

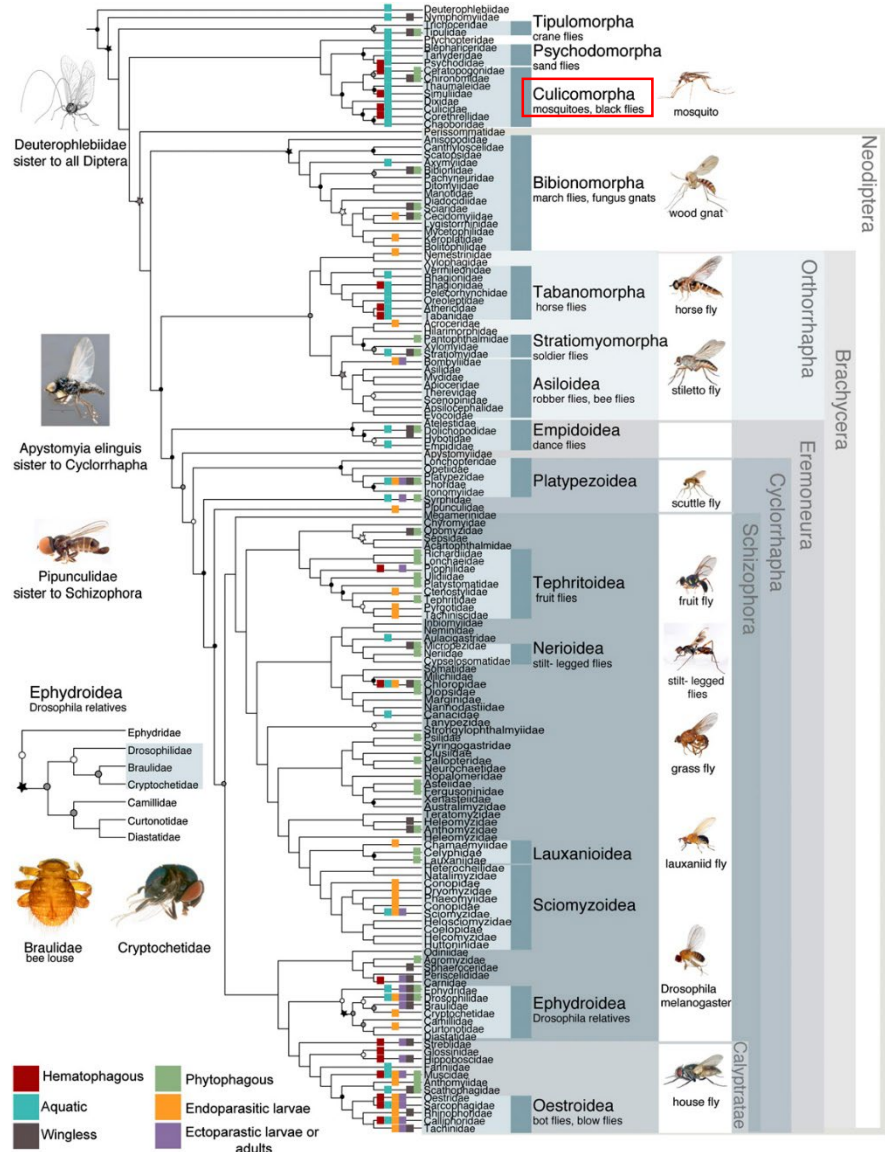
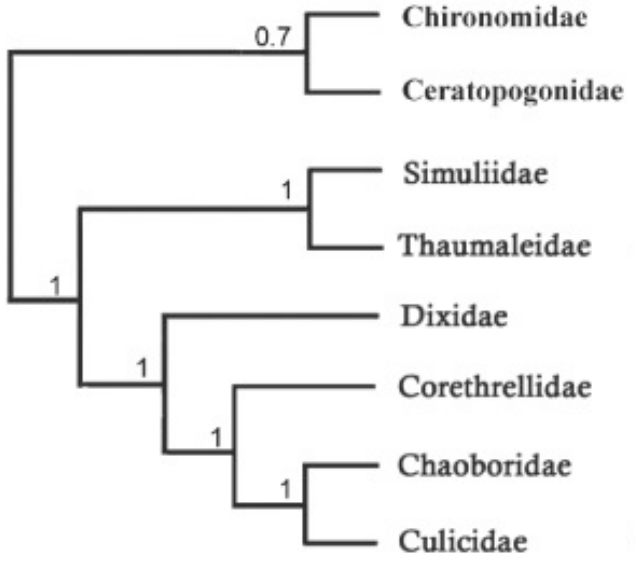


MEDICAL AND VETERINARY ENTOMOLOGY

CULICIDAE (Mosquitoes)

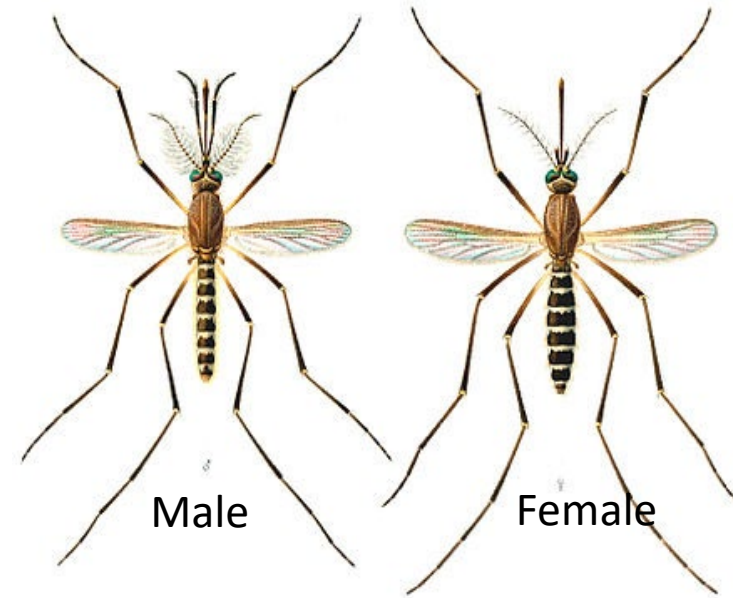
Assoc. Prof. Marija Ivković
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Medically significant Arthropoda - Diptera



Medically significant Arthropoda - Culicidae

- The most important of all insect groups and the group that transmits the largest number of infectious diseases and affects the largest number of people worldwide
- The first Arthropoda associated with disease transmission in vertebrates
- Mosquitoes come from all parts of the world, except Antarctica
- > 3500 species in the world, the greatest diversity in the tropics
- The highest density in the tundra
- They only visit the hosts to feed on blood
- Females feed on blood to obtain the protein necessary for egg maturation (**ANAUTOGENY**)
- They transmit viruses, phagotrophic protists and filarian nematods



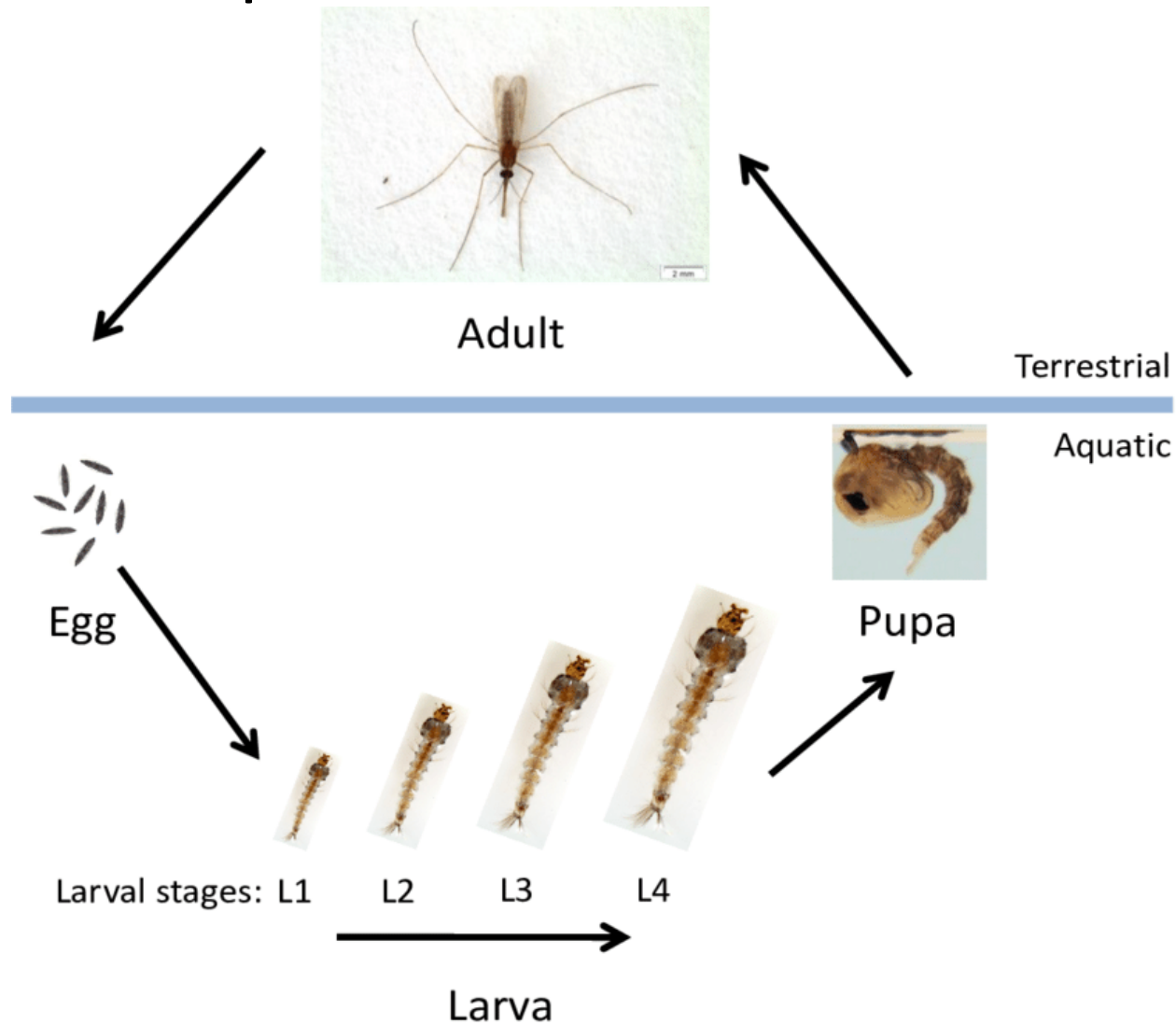
Medically significant Arthropoda - Culicidae

- Larvae are aquatic and can be found in permanent or occasional waterbodies



Medically significant Arthropoda - Culicidae

- The life cycle of mosquitoes



Medically significant Arthropoda - Culicidae



- **Anophelinae:** 3 genera, *Anopheles* among the most important medicinal species
- → vectors of malaria and several arboviruses and filarial nematods
- **Culicinae:** Most species, 37 genera, many of great medical importance, genera *Aedes* and *Culex*
- → vectors of arboviruses (more than 100 viruses that affect humans) and hosts of filarial nematods



Anopheles sp.



Culex sp.



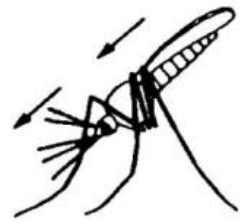
Medically significant Arthropoda - Culicidae

Anophelinae

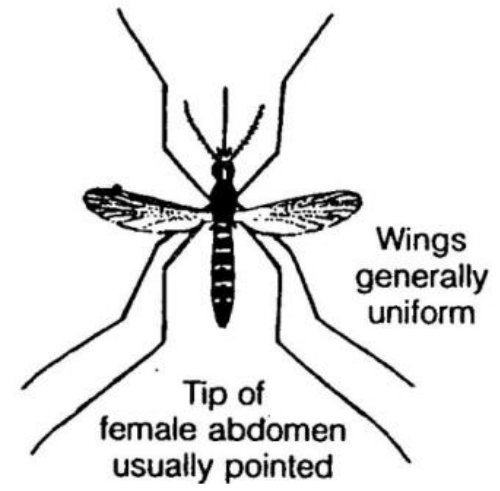
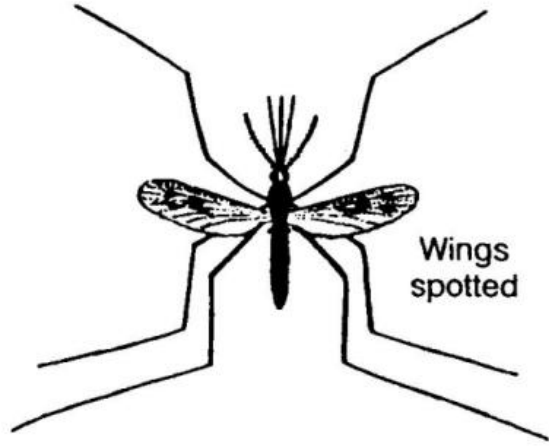
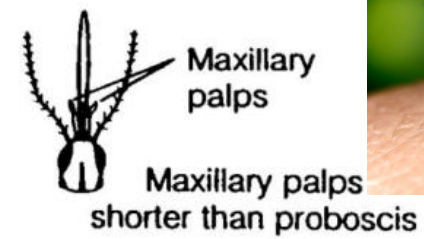
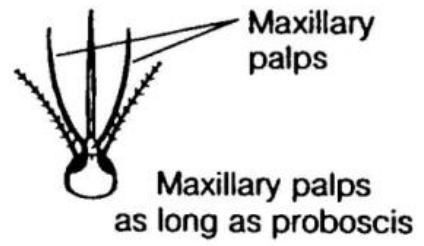
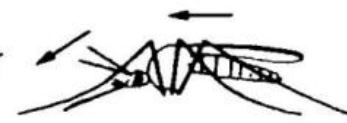
Culicinae

