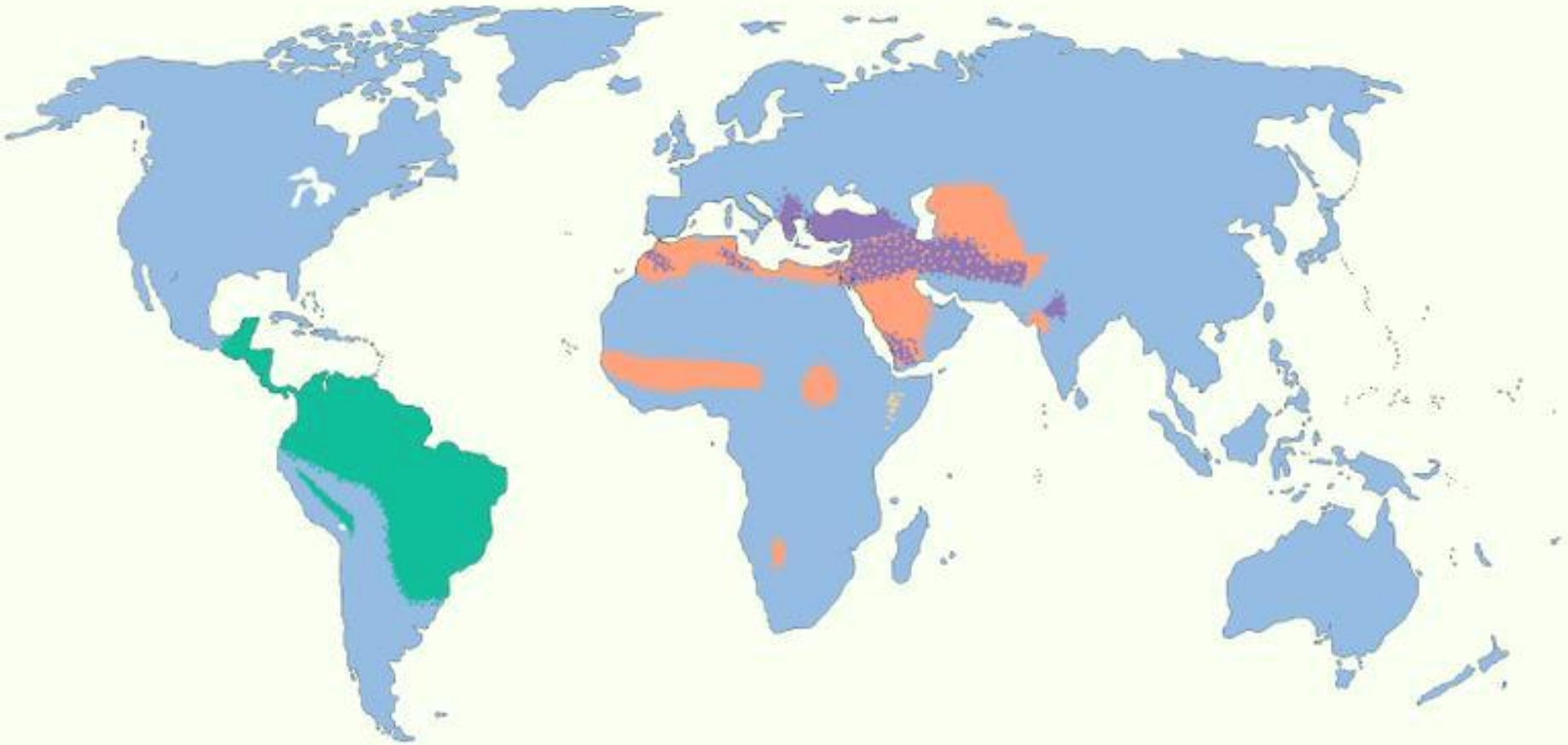


VISCERAL LEISHMANIASIS



SPLENIC ASPIRATION

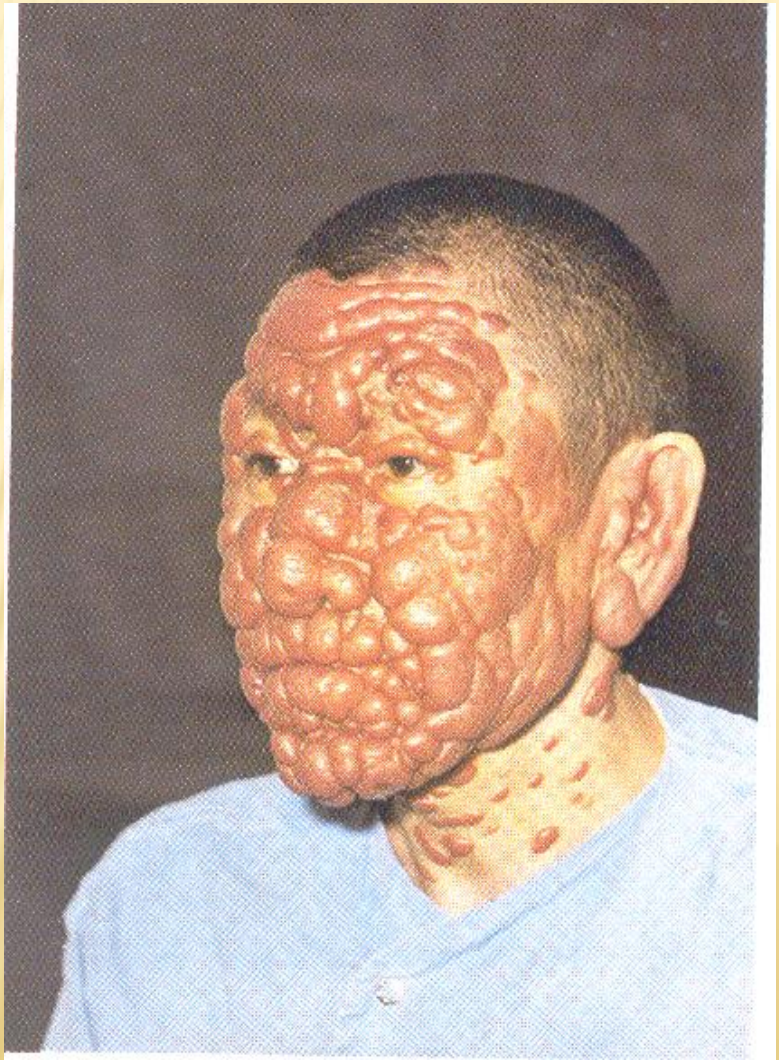
DISTRIBUTION OF CUTANEOUS LEISHMANIASIS



OLD WORLD CUTANEOUS LEISHMANIASIS

CUTANEOUS LEISHMANIASIS

DIFFUSE CUTANEOUS LEISHMANIASIS



MUCOCUTANEOUS LEISHMANIASIS

TICK-BORNE DISEASES

- Tick-borne encephalitis (TBE) is caused by an arbovirus of the family Flaviviridae, and is transmitted by ticks (predominantly *Ixodes ricinus) that act both as vectors* and as reservoirs.
- Similar to other vector-borne diseases, temperature accelerates the ticks' developmental cycle, egg production, population density, and distribution.
- It is likely that climate change has already led to changes in the distribution of *I ricinus populations* in Europe.

TICK-BORNE DISEASES

- In Sweden, since the late 1950s all cases of encephalitis admitted in Stockholm County have been serologically tested for TBE.
- An analysis of the period 1960–98 showed that the increase in TBE incidence since the mid-1980s is related to milder and shorter winters, resulting in longer tick-activity seasons.
- In Sweden, the distribution-limit shifted to higher
- Latitude, the distribution has also shifted in Norway and Germany

LYME BORRELIOSIS

- Lyme borreliosis is caused by infection with the bacterial spirochete *Borrelia burgdorferi, which is* transmitted to human beings during the blood feeding of hard ticks of the genus *Ixodes.*
- *In Europe, the primary* vector is *I ricinus, also known as the deer tick, and Ixodes persulcatus from Estonia to far eastern Russia.*
- *In Europe,* Lyme borreliosis is the most common tick-borne disease with at least 85 000 cases yearly, and has an increasing incidence in several European countries such as Finland, Germany, Russia, Scotland, Slovenia, and Sweden.

CRIMEAN-CONGO HAEMORRHAGIC FEVER (CCHF)

- Crimean-Congo haemorrhagic fever (CCHF) is caused by an RNA virus of the Bunyaviridae family and transmitted by *Hyalomma spp ticks from domestic and* wild animals.
- The virus is the most widespread tick-borne arbovirus and is found in the eastern Mediterranean where there have been a series of outbreaks in Bulgaria in 2002 and 2003, and in Albania and Kosovo in 2001

CRIMEAN-CONGO HAEMORRHAGIC FEVER (CCHF)

- Milder weather conditions, favouring tick reproduction may influence CCHF distribution.
- For example, an outbreak in Turkey was linked to a milder spring season (a substantial number of days in April with a mean temperature higher than 5 °C) in the year before the outbreak.
- However, other factors such as land use and demographic changes have also been implicated.