Adult

Proboscis and body in same straight line



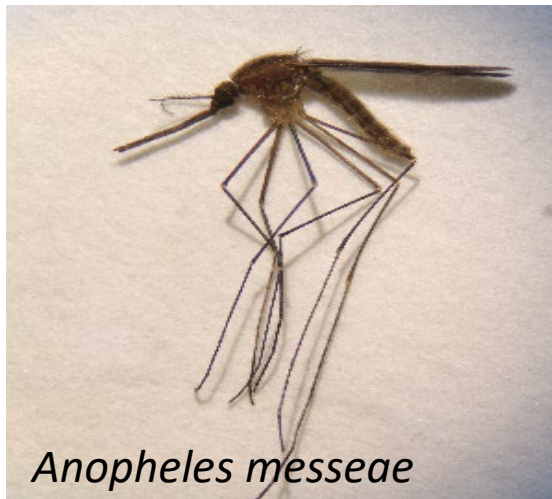
Proboscis and body at an angle to one another



Medically significant Arthropoda - Anophelinae

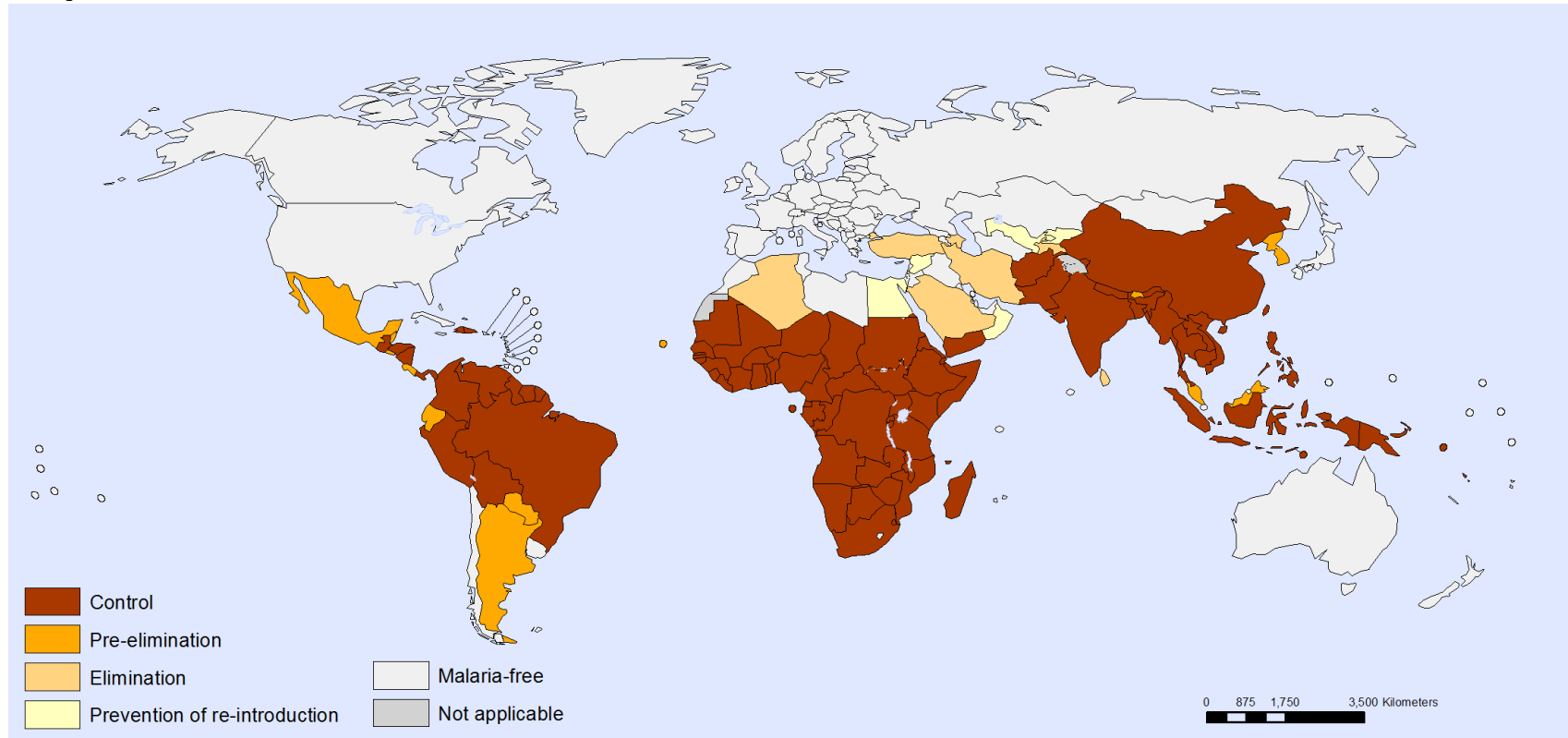


- The life cycle of mosquitoes
- About 430 species of *Anopheles*
- The sting is less irritating than from species of the Culicinae subfamily
- 40 to 70 species transmit malaria (at least 3 species present in Croatia)
- Most species are active at dusk and during the night
- The period of activity (day vs. night), feeding preference (endophagy - feeding inside vs. exophagy - feeding outside, humans vs. animals) and lifespan of the mosquito will determine the efficiency of the mosquito as a vector



Medically significant Arthropoda - Anophelinae

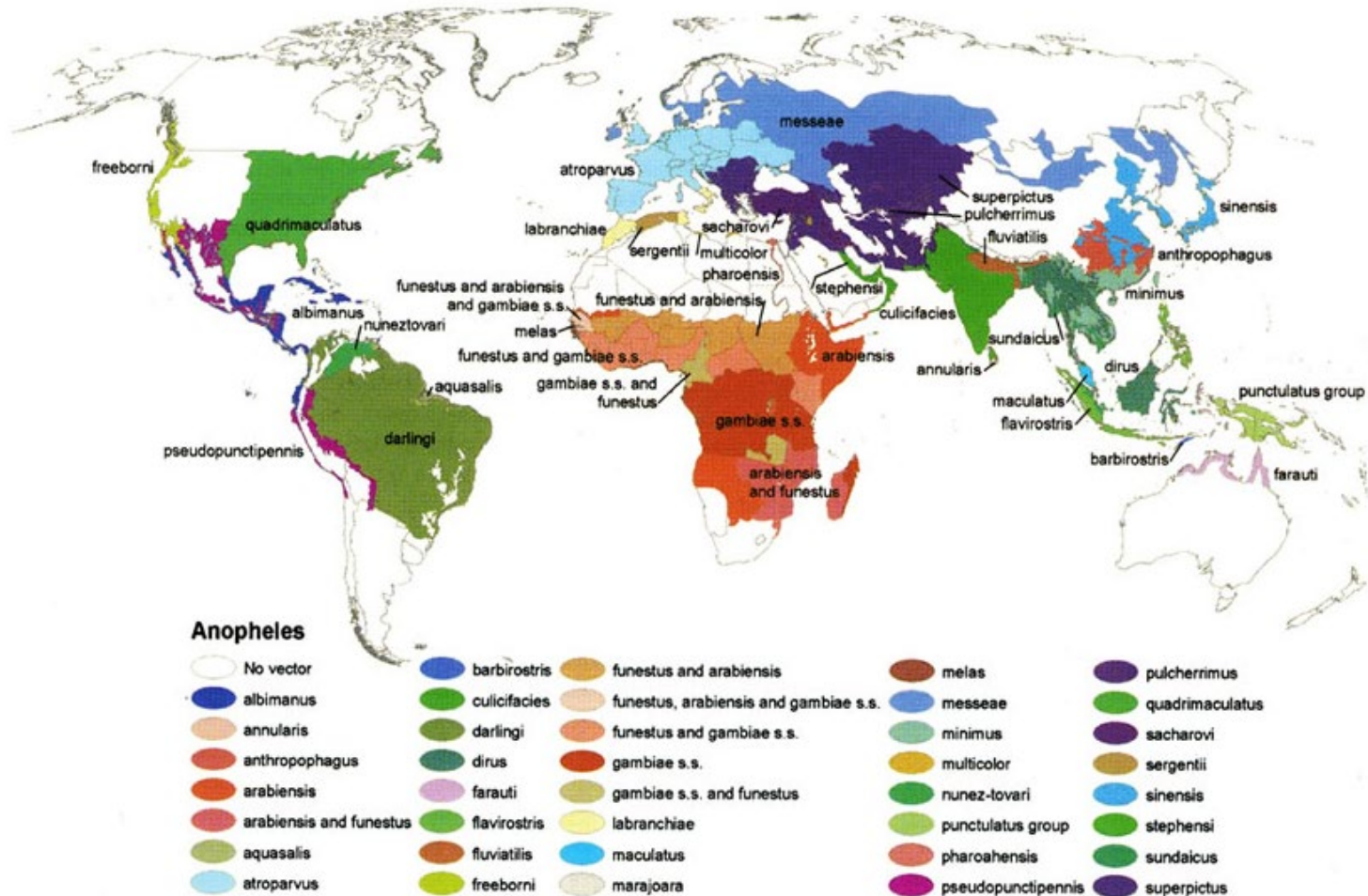
- **MALARIA**
- **It comes from the Italian "mala aria" = "bad air"**
- **Tropical and subtropical distribution with occasional outbreaks of epidemics in cold areas where there are vectors of infection (Anophelinae) - e.g. "Airport malaria" - arrival of infected mosquitoes by airplanes**



Medically significant Arthropoda - Anophelinae

• MALARIA

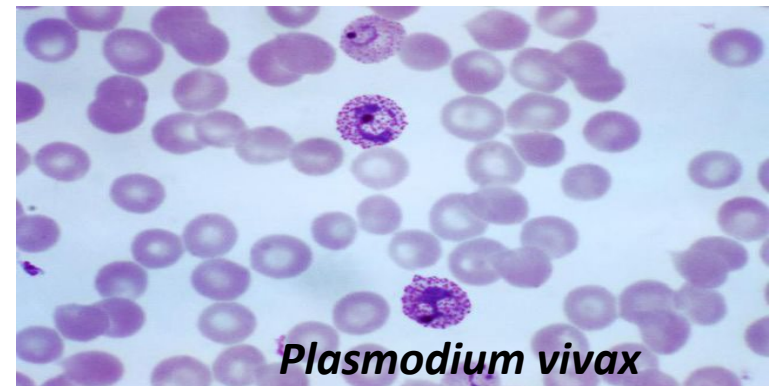
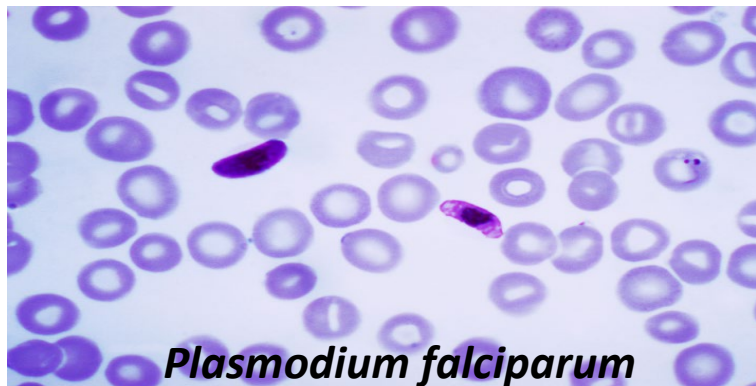
- Distribution of the most important malaria vectors - discovered that mosquitoes are carriers in 1898 in India (Ronald Ross)



Medically significant Arthropoda - Anophelinae



- **MALARIA**
- The causative agent of malaria was discovered by Charles Louis Alphonse Laveran in 1880 in Algeria
- 5 species from the genus *Plasmodium* (phylum Sporozoa, class Haemosporidea, order Haemosporidida) cause malaria:
 - *Plasmodium falciparum* (Tropics)
 - *Plasmodium vivax* (Tropics and Temperate Areas)
 - *Plasmodium malariae* (rare, widespread in the tropics)
 - *Plasmodium ovale* (rare, mostly in Africa)
 - *Plasmodium knowlesi* (very, very rare)