RICKETTSIOSIS

- There have been new records of spotted fever group rickettsioses with new pathogens such as *Rickettsia slovaca, Rickettsia helvetica, Rickettsia aeschlimannii,* and flea-borne rickettsioses (*Rickettsia typhi, Rickettsia felis).*
- *However, this emergence is most likely* detection bias due to advancements in diagnostic techniques.
- Since ticks, fleas, and lice serve as vectors and reservoirs they might contribute to disease amplification under favourable climate change conditions.

ANAPLASMOSIS

- Human granulocytic anaplasmosis is caused by *Anaplasma phagocytophilum, a bacterium usually* transmitted to human beings by *I ricinus. In Europe, this* disease was known to cause fever in goats, sheep, and cattle until it emerged as a disease in human beings in 1996.
- It has now shifted to new geographical habitats throughout Europe, and migrating birds have been implicated in its expansion.
- Spatial models have been developed to project the geographical distribution under climate change scenarios for North America but not for Europe.

RODENT-BORNE DISEASES

- Rodents are reservoirs of a number of human diseases.
- Rodents can act as both intermediate infected hosts and
- as hosts for arthropod vectors such as fl eas and ticks.
- Rodent populations are affected by weather conditions.
- In particular, warm, wet winters and springs increase rodent populations, which have been observed in recent years.
- Under climate change scenarios, rodent populations could be anticipated to increase in temperate zones, resulting in greater interaction between human beings and rodents and a higher risk of disease transmission, especially in urban areas.
- In some European countries breakdown in sanitation and inadequate hygiene are contributing to serious rat infestations.

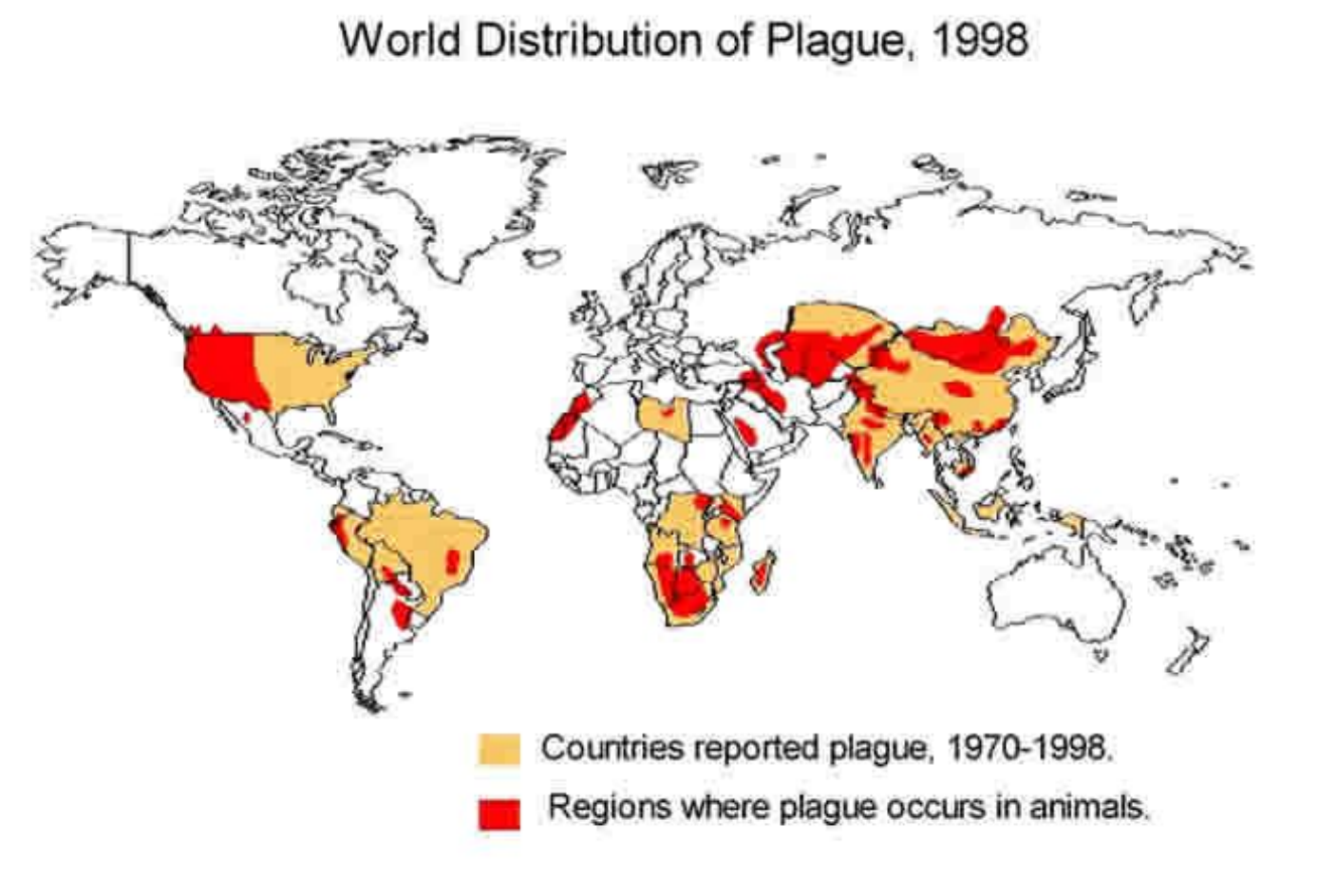
PLAGUE

- Since the last major plague outbreak in 1720, plague is no longer circulating in Europe—neither in human beings nor in rodent populations.
- Plague is a zoonosis caused by the bacterium *Yersinia pestis that is spread by fleas feeding* on black rats (*Rattus rattus).*
- *Milder weather conditions* are favorable to rodent populations, while harsh weather conditions such as heat waves might drive rodents indoors in search of water and thus increase contact with human beings

PLAGUE

- Fluctuations in the abundance of its main reservoir host have been linked to variation in plague incidence.
- Climatic changes in central Asia favour conditions for the propagation of plague; it has been projected that only a 1°C increase in spring temperatures could result in a 50% increase in *Y pestis* prevalence in its reservoir host.79 Plague epizootics may become more frequent in central Asia and pose a threat to eastern European countries

DISTRIBUTION OF PLAGUE



BUBONIC AND SEPTIC PLAGUE

DEVELOPING BUBONIC PLAGUE 1.

UGYANAZ KÉSŐBBI FÁZISBAN

BUBOPESTIS KIALAKULÁSA. JÓL LÁTHATÓ AZ ÉRINTETT NYIROKCSOMÓ BEOLVADÁSA ÉS A GENNY KIÜRÜLÉSE.

HANTAVIRUS INFECTIONS

- Hantaviruses are rodent-borne viruses with four genotypes circulating in Europe, of which at least Puumala, Dobrava, and Saaremaa viruses are human pathogens.
- Human beings are at risk of exposure through the inhalation of virus aerosols from the excreta of infected rodents.
- Excess proliferation of rodent populations related to climatic changes is of considerable international public health concern

HANTAVIRUS INFECTIONS

- Hantavirus infection is sensitive to climatic conditions; for example, increased grass seed production following heavy precipitation has been linked to higher deer mouse densities that caused an outbreak in the Four Corners region (New Mexico) of the USA.
- Similarly, bank vole populations in Belgium are linked to tree-seed production that in turn has been linked to high summer and autumn temperatures associated with hantavirus disease incidence, and can be used as early warning indicators of potential outbreaks.
- In other parts of Europe warm weather has also been associated with hantavirus, and it is anticipated that these climatic conditions are general warming of the European climate will increase the risk of infection.

DID SMALLPOX HIT THE USA IN MAY 2003?

Fortunately not! It was Monkeypox

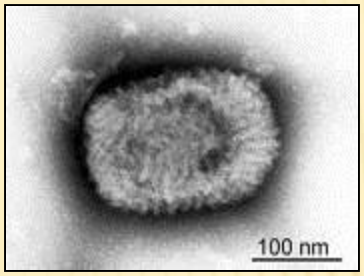
MONKEYPOX IN MONKEYS AND HUMANS IN WEST AND CENTRAL AFRICA

Hogy történhetett?

Prairie dogs

Is there any precedent?

Human, Cow and Cat Infections with Cowpox Virus in Europe



Bank Vole
Clethrionomys glareolus

Rat-to-Human Transmission of Cowpox Infection

Tom F.W. Wolfs,* Jaap A. Wagenaar,†
Hubert G.M. Niesters,‡ and Albert D.M.E. Osterhaus‡

We isolated *Cowpox virus* (CPXV) from the ulcerative eyelid lesions of a 14-year-old girl, who had cared for a clinically ill wild rat that later died. CPXV isolated from the rat (*Rattus norvegicus*) showed complete homology with the girl's virus. Our case is the first proven rat-to-human transmission of cowpox.