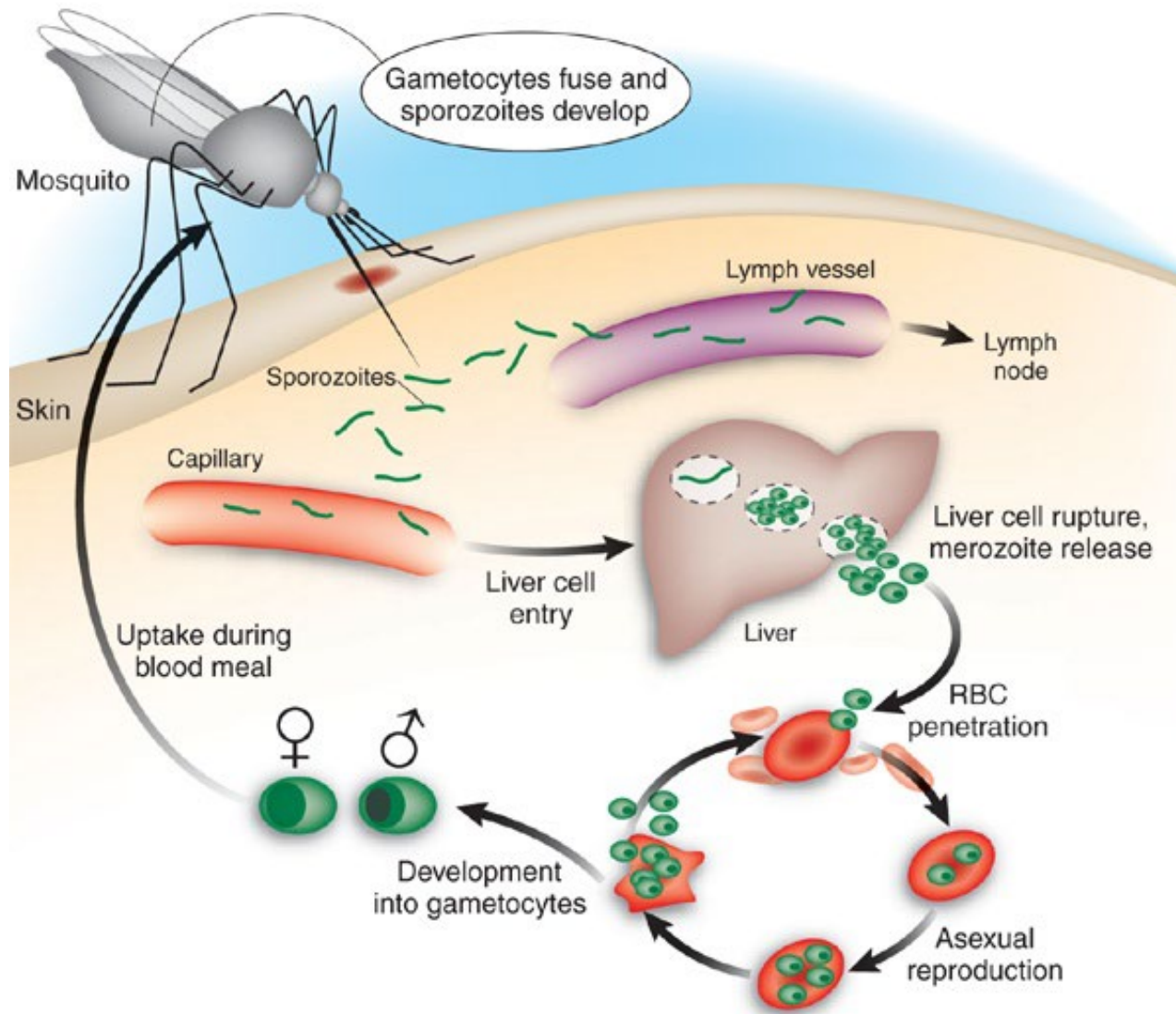
Medically significant Arthropoda - Anophelinae

- **MALARIA**
- Most often, it is not a zoonosis, except for *Plasmodium knowlesi* whose true hosts are macaque monkeys, common in SE Asia
- Potential zoonoses from species attacking other primates in Brazil (*P. brasilianum* = *P. malariae* and *P. simium*)
- Significantly more complicated life cycle than *Trypanosoma* or *Leishmania*



Medically significant Arthropoda - Anophelinae

- MALARIA** – life cycle



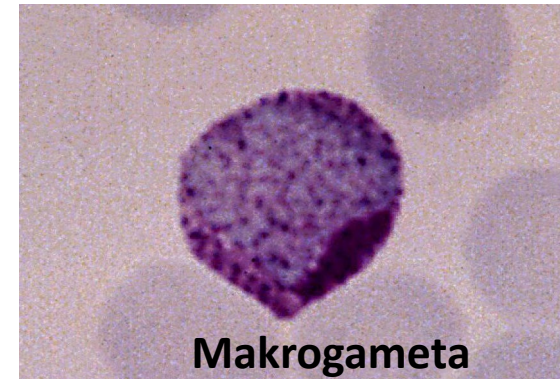
Medically significant Arthropoda - Anophelinae

- **MALARIA** – life cycle
 - **SPOROZOITES** migrate to the liver immediately after arriving in the subdermal capillaries and create a **PRIMARY TISSUE MERONT** in the liver (in the case of *P. vivax* and *P. ovale* they can create a **HYPNOZOITE** - resting phase)
 - They reproduce asexually in the liver for days or weeks (**EXOERYTHROCYTIC PHASE**), creating **MEROZOITES** and then they are released into the bloodstream where they infect red blood cells and in them they first create **TROPHOSOITES**, which feed on hemoglobin, then transition into **MERONTES (SHIZONTES)** and reproduce asexually in them (**ERYTHROCYTIC PHASE**) creating **MEROZOITES**
 - *Plasmodium* feeds on hemoglobin



Medically significant Arthropoda - Anophelinae

- **MALARIA** – life cycle
 - After some time, the sexual phase of the cycle begins in erythrocytes (**GAMETOGONY**), in erythrocytes a **GAMETOCIST** is formed (more precisely, male - **microgametocyst** and female - **macrogametocyst**).
 - When a mosquito drinks blood with infected erythrocytes that contain a **GAMETOCIST** and it reaches the lumen of the mosquito's intestine, a **MICROGAMETE** with 4 to 8 flagella comes out of the erythrocyte in a process called **EXFLAGELLATION**
 - A **MACROGAMETOCYTE** removes the erythrocyte membrane and turns into a mature **MACROGAMETE**

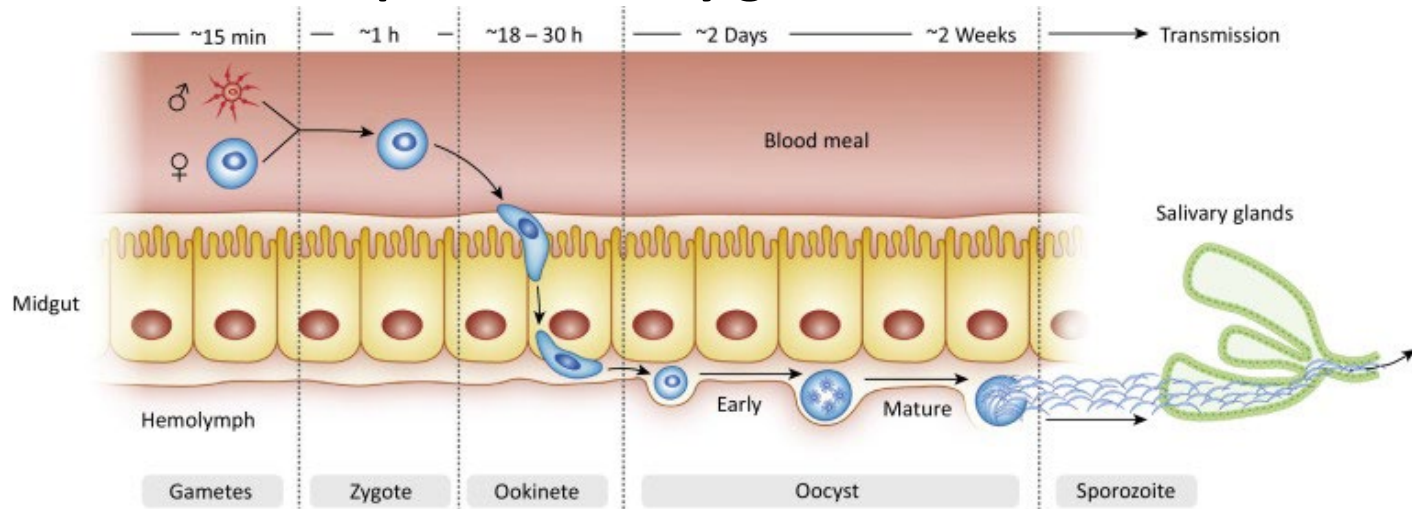


Medically significant Arthropoda - Anophelinae



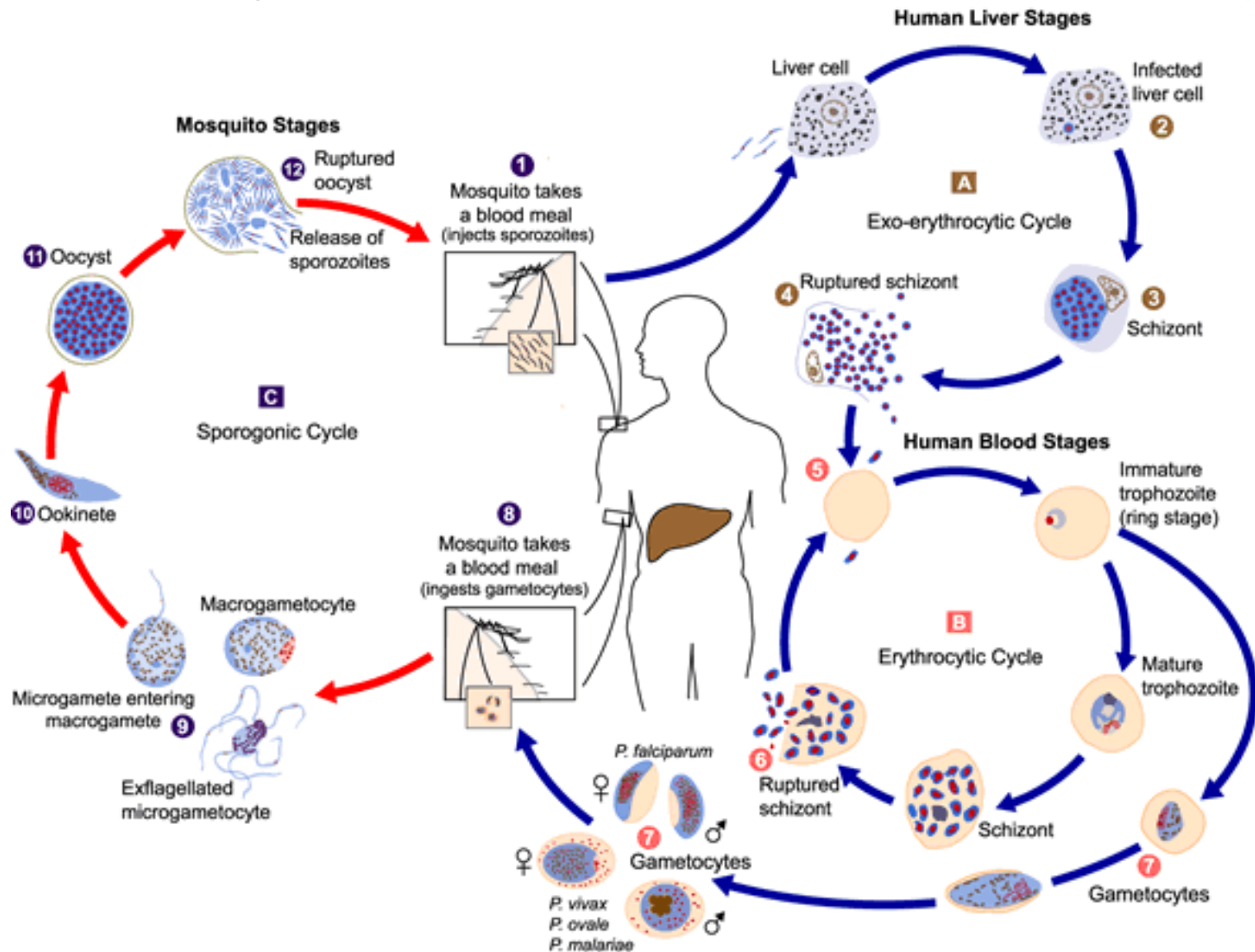
• **MALARIA** – life cycle

- A microgamete fertilizes a macrogamete and a zygote is formed, which turns into a motile **OOKINETE**
- The ookinete passes through the membranes of the mosquito intestine and forms an **OOCYST** between the cells of the intestinal epithelium and the basement membrane of the epithelium
- The oocyst then enters the **SPOROAGONIA** and contains haploid motile **SPOROZOITES**
- The oocysts eventually burst and release the sporozoites, which then travel to the mosquito's salivary glands



Medically significant Arthropoda - Anophelinae

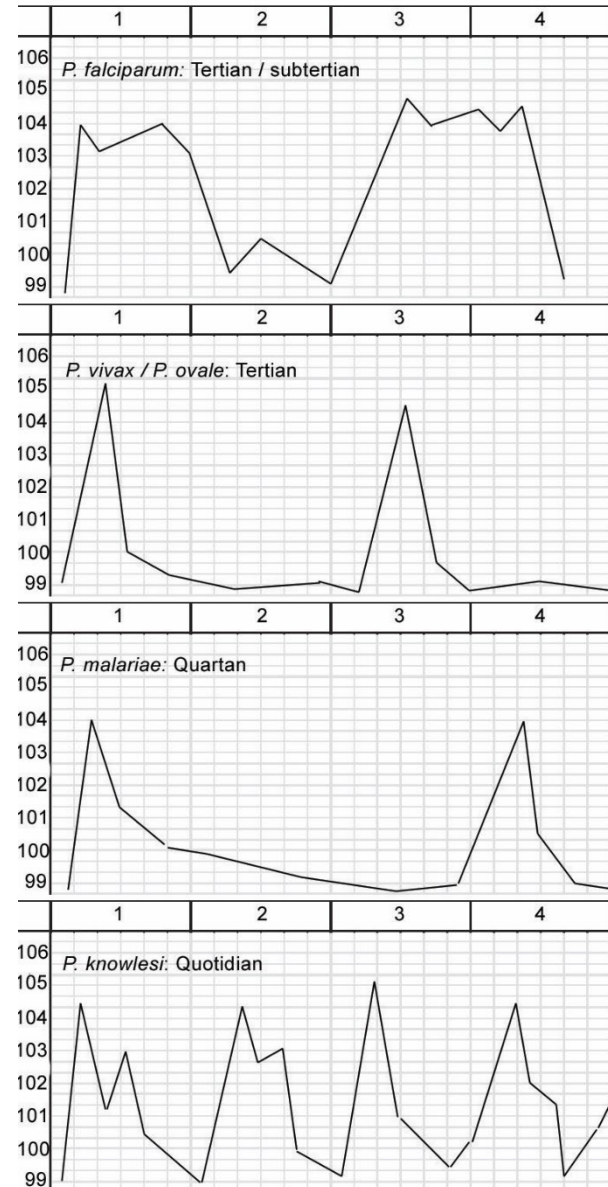
• MALARIA – life cycle



Medically significant Arthropoda - Anophelinae

• **MALARIA** – Symptoms

- They begin with the erythrocyte phase of the cycle from 7 to 25 days after infection (possible in the case of *P. vivax* up to 3 years)
- Recurrent acute episodes of fever and chills, headache and sweating that may be complicated by anemia, enlarged spleen (splenomegaly), lethargy, tissue anoxia and death
- Periodic paroxysms of fever and chills are associated with toxins produced during the breakdown of erythrocytes
- Synchronized rupture of erythrocytes causes exact waves of symptoms 24 h, 48 h, 72 h depending on the species of *Plasmodium*