WATER-BORNE DISEASES

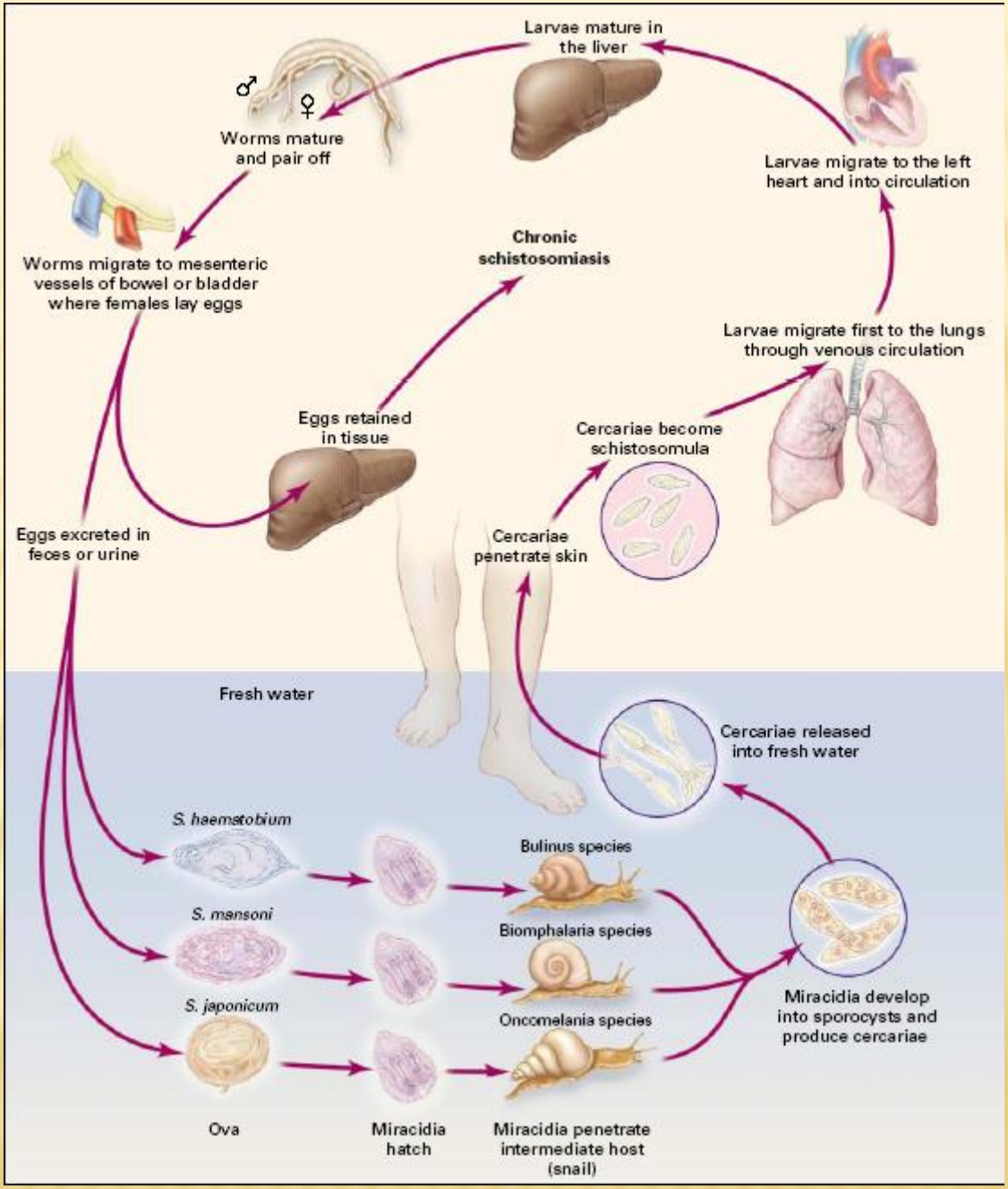
- Global climate change will interfere with these interactions and alter the hydrological cycle not only by altering mean meteorological measures but also by increasing the frequency of extreme events such as excessive precipitation, storm surges, floods, and droughts.
- These extreme weather-related events can affect water availability, quality, or access, posing a threat to human populations.
- Water-borne pathogens often act in concert through two major exposure pathways: drinking water and recreational water use.

RECREATIONAL WATER USE

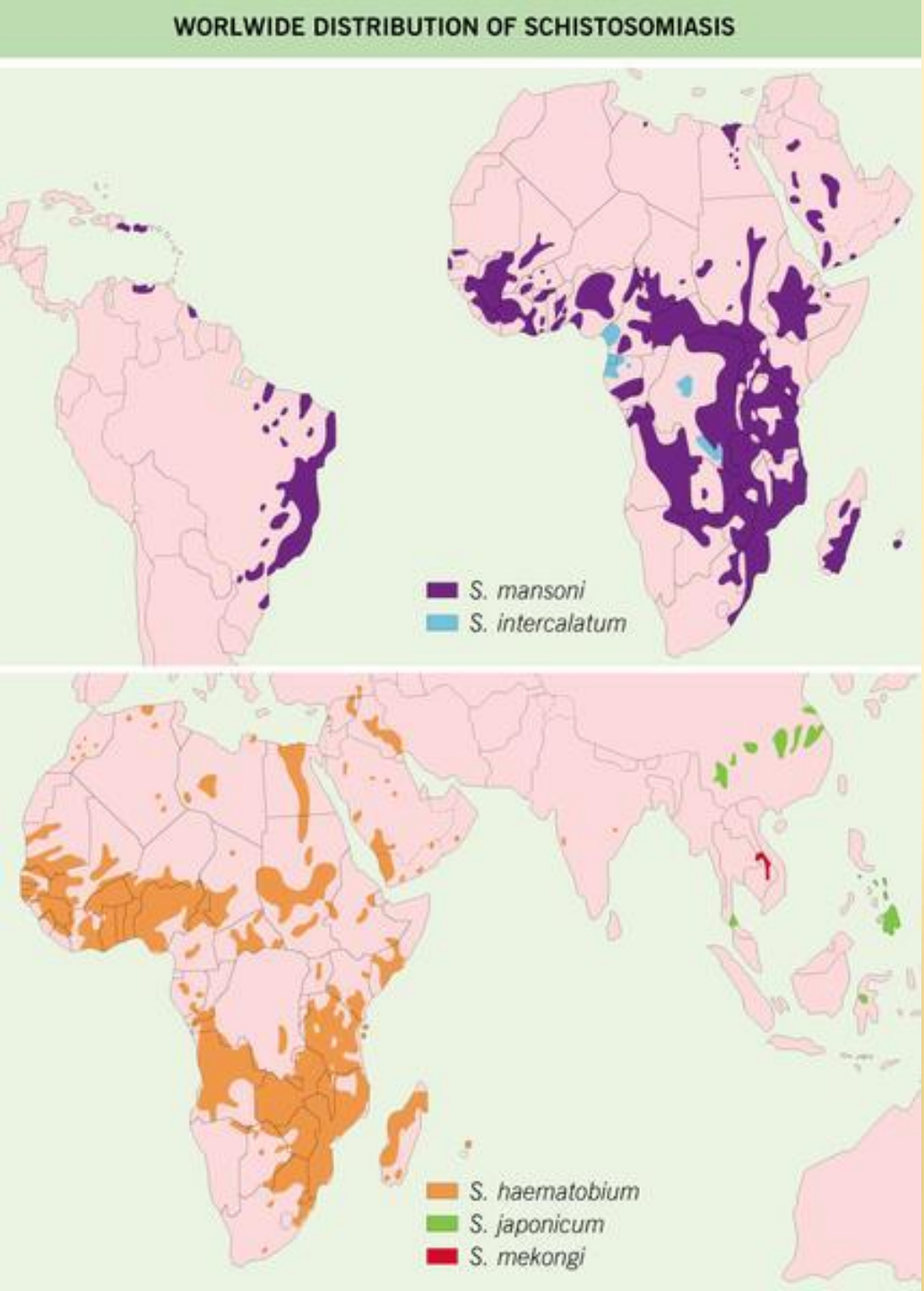
- Climate variability can negatively impact public health: exposure to southern California coastal waters during an El Niño winter compared with a La Niña winter doubles the risk of symptoms related to infectious agents.
- Risk of gastro enteritis and respiratory infections due to recreational water use are much higher during the rainy season rather than the dry season.
- Precipitation is projected to increase in northern Europe, but no similar studies have been published for Europe so far

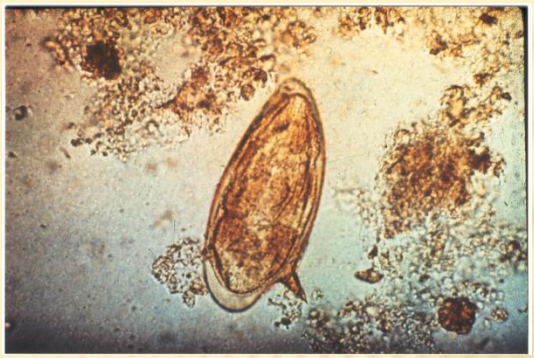
RECREATIONAL WATER USE

- Conversely, extended periods of hot weather can increase the mean temperature of water bodies, which can be favorable for micro organism reproduction cycles and algal blooms.
- For example, *Vibrio spp bacteria (including Vibrio vulnificus* and *Vibrio cholerae non-O1 and non-O139) indigenous to* the Baltic and the North Sea, have displayed increased growth rates during unusually hot summers (eg, 2006) and infected open wounds that can necrotise and cause severe sepsis.