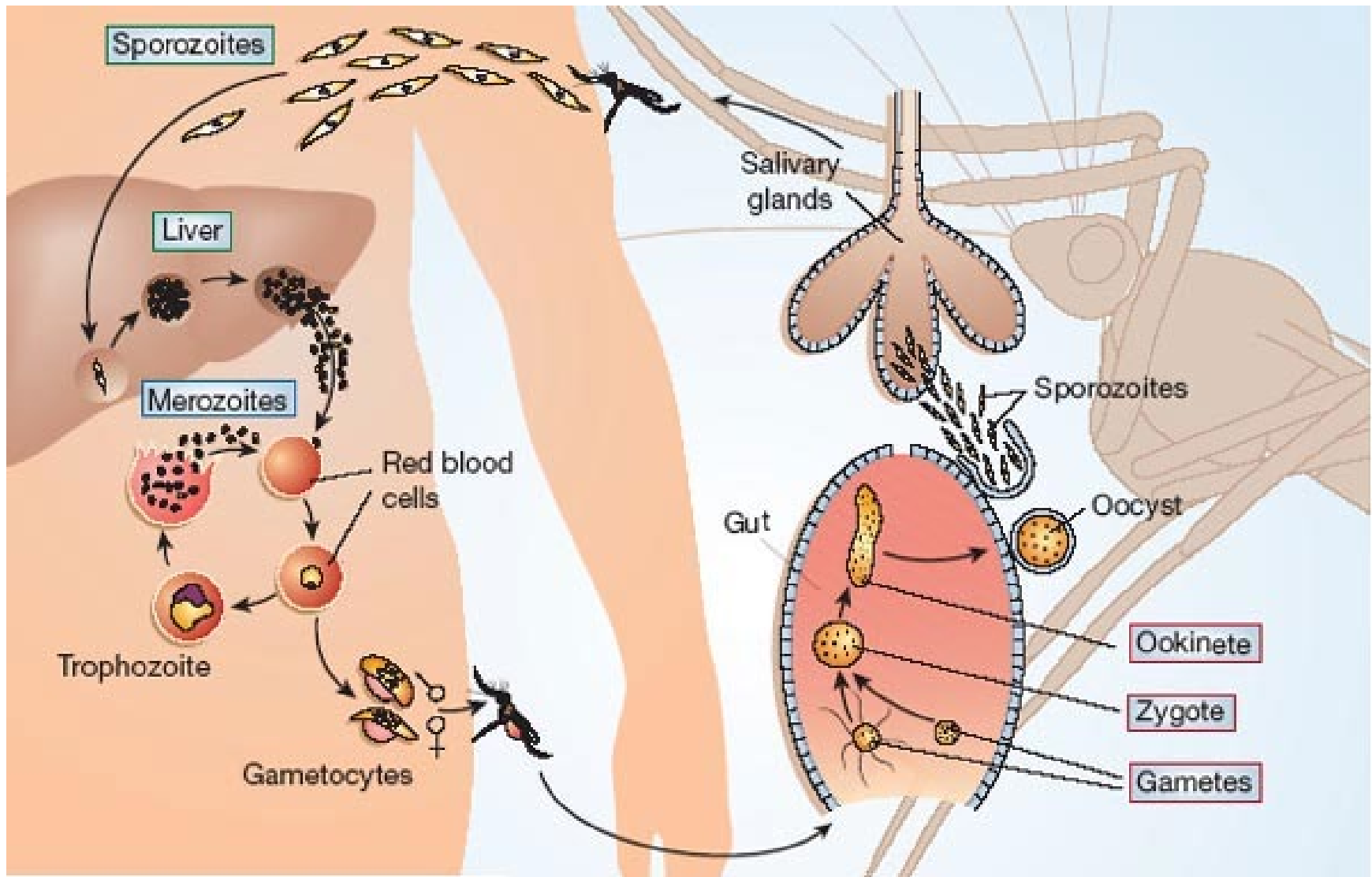
Medically significant Arthropoda - Anophelinae



- **MALARIA – *Plasmodium falciparum* – Malignant tertiary malaria**
 - *P. falciparum* enters all erythrocytes, causes severe anemia and tissue anoxia
 - Infected erythrocytes stick to the walls of capillaries and can lead to interruption of blood supply to certain organs - can cause fatal **CEREBRAL MALARIA**
 - The periodicity of symptoms (periodic paroxysm) varies from 36 h to 48 h
 - Worst of all forms of malaria (98% of all malaria deaths)
 - Symptoms can last over 5 months (up to 2 years) if left untreated
 - More than 50% of all cases in the world

Medically significant Arthropoda - Anophelinae

- **MALARIA** – *Plasmodium falciparum* – Malignant tertiary malaria



Medically significant Arthropoda - Anophelinae

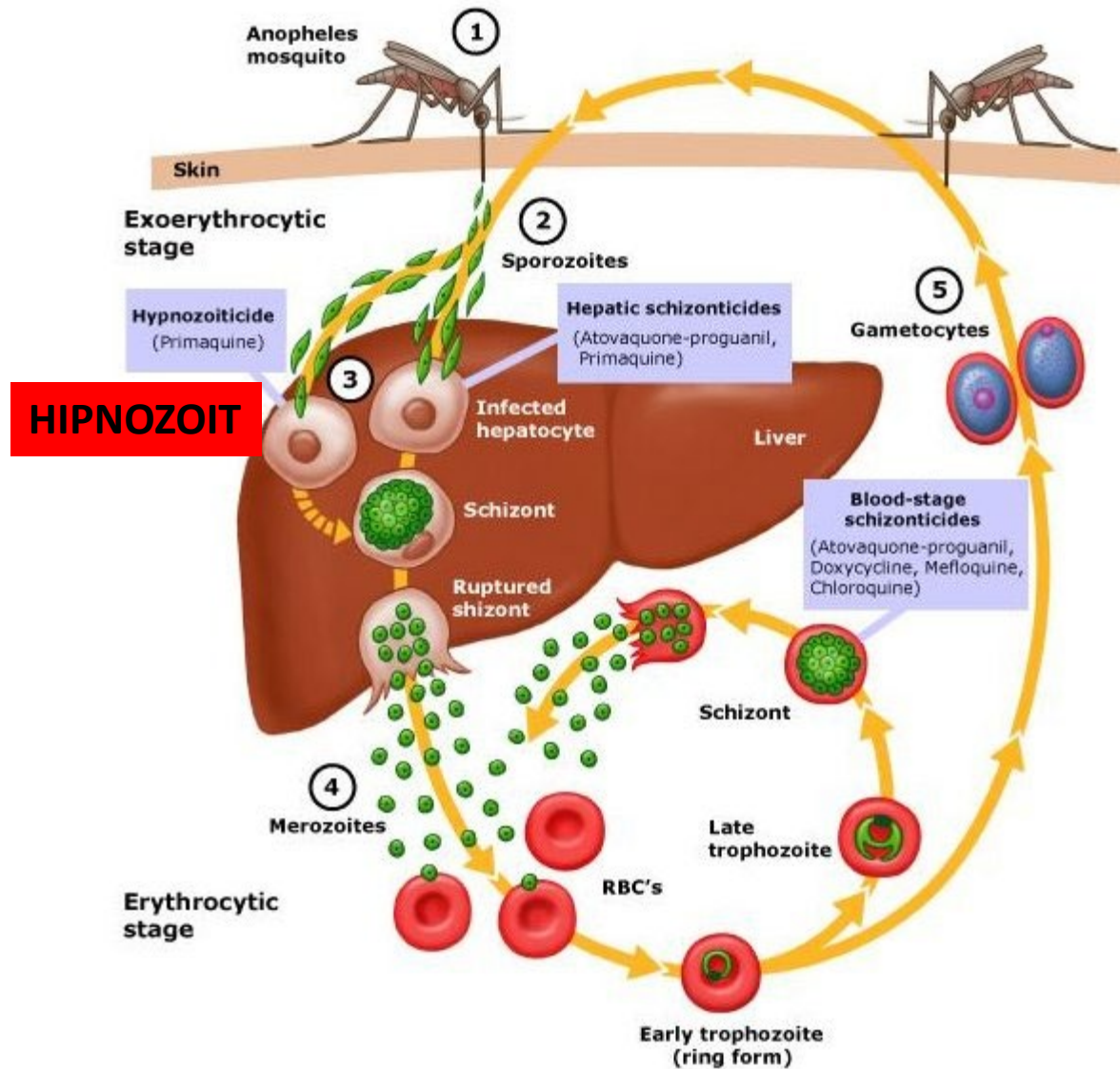


- **MALARIJA – *Plasmodium vivax* – Benign tertiary malaria**
 - *P. vivax* can only attack immature erythrocytes (less than 6% of all erythrocytes)
 - Periodicity of 48 h with relatively mild symptoms, rarely ends fatally, but can last for months or years if untreated
 - 25% of all cases in the world, but the widest distribution
 - The most common form in South America, SE Asia, the Mediterranean region, Europe and relatively rare in Africa
 - **HYPNOZOITE** phase present (delayed onset of the disease, common in areas with a temperate climate) and reappearance of the disease after some time
 - Chronic infection - enlarged spleen - **SPLENOMEGALY** (possible in others as well)



Medically significant Arthropoda - Anophelinae

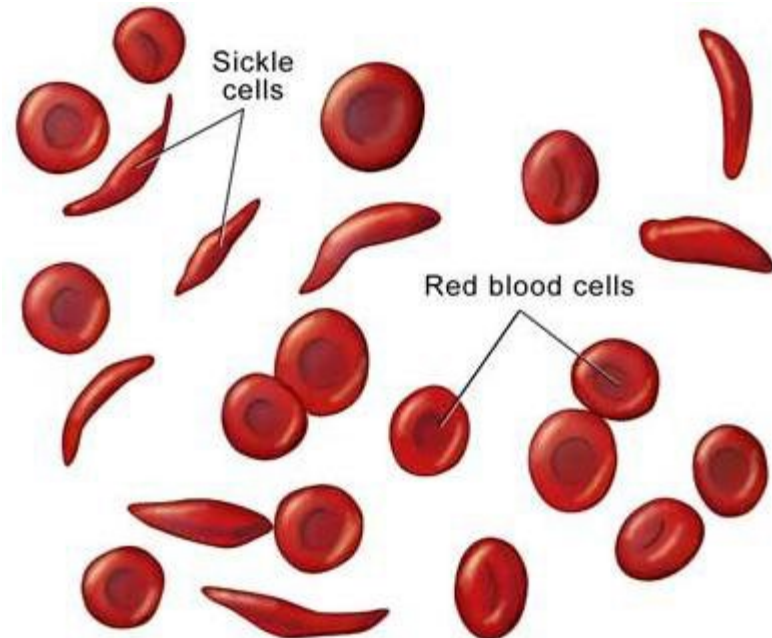
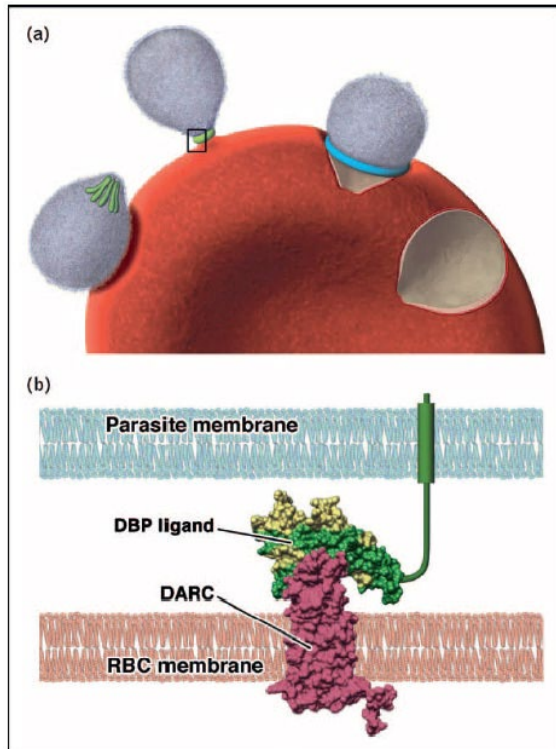
- **MALARIA – *Plasmodium vivax* – Benign tertiary malaria**



Medically significant Arthropoda - Anophelinae

- **MALARIA** – Symptoms

- The severity of the symptoms depends on the age of the patients (children are more at risk), lack of spleen, exposure, certain genetic characteristics - for example, sickle cell anemia in *P. falciparum* (In Africa, in some countries up to 45% of people have it - Uganda), mutation of the Duffy antigen (Fy antigen system) on blood groups that provides partial or complete protection against *P. vivax*



Medically significant Arthropoda - Anophelinae

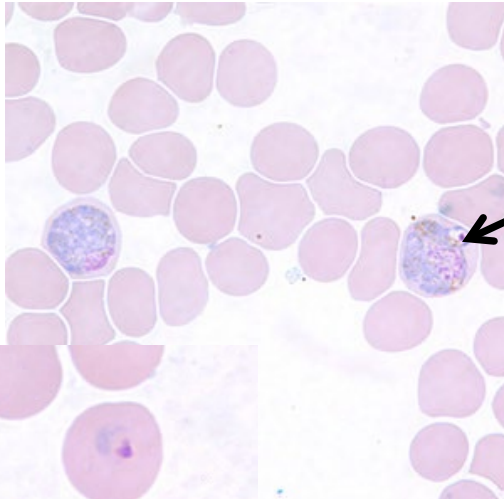


- **MALARIA** – Symptoms and recurrence
- In *P. vivax* and *P. ovale* (rare but similar to *P. vivax*), some HYPNOZOITES remain dormant in the liver for years, causing disease to recur long after the first time
- In *P. falciparum* and *P. malariae* (Benign quaternary malaria) there is no HYPNOZOITE phase, but the parasite never completely disappears from the blood??? (constant low infection of erythrocytes) and relapse of the disease in case of immunosuppression
- *Plasmodium* spp. contains various antigens on its surface that allow it to evade the host's immune response - The immune response is still not fully understood
- Non-sterile immunity usually needs to develop around 2 years for *P. falciparum*, 5 years for *P. vivax*, up to 30 years for *P. malariae*
- Re-emergence of infection in *P. falciparum* and *P. malariae*, and relapses in *P. vivax* and *P. ovale*
- Immunity is species-specific, perhaps even strain-specific (symptoms reappear after reinfection with the same species)

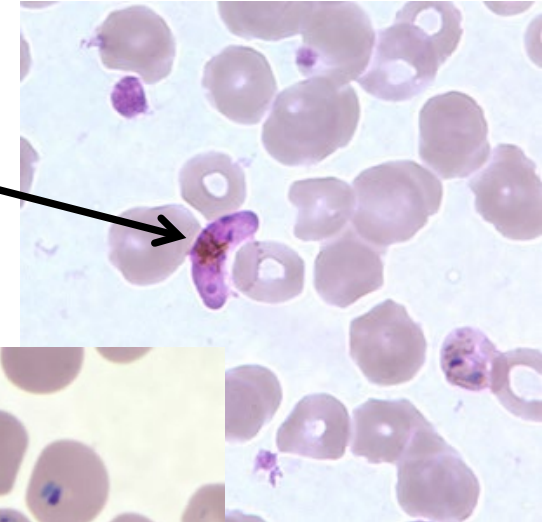
Medically significant Arthropoda - Anophelinae

- **MALARIA** – Diagnosis
- It can be diagnosed clinically, but if at all possible, confirmation through blood smears is recommended

P. vivax

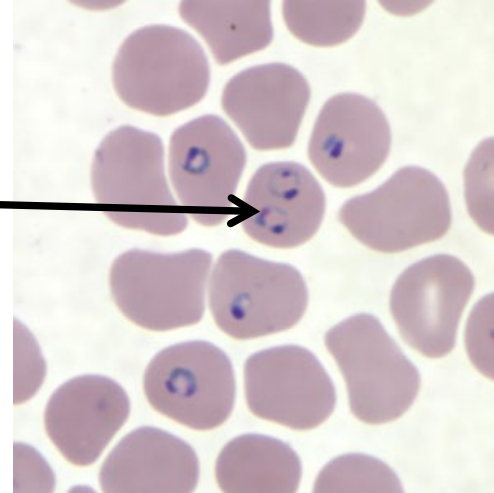
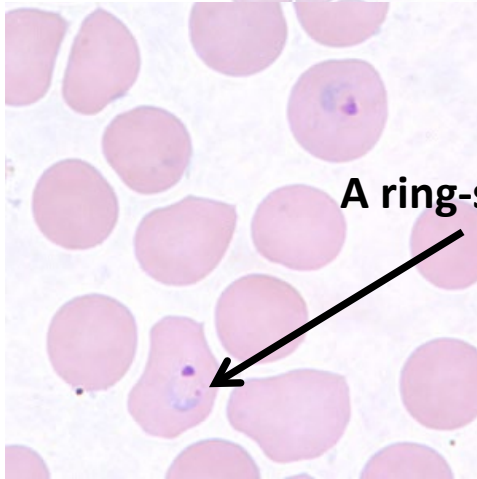


P. falciparum



GAMETOCYTES

A ring-shaped TROPHOZOITE



Medically significant Arthropoda - Anophelinae

- **MALARIA** – Diagnosis
- Antigen detection using Rapid Diagnostic Tests (Antibodies on the strips react with parasite antigens in the patient's blood)
- Detection by PCR
- Serology: different approaches based on antibody detection (not applicable for acute episodes) – Variable sensitivity, much better in combination with other techniques (PCR, blood smear, etc.)



Medically significant Arthropoda - Anophelinae



- **MALARIA** – Treatment
- Quinine was the first drug available, but it has many side effects, it is still used in very severe cases of malaria caused by *P. falciparum*
- Chloroquine (Hydroxychloroquine) became very common in use in the 1950s and replaced quinine whenever possible
- High resistance to both drugs, a large number of relapses and re-outbreaks of infection
- New treatments based on species and location



Medically significant Arthropoda - Anophelinae

- **MALARIA – QUININE**
- Quinine was used to relax muscles and fever among the Quechua people in Peru, Bolivia and Ecuador - they mixed the bark of the quinine tree with sweetened water - the first tonic
- Quinine in its unextracted form was used in Europe from the beginning of the 17th century - it was introduced by the Jesuit from Lima Agostino Salumbrino - it was sent to Rome for testing because Rome was full of malaria at that time
- In London, quinine became popular at the end of the 17th century when King Charles II. was cured of malaria
- In 1820, Pierre Joseph Pelletier and Joseph Bienaimé Caventou isolated the alkaloid quinine from the plant *Cinchona* sp.
- The widespread use of quinine as a prophylaxis began around 1850
- The Dutch produced 97% of quinine in Java until II. World War and the occupation of the Netherlands, the USA began production in Costa Rica
- During II. During World War 60,000 US soldiers died of malaria - lack of quinine

Medically significant Arthropoda - Anophelinae

- **MALARIA – QUININE**
 - Quinine was drunk in tonic water, but due to its great bitterness, at the beginning of the 19th century, British officers in India added water, sugar, lime and gin to it, and that's how one of today's most famous cocktails, **GIN AND TONIK**, was born



Medically significant Arthropoda - Anophelinae



- **MALARIA** – Treatment
- **Artemisinin** combination therapy (ACT) is currently the most effective therapy for uncomplicated cases
- Combination of Artemisinin derivatives (very short drug half-life) with other drugs (eg: Artemether + Lumefantrine; Artesunate + Mefloquine)
- The drug has a targeted effect on all life stages of *P. falciparum*
- Resistance to Artemisinin monotherapy developed rapidly and varies geographically (WHO 2014)



Medically significant Arthropoda - Anophelinae

- **MALARIA** – Treatment
- Artemisinin was discovered by the Chinese scientist and chemist Tu Youyou, for which she received the Nobel Prize



Medically significant Arthropoda - Anophelinae



- **MALARIA** – Treatment
- The treatment of *P. vivax* is a little more complex because the phase of the cycle in erythrocytes and the dormant phase (HYPNOZOITE) in the exoerythrocytic cycle must be treated.
- To kill SCHIZONT: Chloroquine or in resistant areas Malarone (Atovaquone-proguanil), Mefloquine or Artemisinin-based therapy (ACT)
- Primaquine is used to kill HYPNOZOITES (except in the absence of the G6DP enzyme (glucose-6-phosphate dehydrogenase) and during pregnancy)
- **Antimalarial drugs (Prophylaxis)** - when going to an area where there is malaria (Atovakon - proguanil, Chloroquine phosphate, Clindamycin, Doxycycline,...) - it depends on where you are going, which additional vaccines you need to get, which type of *Plasmodium* is there, resistance on medication, etc.

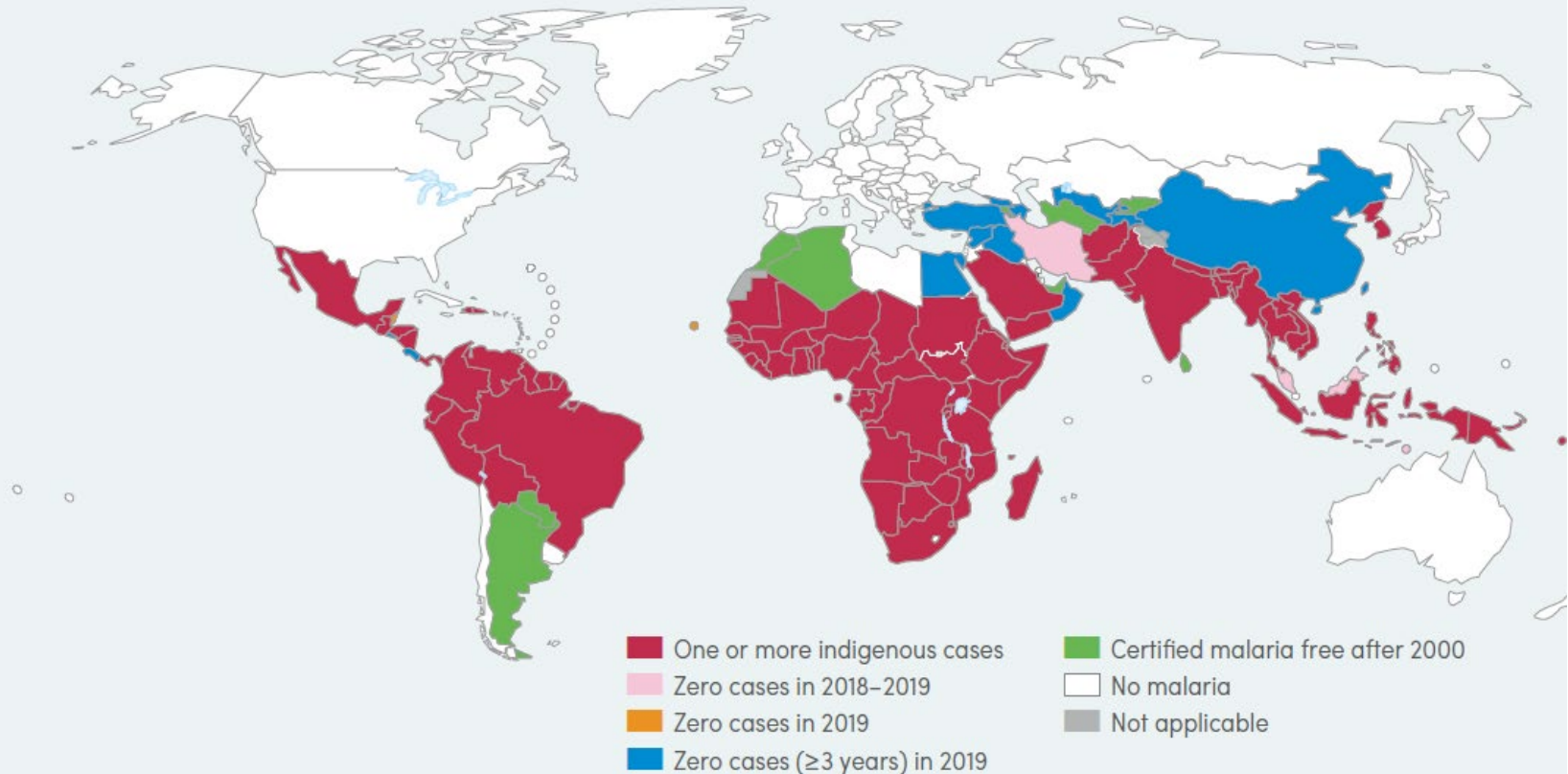


Medically significant Arthropoda - Anophelinae

• MALARIA – Global view

FIG. 3.1.

Countries with indigenous cases in 2000 and their status by 2019 Countries with zero indigenous cases over at least the past 3 consecutive years are considered to have eliminated malaria. In 2019, China and El Salvador reported zero indigenous cases for the third consecutive year and have applied for WHO certification of malaria elimination; also, the Islamic Republic of Iran, Malaysia and Timor-Leste reported zero indigenous cases for the second time. *Source: WHO database.*



Medically significant Arthropoda - Anophelinae

• MALARIA – Global view

TABLE 3.1.