Larvae mature in the liver
♂
♀
Worms mature and pair off
Larvae migrate to the left heart and into circulation
Worms migrate to mesenteric vessels of bowel or bladder where females lay eggs
Chronic schistosomiasis
Larvae migrate first to the lungs through venous circulation
Eggs retained in tissue
Cercariae become schistosomula
Eggs excreted in feces or urine
Cercariae penetrate skin
Fresh water
Cercariae released into fresh water
S. haematobium
Bulinus species
S. mansoni
Biomphalaria species
S. japonicum
Oncomelania species
Miracidia develop into sporocysts and produce cercariae
Ova
Miracidia hatch
Miracidia penetrate intermediate host (snail)

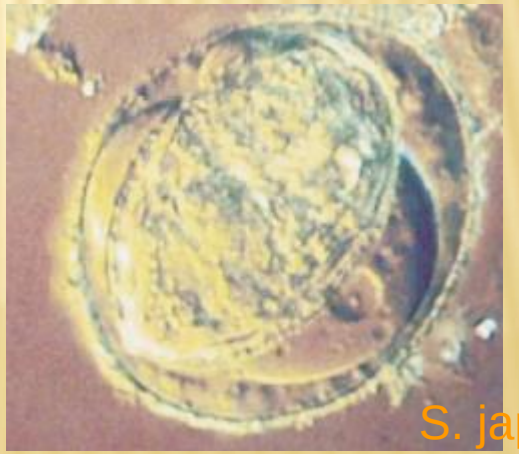
ADULT SCHISTOSOMA SPP.M IRACIDIUM, CERCARIA





S. mansoni

S. haematobium



S. japonicum

DRINKING WATER

- Water-borne outbreaks have the potential to be rather large and of mixed aetiology, but the actual disease burden in Europe is difficult to approximate and most likely underestimated.
- In 2006, only 17 water-borne outbreaks were reported by five countries, clearly substantially under-reported.
- These outbreaks involved 3952 patients, of whom 181 were hospitalised, afflicted by a number of causative agents including campylobacter, calicivirus, giardia, and crypto sporidium.

DRINKING WATER

- Erratic and extreme precipitation events can overwhelm water treatment plants and lead to cryptosporidium outbreaks due to oocysts infiltrating drinking-water reservoirs from springs and lakes and persisting in the water distribution system.
- A study from England and Wales found that 20% of water-borne outbreaks in the past century were associated with a sustained period of low rainfall, compared with 10% associated with heavy rainfall.
- Droughts or extended dry spells can reduce the volume of river flow possibly increasing the concentration of effluent pathogens, which might pose a problem forthe clearance capacity of treatment plants.

DRINKING WATER

- In Europe, flooding has rarely been associated with an increased risk of water-borne disease outbreaks, but a few exceptions exist in the UK, Finland, the Czech Republic, and Sweden.
- Cholera, caused by *Vibrio cholerae, is an imported disease in Europe, with only 10*-11 confirmed cases per year
- However, internationally, cholera outbreaks during the warmer months display a seasonal pattern in higher absolute latitudes, and climate change might influence the strength, duration, or appearance of such a seasonal pattern.

CHOLERA

CHOLERA TRIAGE CENTRE

CHOLERA BED & PATIENT

CHOLERA BED & PATIENT

AIRBORNE DISEASES

- Climatic factors such as absolute humidity have been associated with the risk of lower respiratory tract infections.
- Respiratory syncytial virus (RSV) is one of the most important viral respiratory pathogens, especially for infants.
- The epidemic activity of RSV infection is related to meteorological conditions and thus to latitude: persistently high temperature and humidity results in epidemic peaks in summer and early autumn, while in temperate climates RSV infection peaks in the winter.

AIRBORNE DISEASES

- A causal link with temperature seems inconsistent based on these climatic data, but the RSV infection season in England and Wales has ended earlier and its duration has shortened as the climate has become warmer.
- Seasonality has been documented for a number of other respiratory infections including tuberculosis, and seasonal fluctuations of the El Niño southern oscillation in California are associated with the impact of influenza epidemics (hospital admissions or mortality profiles), but a direct link to climate change has not been established.

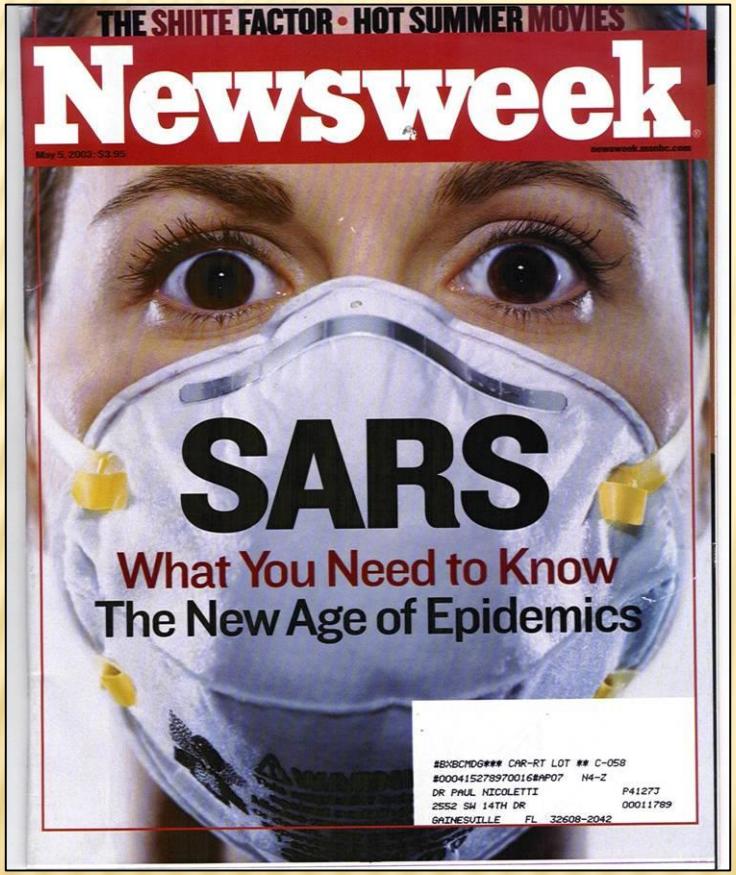
AIRBORNE DISEASES

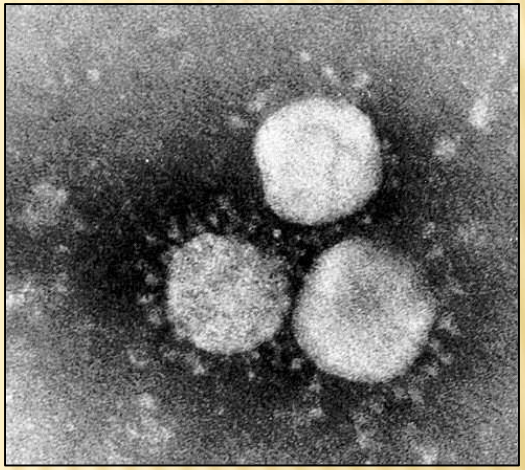
- Furthermore, increased use of cooling towers during heat waves might increase the risk for exposure to *Legionella spp, although* appropriate public health measures should be able to contain this risk.

MEASLES

PERTUSSIS, SUFFUSION IN THE CONJUNCTIVA

SEVERE ACUTE RESPIRATORY SYNDROME SARS
A NEW DISEASE; A NEW VIRUS!





SARS OUTBREAK, WORLDWIDE CASES BY COUNTRY (JUNE 3, 2003)

According to the World Health Organization (WHO), during the SARS outbreak of 2003, a total of 8,098 people worldwide became sick with SARS; of these, 774 died.

THE FIRST CLUES THAT SARS MAY BE A ZOONOTIC DISEASE

- Food handlers with likely animal contact were over represented in early cases (9/23, 39%)
- People living near markets were over represented in early cases

FOOD-BORNE DISEASES

- Climatic factors influence the growth and survival of pathogens, as well as transmission pathways.
- Higher ambient temperatures increase replication cycles of food-borne pathogens, and prolonged seasons may augment the opportunity for food handling mistakes in 32% of investigated food-borne outbreaks in Europe “temperature misuse” is considered a contributing factor.123