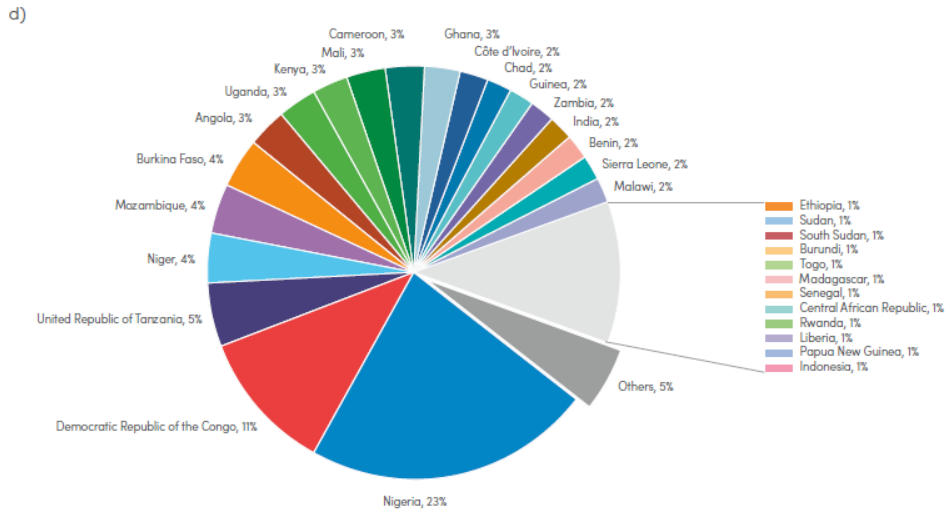
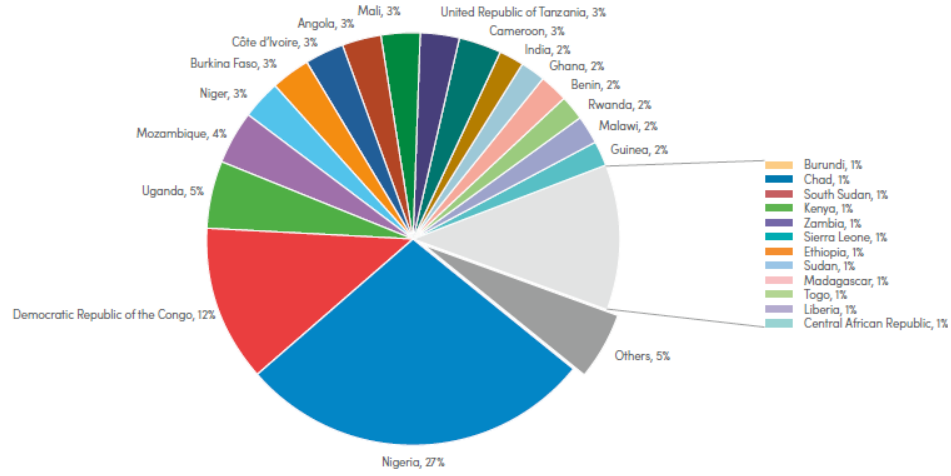
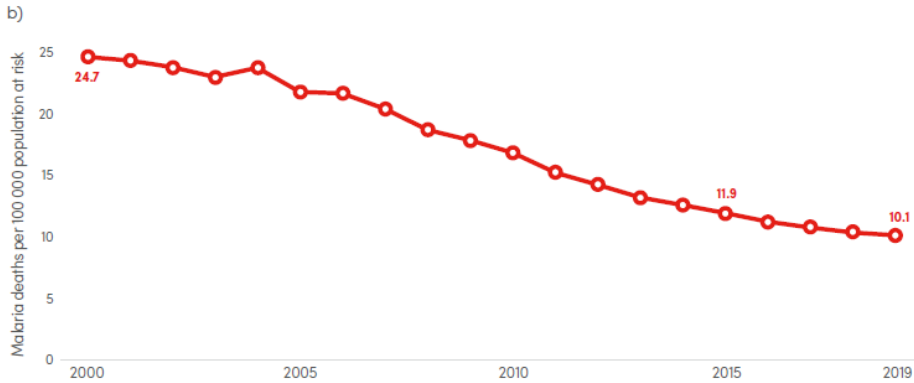
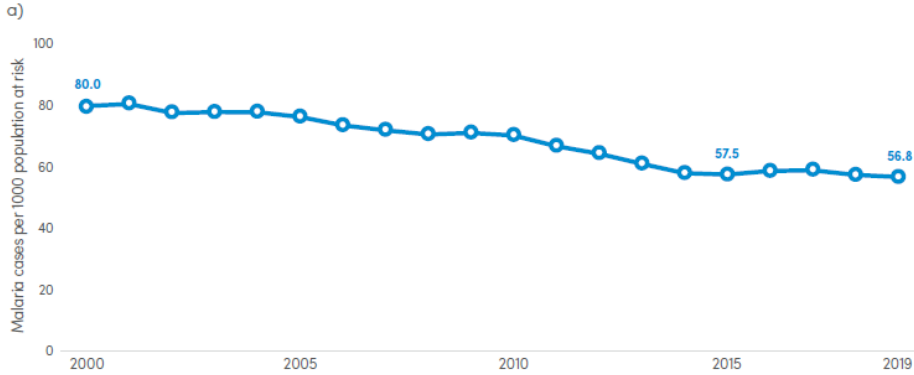
Global estimated malaria cases and deaths, 2000–2019 Estimated cases and deaths are shown with 95% upper and lower confidence intervals. *Source: WHO estimates.*

Year	Number of cases (000)				Number of deaths		
	Point	Lower bound	Upper bound	% <i>P. vivax</i>	Point	Lower bound	Upper bound
2000	238 000	222 000	259 000	6.9%	736 000	697 000	782 000
2001	244 000	228 000	265 000	7.4%	739 000	700 000	786 000
2002	239 000	223 000	260 000	7.1%	736 000	698 000	783 000
2003	244 000	226 000	268 000	7.8%	723 000	681 000	775 000
2004	248 000	227 000	277 000	8.0%	759 000	708 000	830 000
2005	247 000	229 000	272 000	8.3%	708 000	662 000	765 000
2006	242 000	223 000	268 000	7.2%	716 000	675 000	771 000
2007	241 000	222 000	265 000	6.8%	685 000	644 000	735 000
2008	240 000	222 000	264 000	6.5%	638 000	599 000	685 000
2009	246 000	226 000	271 000	6.5%	620 000	572 000	681 000
2010	247 000	226 000	273 000	7.0%	594 000	546 000	658 000
2011	239 000	218 000	262 000	7.2%	545 000	505 000	596 000
2012	234 000	213 000	258 000	6.6%	517 000	481 000	568 000
2013	225 000	206 000	248 000	5.3%	487 000	451 000	538 000
2014	217 000	201 000	236 000	4.3%	471 000	440 000	511 000
2015	218 000	203 000	238 000	3.9%	453 000	422 000	496 000
2016	226 000	210 000	247 000	4.0%	433 000	403 000	478 000
2017	231 000	213 000	252 000	3.4%	422 000	396 000	467 000
2018	228 000	211 000	250 000	3.2%	411 000	389 000	458 000
2019	229 000	211 000	252 000	2.8%	409 000	387 000	460 000

Medically significant Arthropoda - Anophelinae

• MALARIA – Global view

FIG. 3.2. Global trends in a) malaria case incidence rate (cases per 1000 population at risk), b) mortality rate (deaths per 100 000 population at risk), 2000–2019, c) distribution of malaria cases and d) deaths by country, 2019 Source: WHO estimates.



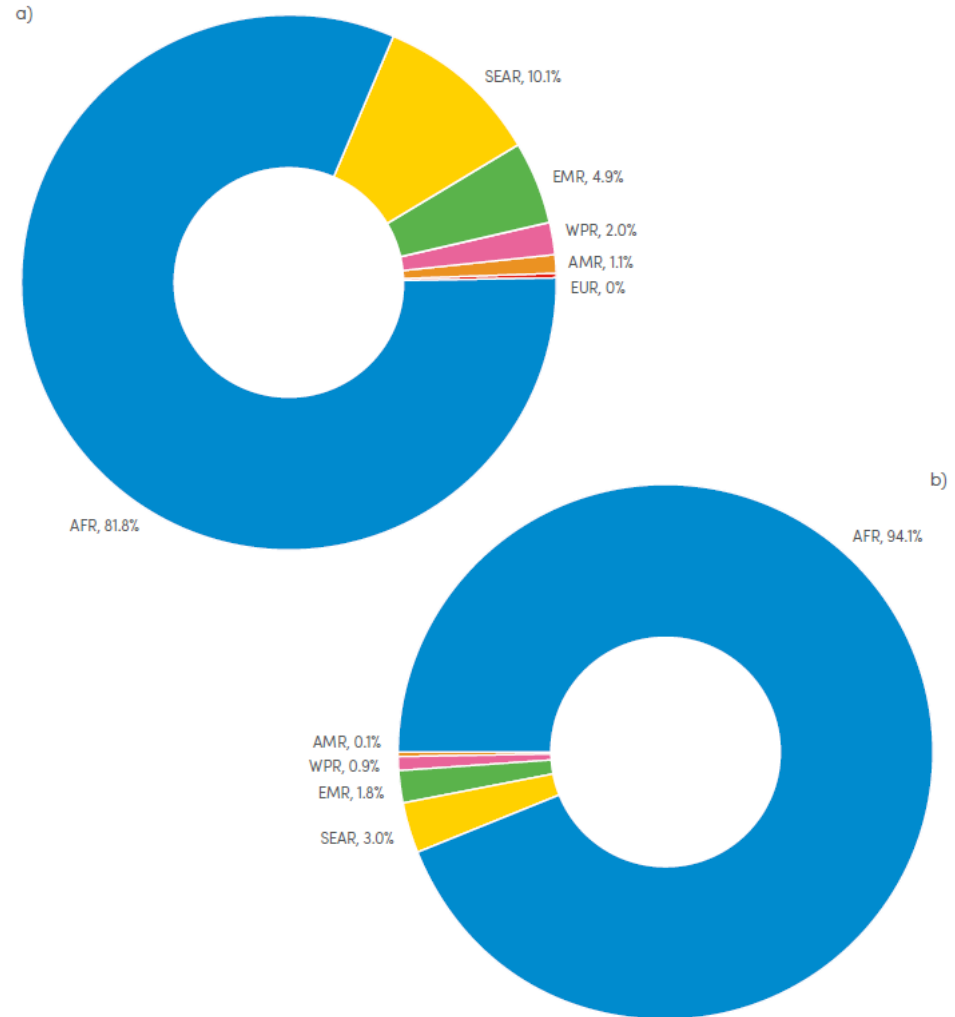
Medically significant Arthropoda - Anophelinae

• MALARIJA – Global view

- 98% of mortality related to *P. falciparum*
- In 2022, 249 million new cases and 608,000 deaths
- In the African region, 94% of all malaria cases and related mortality
- Mortality has fallen from 1 million cases before 2000 to just over 600,000, a significant reduction
- In Africa, mortality decreased by 50%, in some countries by up to 90%

FIG. 3.9.

Percentage of a) cases and b) deaths averted by WHO region, 2000–2019 Source: WHO estimates.

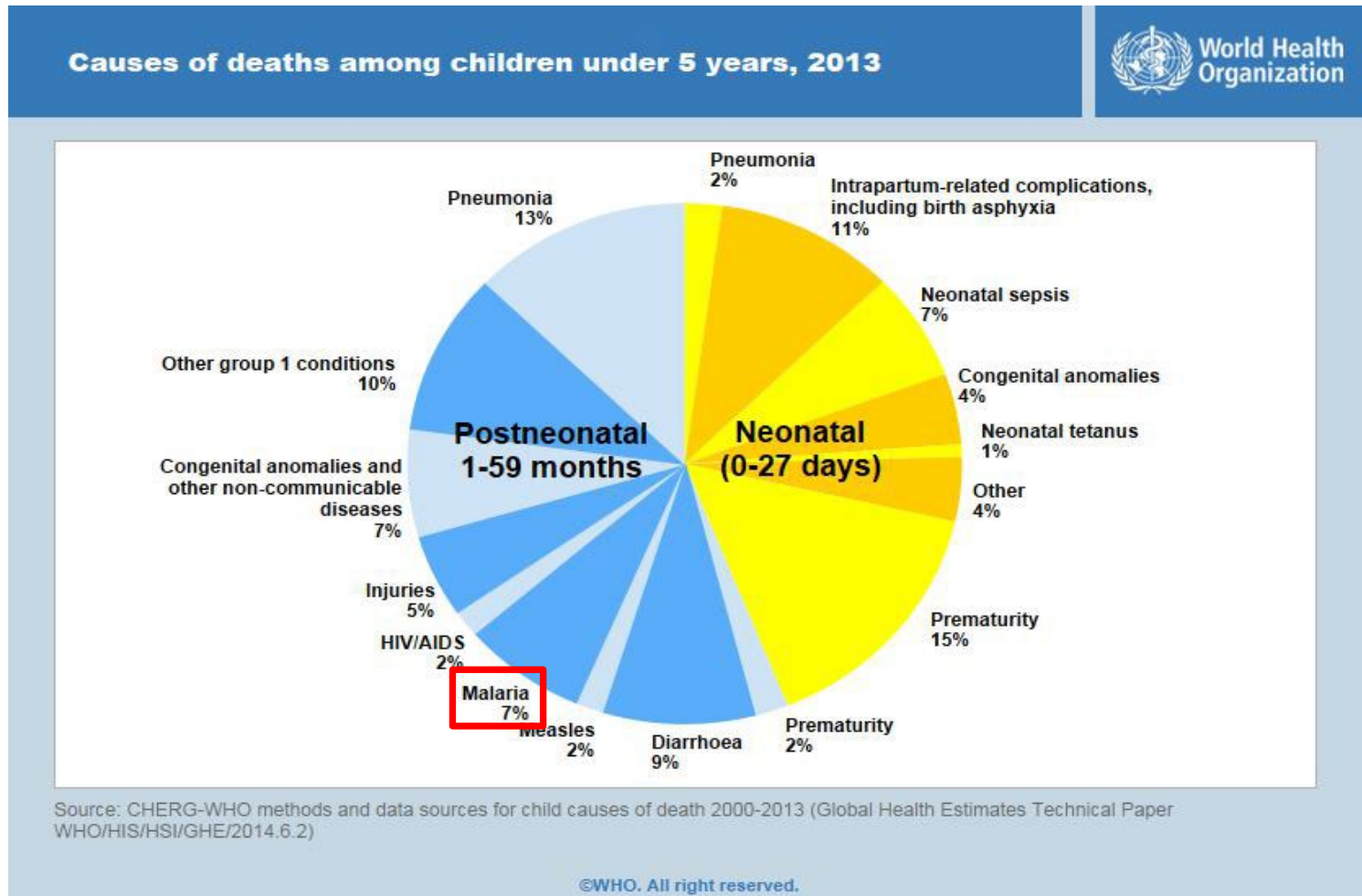


AFR: WHO African Region; AMR: WHO Region of the Americas; EMR: WHO Eastern Mediterranean Region; EUR: WHO European Region; SEAR: WHO South-East Asia Region; WHO: World Health Organization; WPR: WHO Western Pacific Region.

Medically significant Arthropoda - Anophelinae

• MALARIA – Global view

- 608,000 deaths in 2022, of which almost 70% are African children under the age of 5 (~275,000)




Medically significant Arthropoda - Anophelinae

- **MALARIA** – Global view
 - Malaria prevention and control increased from 100 million dollars a year in 2000 to 2.5 billion dollars in 2015
 - Distribution of one billion ITN (insecticide-treated bed nets) between 2000-2015 (In 3% of Sub-Saharan households in 2000, >50% in 2015)
 - Mass distribution of ACT (Artemisinin-based combination therapy)
 - The WHO has estimated that 8 billion are needed annually to control malaria globally
 - Malaria is transmitted through the placenta and blood transfusion
 - Although most people survive, the socio-economic pressure on areas where malaria is endemic is great and long-lasting
 - Vector breeding area reductions (helps up to a certain level)
 - Repellents against insects (mosquitoes) can definitely help and the use of ITN nets for beds
 - **BUT THE LIGHT AT THE END OF THE TUNNEL....**

Medically significant Arthropoda - Anophelinae

- **MALARIA – VACCINE**
- Approved vaccine for the first time in 2021!!!!!!!!!!!!
- RTS,S/AS01 (Mosquirix) - primarily intended for vaccination of children - started with vaccination in 2019 in Malawi, Ghana and Kenya - already visible reduction in child mortality up to 30%!!!!!!!!!!!!





World Health Organization


The Malaria Vaccine Implementation Programme is a collaboration of the Ministries of Health in Ghana, Kenya and Malawi, WHO, PATH, GSK, UNICEF and partners.

The RTS,S Malaria Vaccine

A WHO recommended vaccine for added protection against malaria to improve child health, save lives and strengthen malaria control in Africa and in other regions with moderate to high malaria transmission

Malaria: An enduring health challenge

Malaria remains a primary cause of childhood illness and death in Africa and holds back prosperity in the region.



400K+
DEATHS
per year

African children are at highest risk

260K+
CHILD DEATHS
PER YEAR

Malaria has a negative impact on economies

USD
\$12
BILLION

in lost productivity annually worldwide




70%




per capita income levels in endemic countries

UP TO 40%

of public health budget of some African countries goes to treating malaria


Malaria progress has stalled. A tailored, optimal mix of tools – including RTS,S – can get malaria control back on track.

The RTS,S/AS01 malaria vaccine pilots in Africa

Significantly reduces malaria and life-threatening severe malaria. Since 2019, delivered in childhood vaccination in 3 country-led pilots.



IN 2+ YEARS

2.3 Million+

DOSES

800K+

CHILDREN VACCINATED

Estimated to be cost-effective in areas of moderate to high malaria transmission

30

YEARS

The result of 30 years of research & development

The RTS,S vaccine can be delivered through the existing platform of childhood vaccination that reaches more than 80% of children.

What we know about the RTS,S malaria vaccine in routine use in Africa

Feasibility

- ▲ Delivery of the vaccine is feasible.
- ▲ High, equitable vaccine coverage shown in routine use indicates community demand and the capacity of countries to effectively deliver it.
- ▲ No negative impact of vaccination on insecticide-treated bednet (ITN) use, uptake of other childhood vaccines, or care-seeking behaviour

Equity

- ▲ Increases equity in access to malaria prevention: in routine use, the vaccine reached more than two-thirds of children who are not sleeping under a bednet (ITN)
- ▲ Layering the tools results in over 90% of children benefiting from at least one preventive intervention (ITN or the malaria vaccine)

Impact

- ▲ 1 life saved for every 200 children vaccinated
- ▲ 40% reduction in malaria episodes
- ▲ Substantial reduction in deadly severe malaria in routine use
- ▲ Impact optimized in highly seasonal malaria settings by providing doses prior to peak “rainy” season

+

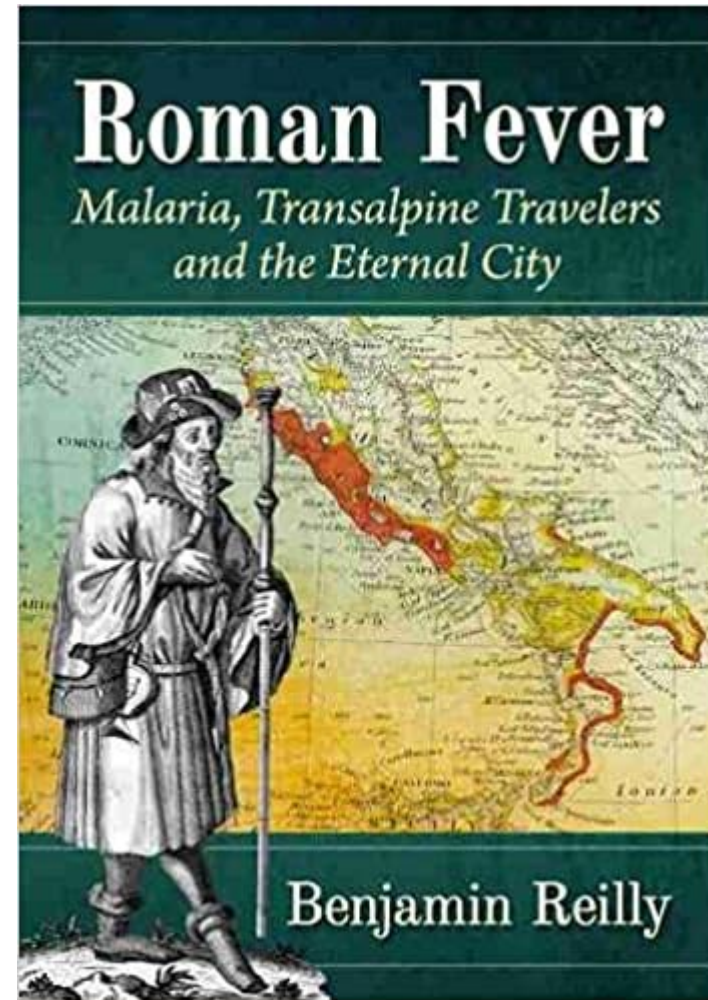
To date, more than 2.3 million doses of the vaccine have been administered – the vaccine has a favorable safety profile.

Thank you

Thank you to the Ministries of Health of Ghana, Kenya and Malawi for their leadership and commitment to the RTS,S/AS01 malaria vaccine pilot programme. Thank you to Gavi, the Vaccine Alliance, the Global Fund to Fight AIDS, Tuberculosis and Malaria and Unitaid for their generous support.

Medically significant Arthropoda - Anophelinae

- **MALARIA** – In the world
- Malaria is thought to have been present in humans for 50,000 years
- It is possible that it shaped and influenced the collapse of the Roman Empire - *P. falciparum*
- Influenced the relocation of holidays - in 835, the holiday of All Saints Pope Gregory IV moved from the 5th month to the 11th month due to the "Roman fever" that was raging in Rome and spread due to the large number of pilgrims



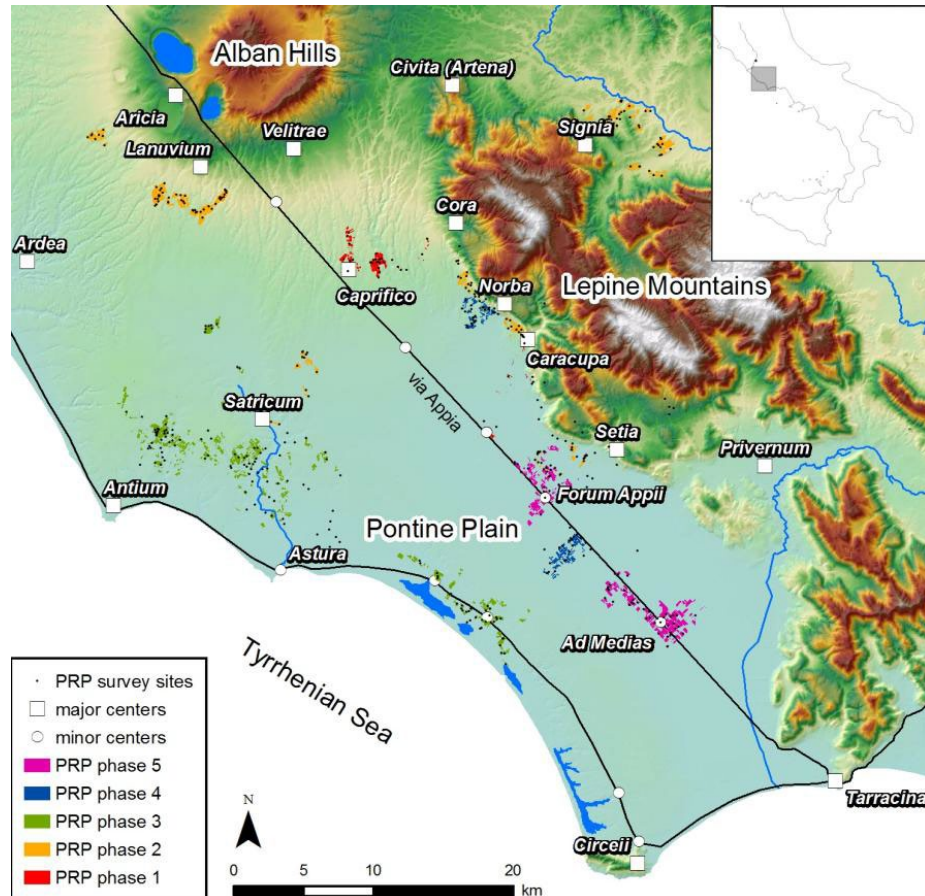
Medically significant Arthropoda - Anophelinae

- **MALARIA** – In the world
- An example of the construction of the Rideau Canal in 1827 - 1832 (Canada) – more than 500 people died from malaria (*Plasmodium vivax*)
- In Denmark, devastating epidemics in rural areas until 1860, similarly in Sweden, sporadic cases until 1939
- In Paris, a large epidemic in 1865 during the construction of the Grand Boulevards
- Construction of canals (Suez and Panama canals) – good prevention against malaria



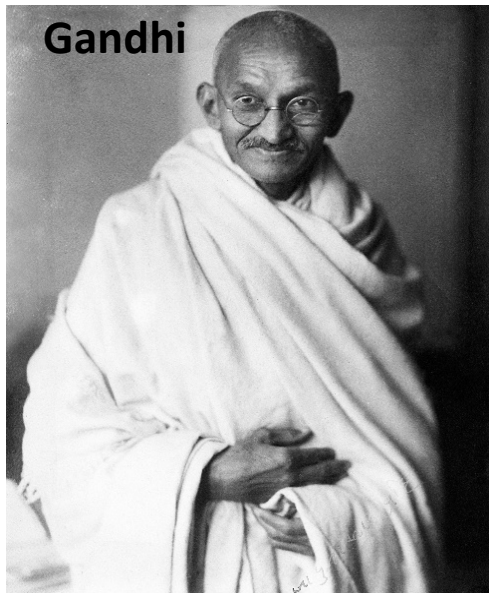
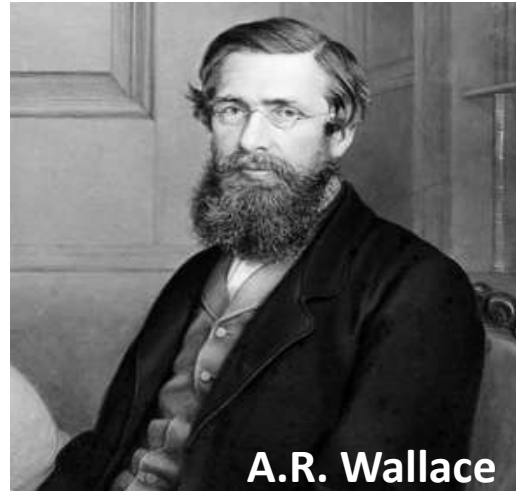
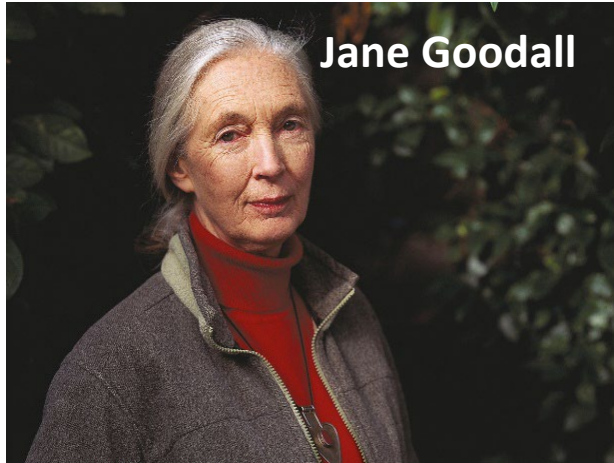
Medically significant Arthropoda - Anophelinae

- **MALARIA** – In the world
- During II. In 1943, the Germans flooded the Pontic Marsh and reintroduced malaria to stop the advance of the British



Medically significant Arthropoda - Anophelinae

- **MALARIA** – In the world
- Famous people who got over or died from malaria

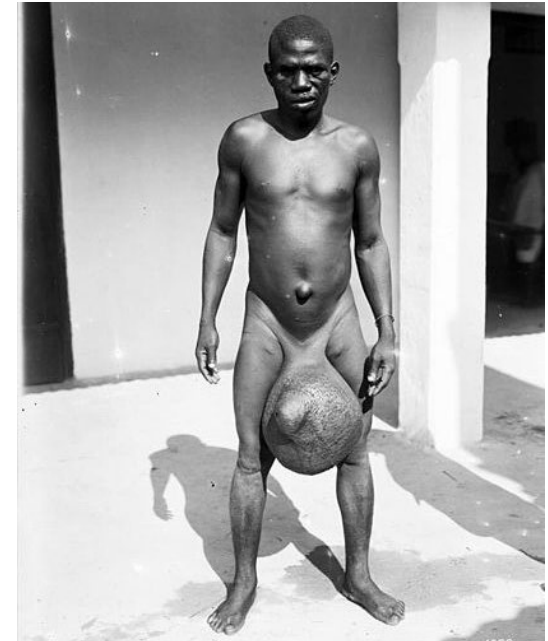


And many, many others...