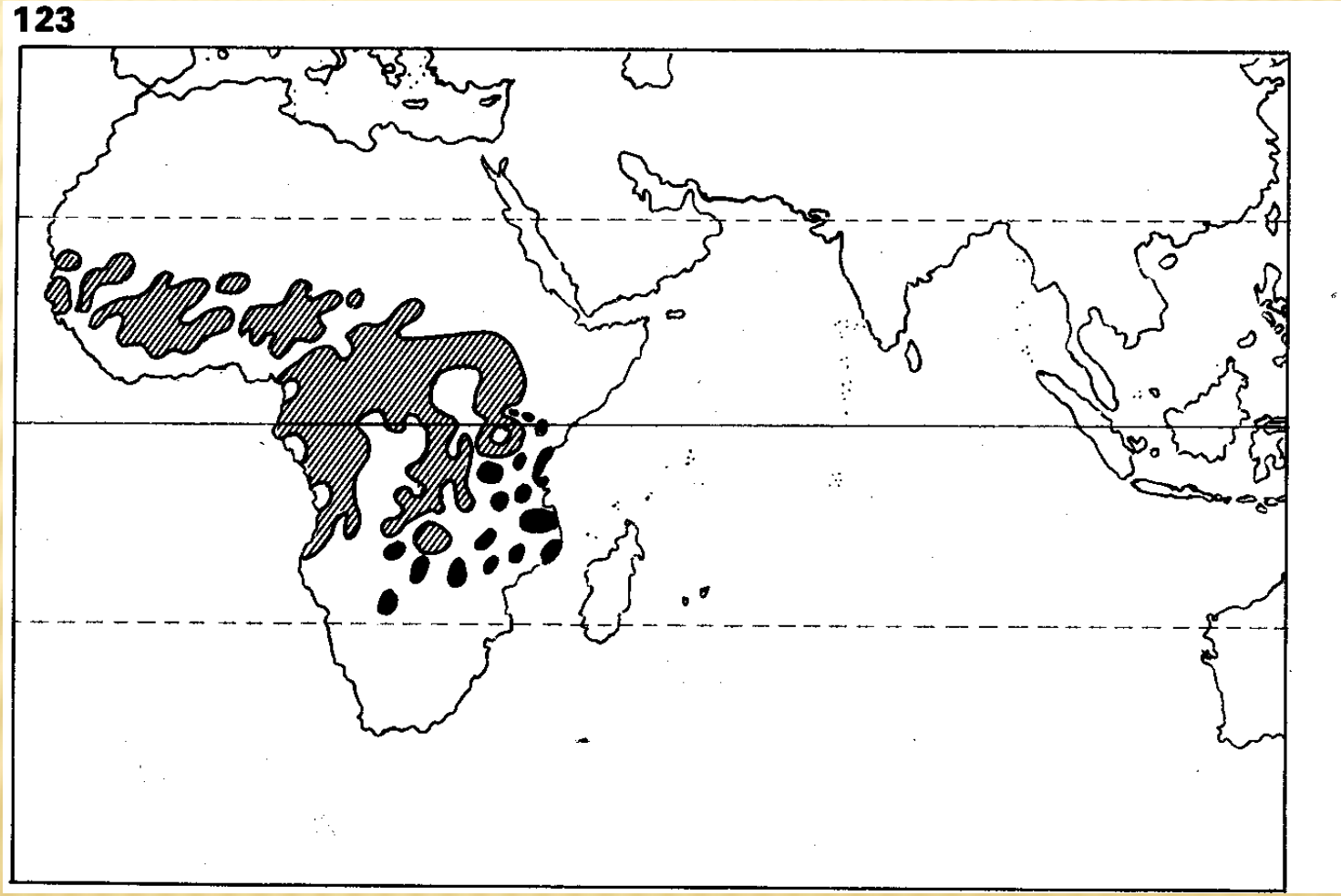
CAMPYLOBACTERIOSIS

- Campylobacter is the most commonly reported gastrointestinal bacterial disease, and is caused by thermophilic *Campylobacter spp bacteria.*
- Colonisation of broiler-chicken flocks with campylobacter increases rapidly with rising temperatures.
- The risk of campylobacteriosis is positively associated with mean weekly temperatures, although the strength of association is not consistent in all studies.

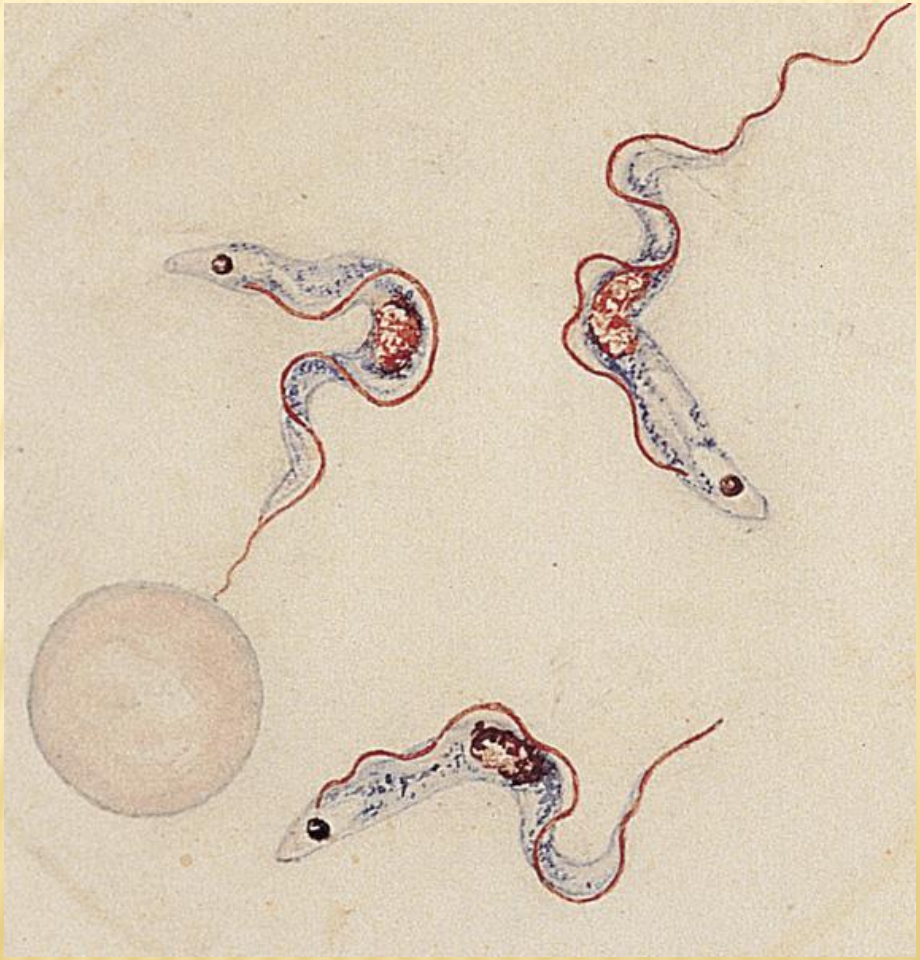
SALMONELLOSIS

- The second largest number of human food-borne diseases is caused by *Salmonella spp bacteria.*
- Higher ambient temperatures have been associated with 5–10% higher salmonellosis notifications for each degree increase in weekly temperature, for ambient temperatures above 5 °C.
- Roughly one-third of the transmission of salmonellosis (population attributable fraction) in England and Wales, Poland, the Netherlands, the Czech Republic, Switzerland, and Spain can be attributed to temperature influences.

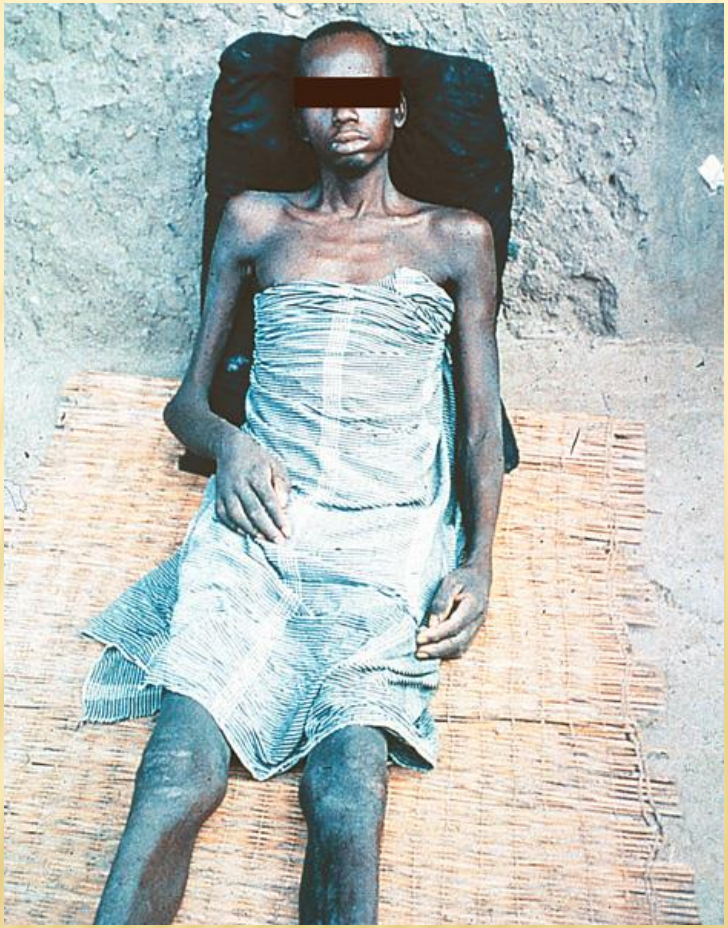
THE DISTRIBUTION OF AFRICAN TRYPANOSOMIASIS



TRYPANOSOMA BRUCEI GAMBIENSE

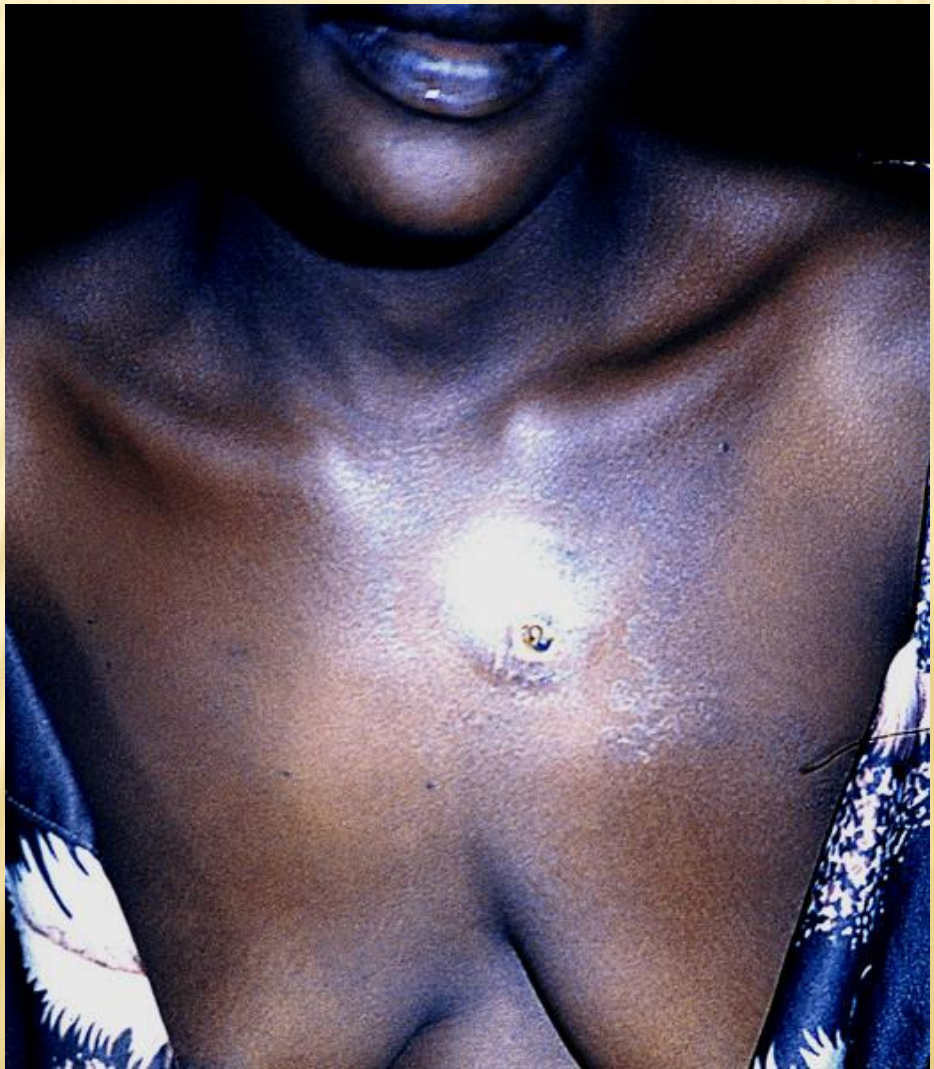


COMATOSE TERMINAL STAGE PATIENT WITH SLEEPING SICKNESS

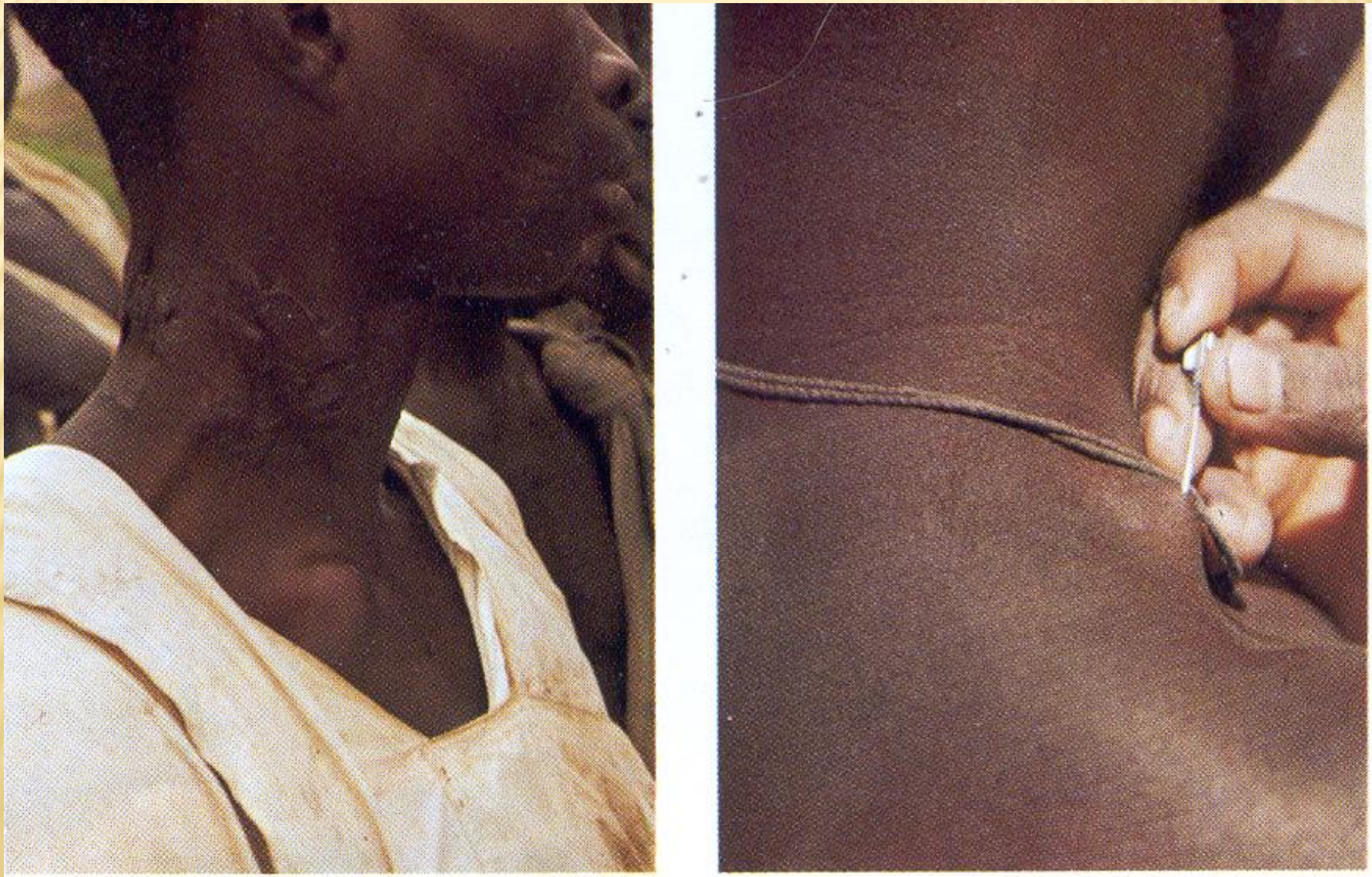


PRIMARY CHANCRE

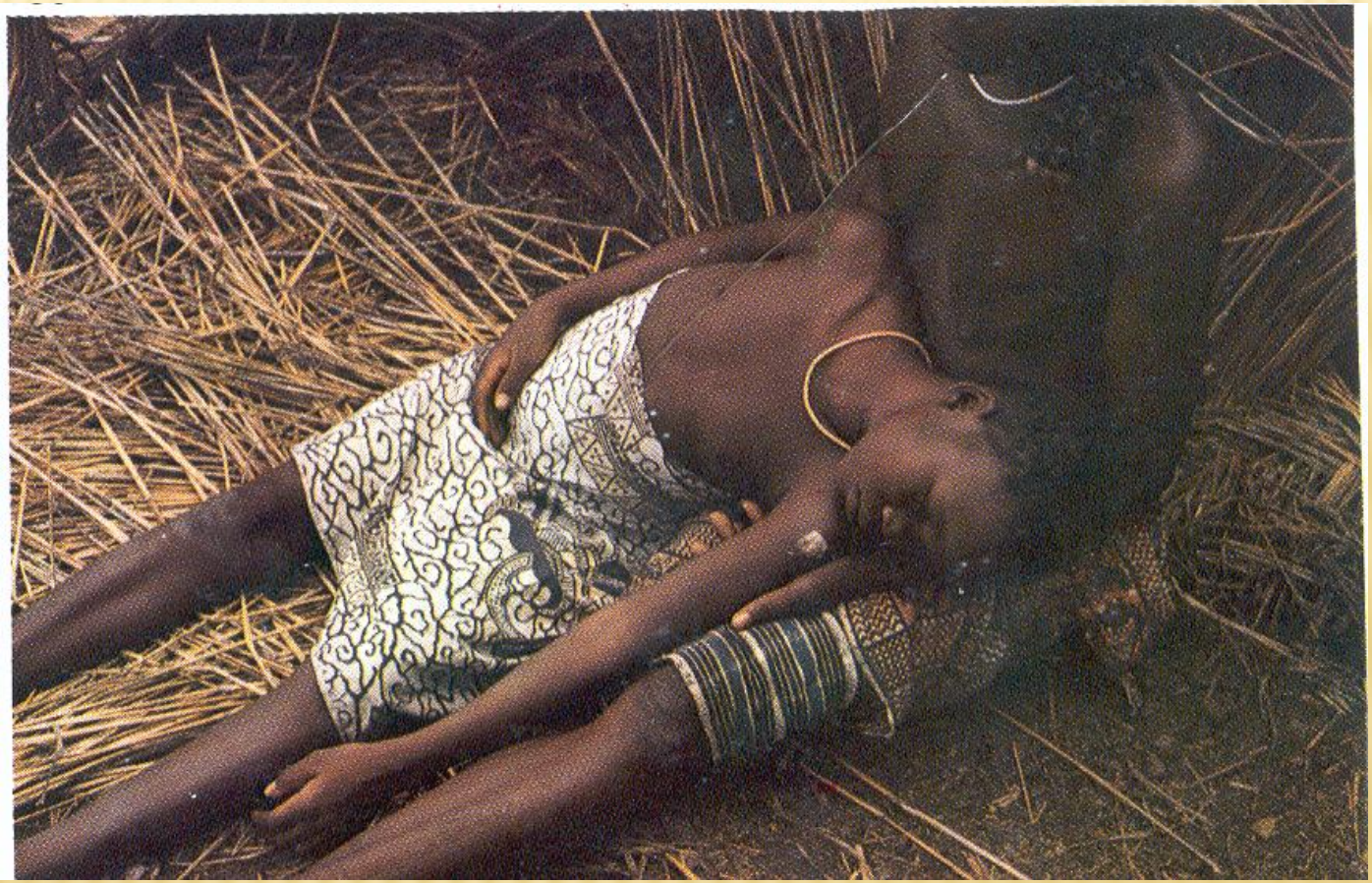
TYPICAL CHANCRE OF A PATIENT INFECTED WITH TRYPANOSOMA BRUCEI RHODESIENSE



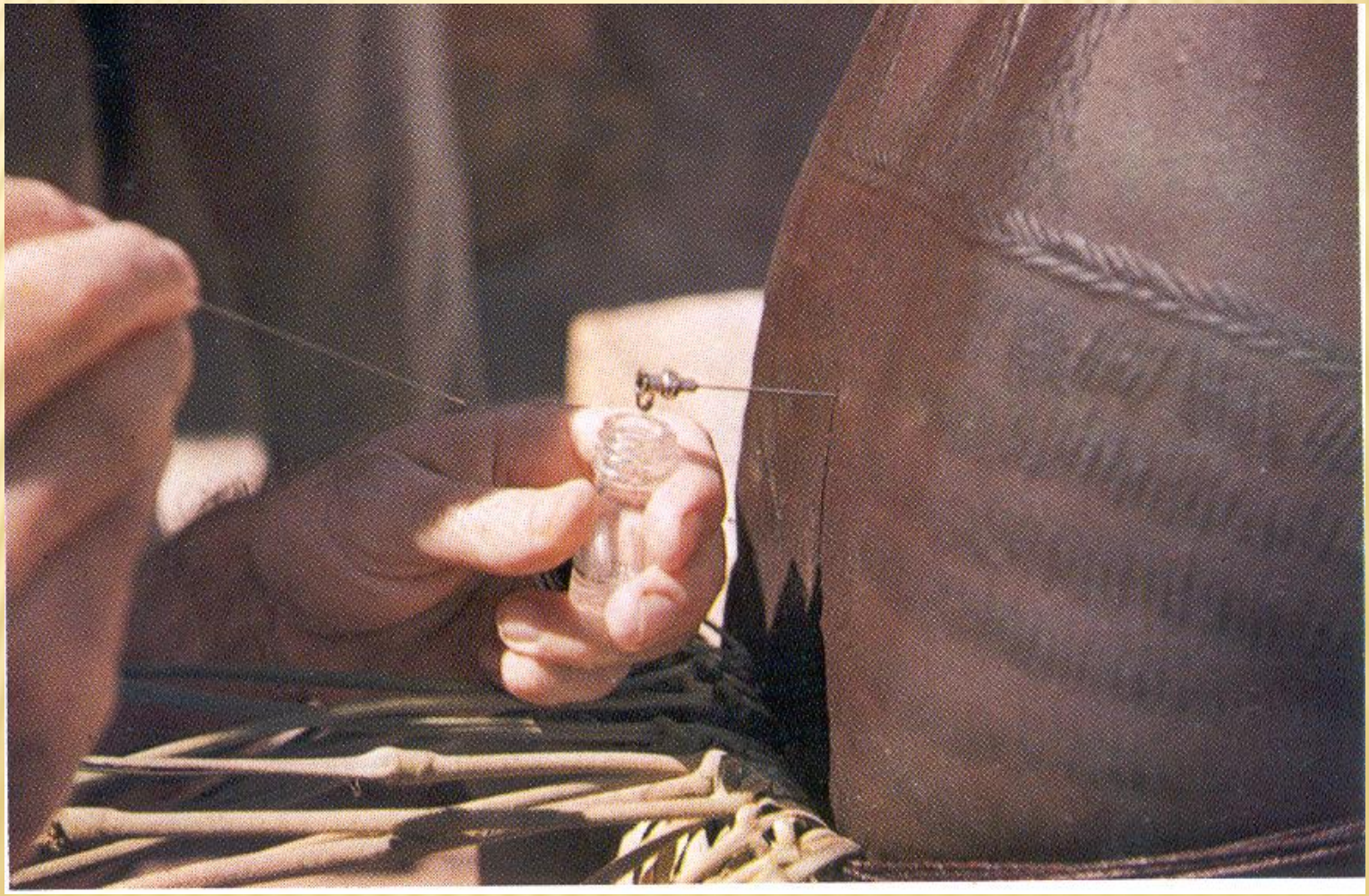
WINTERBOTTOM SIGN



TERMINAL STAGE OF SLEEPING SICKNESS



LUMBAR TAP FOR DIAGNOSING SLEEPING SICKNESS

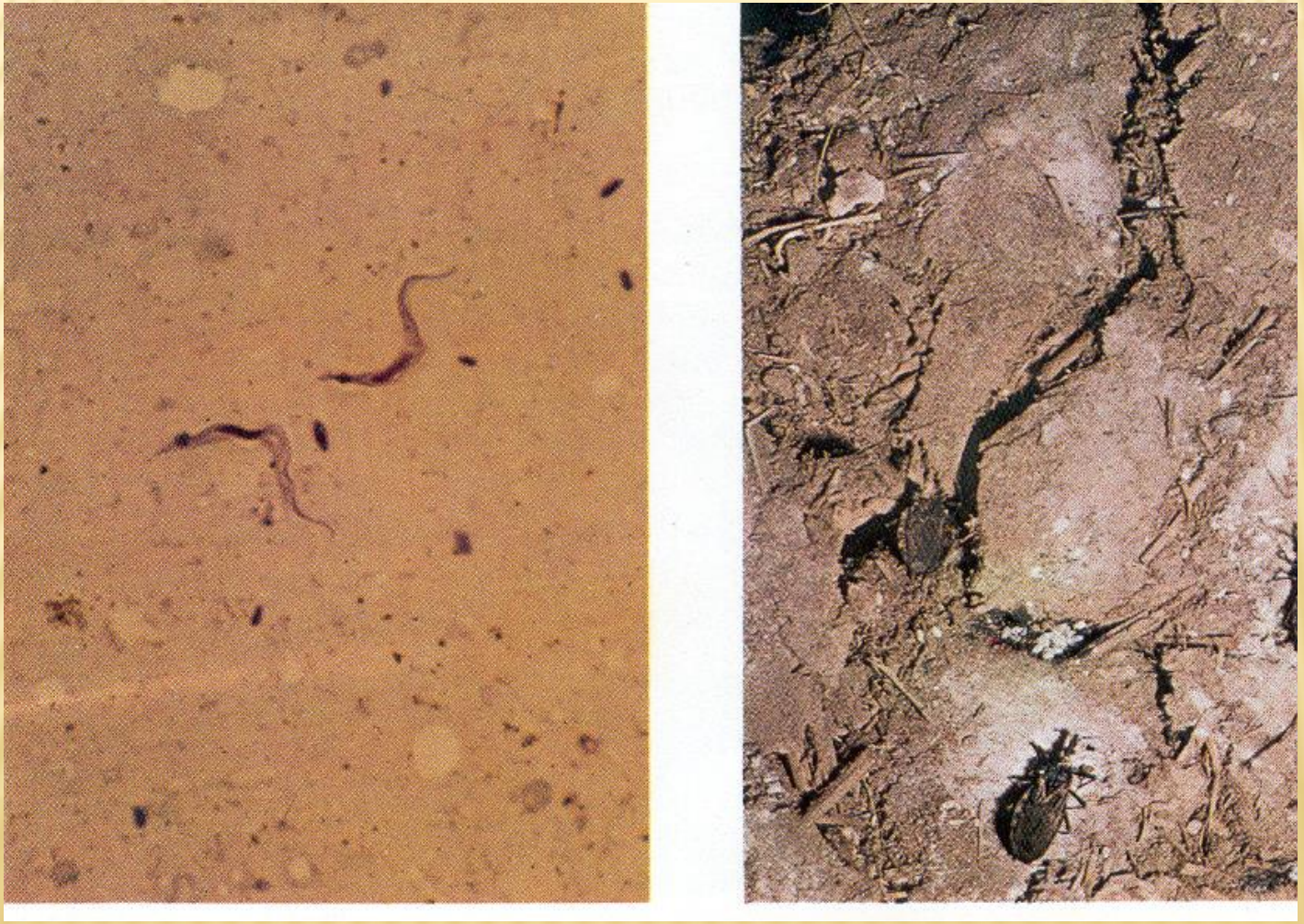


TREATMENT OF A PATIENT WITH AN INJECTION OF MELARSOPROL

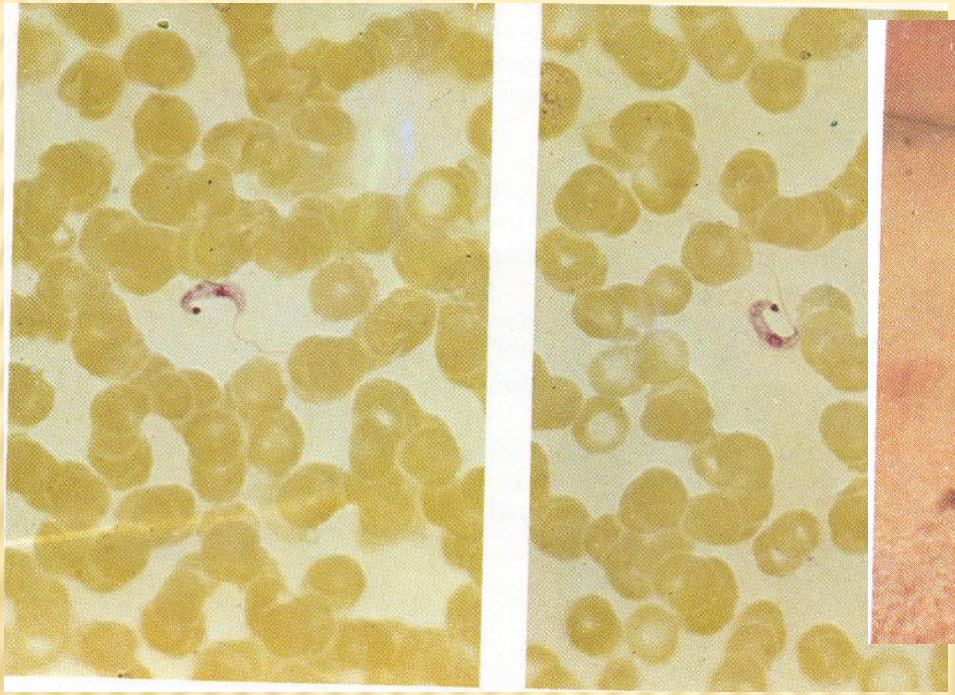
EMERGENCY TREATMENT CENTER IN UGANDA

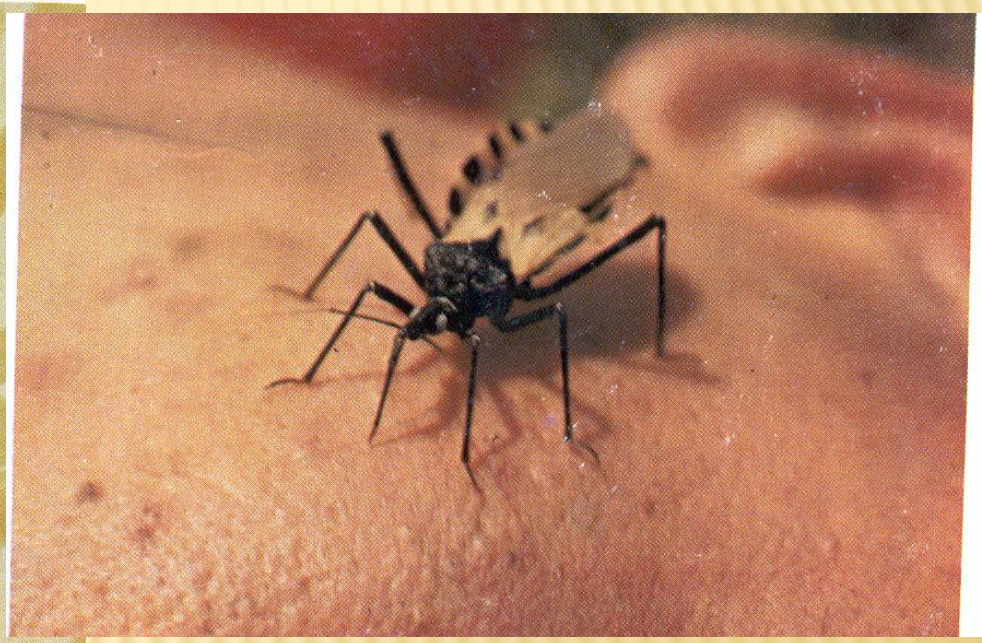
THE DISTRIBUTION OF CHAGAS DISEASE

TRYPANOSOMA CRUZII IN THE FECES OF BUGS, THE NATURAL SHELTER OF BUGS



TRYPANSOMA CRUZI IN EPRIPHERAL BLOOD, FEEDING BUG





TRYPANOSOMA CRUZI IN GIEMSA-STAINED THIN BLOOD FILM

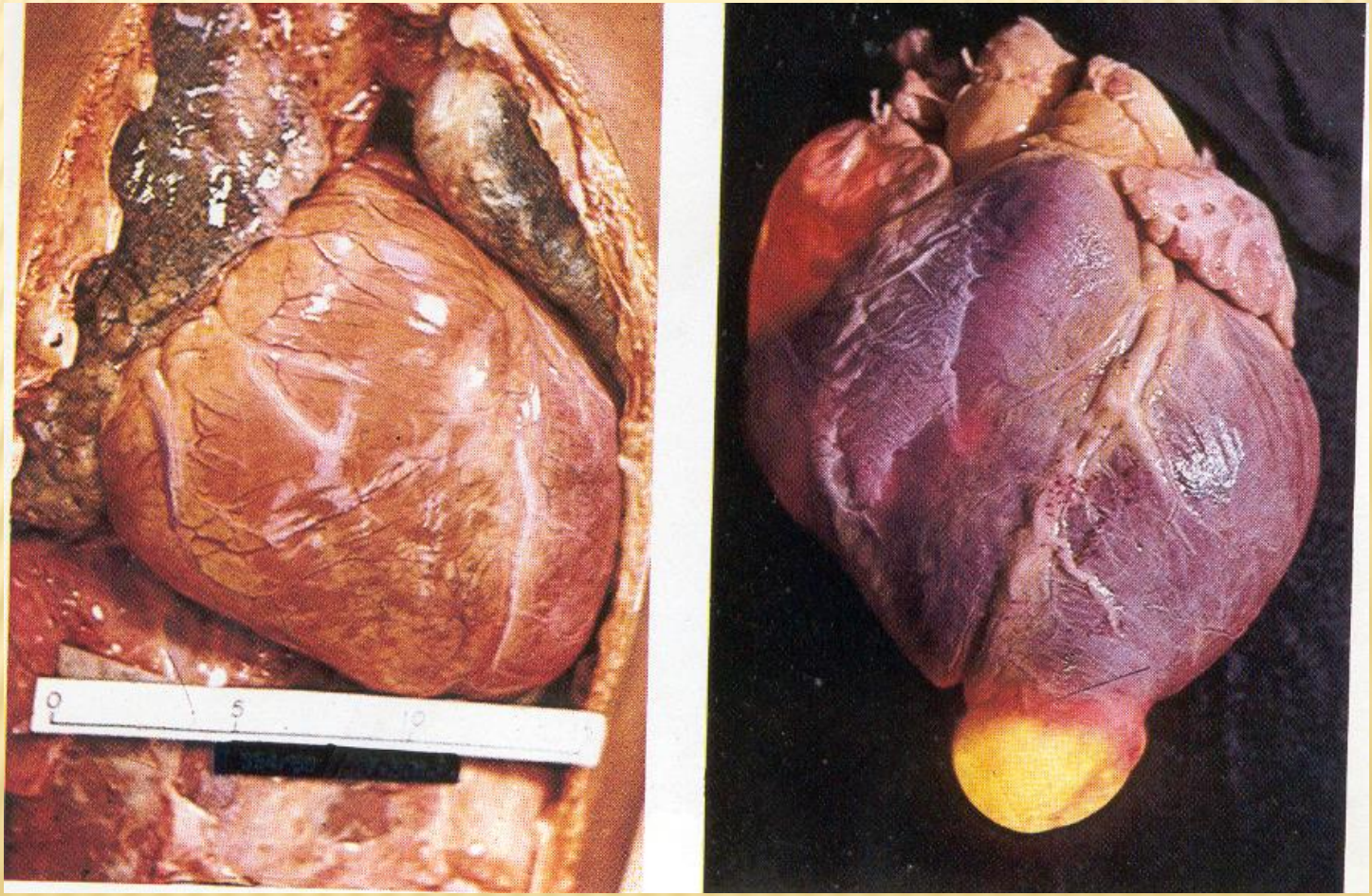
NATURAL HOST: ARMADILLO

ROMAŇA - SIGN

MEGACOLON

MEGAOESOPHAGUS ON RADIOGRAPH

CARDIOMEGALY AND APICAL ANEURISM IN CHAGAS DISEASE




EXCELLENCE IN HEALTHCARE


HAVE YOU WASHED
YOUR HANDS?
PLEASE,
DO.