Medically significant Arthropoda - Anophelinae and Culicinae



- **LYMPH FILARIOSIS (ELEPHANTIASIS)**
- It is caused by 3 types of filarial worms (Nematodes) *Wuchereria bancrofti*, *Brugia malayi* and *B. timori* (causing Bancroftian or Brugia (Malay) filariasis)
- 40 species of Anophelinae mosquitoes (most often nocturnal species, *Anopheles* spp.) and about 40 species of Culicinae mosquitoes (mostly diurnal species, *Culex* spp., *Mansonia* spp., *Aedes* spp.) can transmit forms

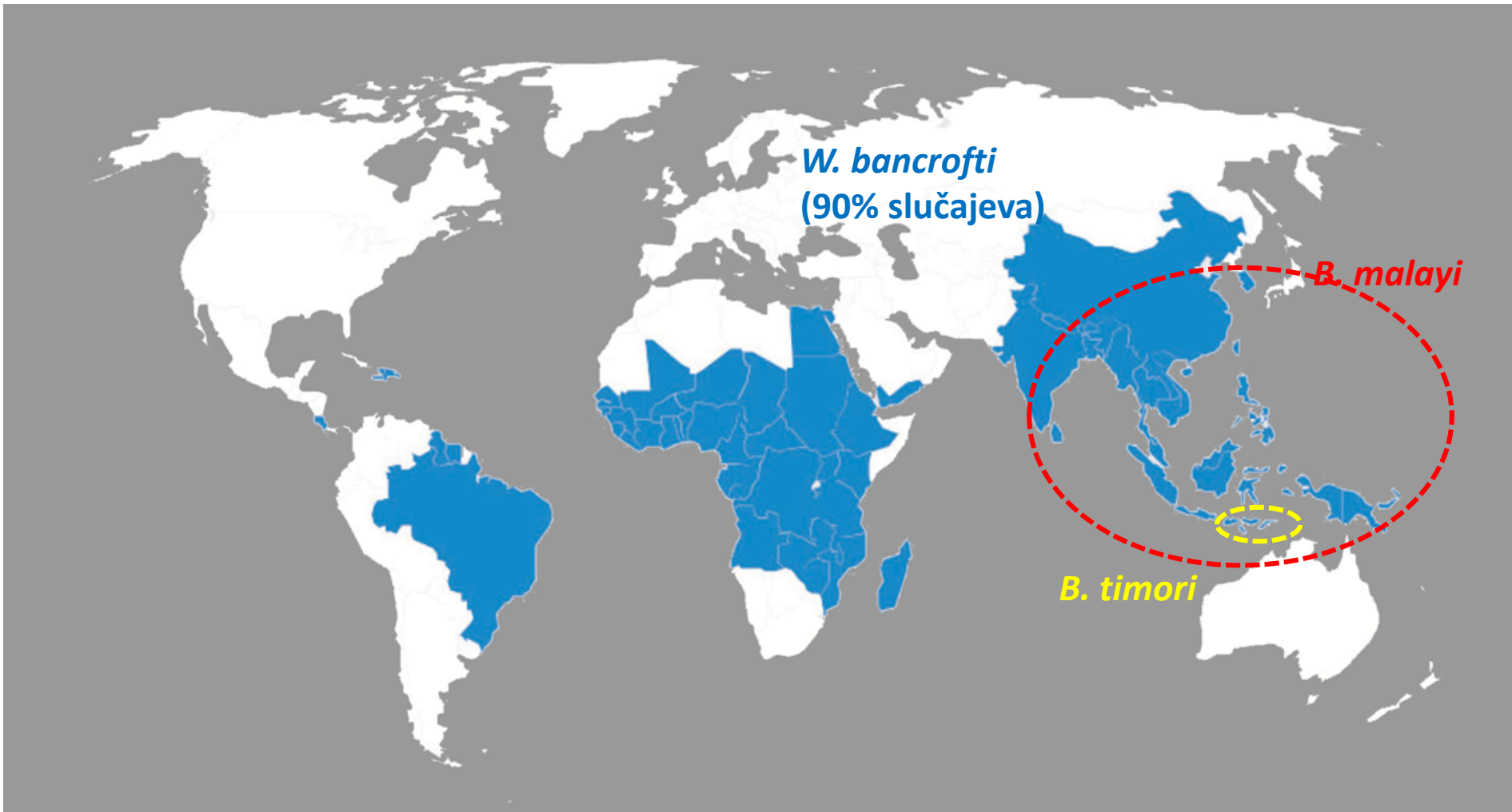


Wuchereria bancrofti

Medically significant Arthropoda - Anophelinae and Culicinae



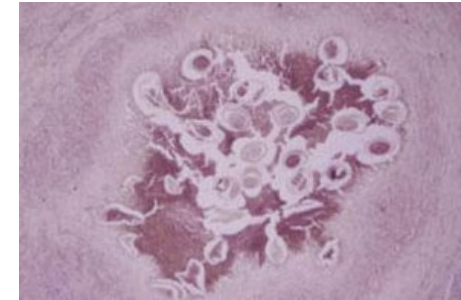
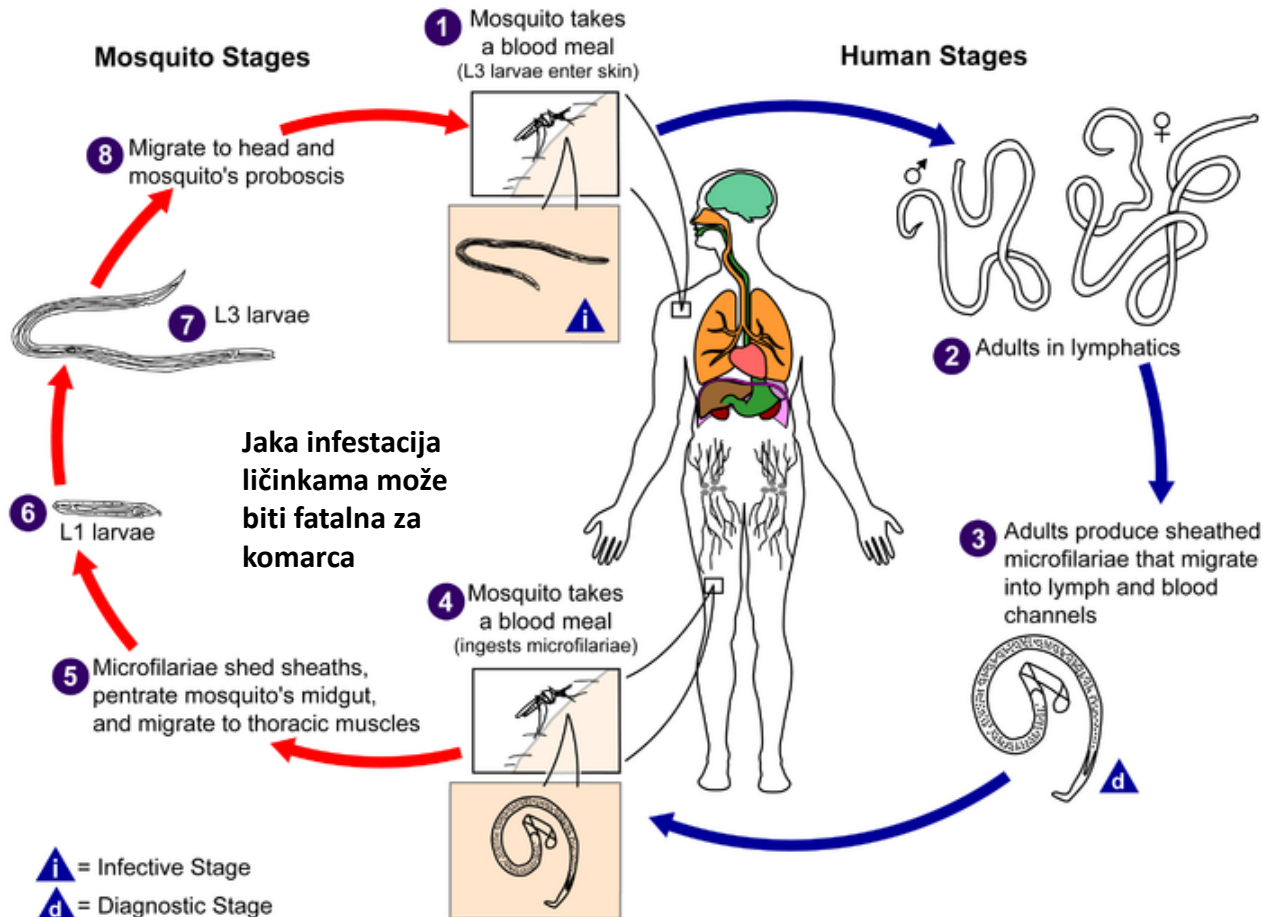
- LYMPH FILARIOSIS (ELEPHANTIASIS)



Medically significant Arthropoda - Anophelinae and Culicinae



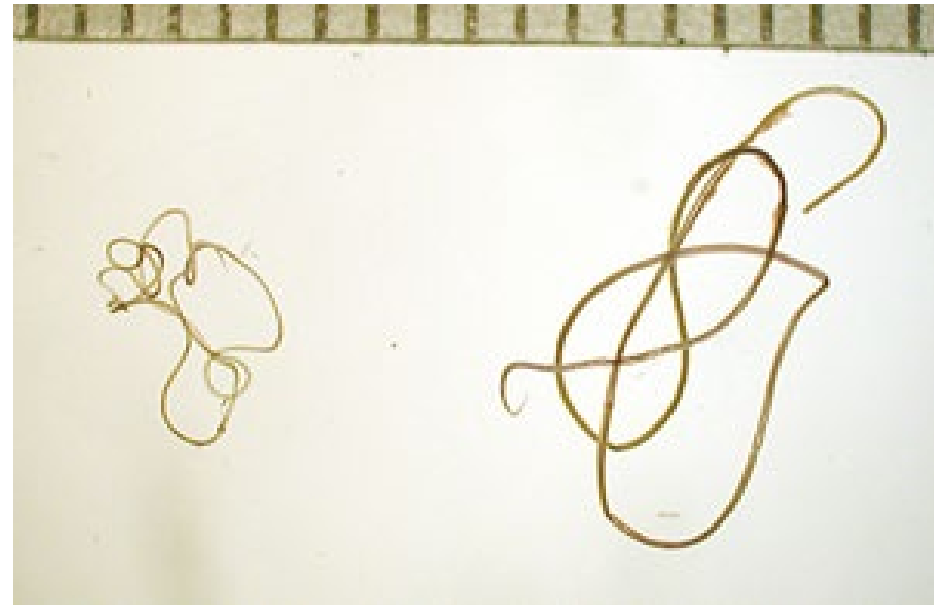
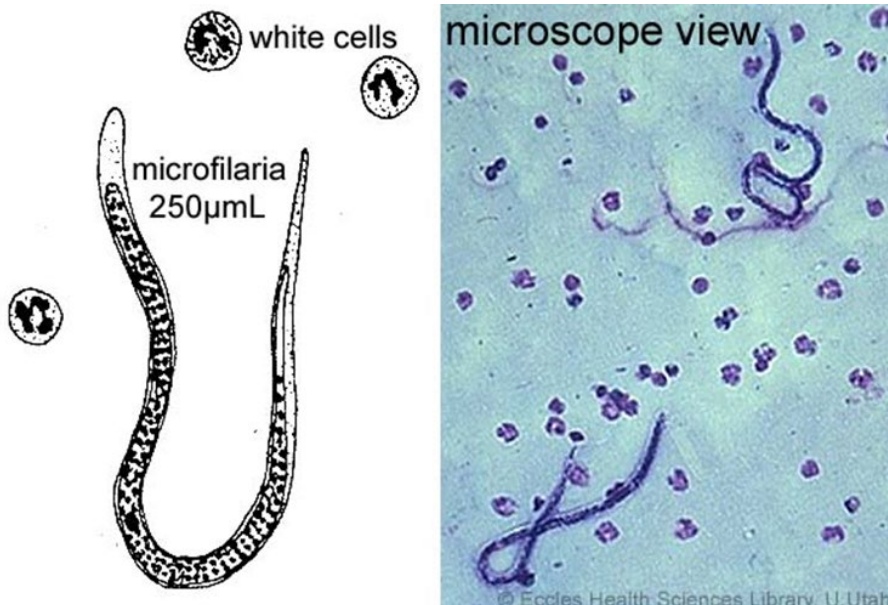
• LYMPH FILARIOSIS (ELEPHANTIASIS) – Life cycle *W. bancrofti*



Medically significant Arthropoda - Anophelinae and Culicinae



- **LYMPH FILARIOSIS (ELEPHANTIASIS)**
- 128 million infected people with Bancroftian filariasis and 13 million with Malayan filariasis
- The presence of microfilariae in the blood is called **MICROFILARIAEMIA** and occurs 6 months to a year after the adult forms have settled in the lymphatic system, it can last up to 10 years



Medically significant Arthropoda - Anophelinae and Culicinae



• LYMPH FILARIOSIS (ELEPHANTIASIS)

- The presence of microfilariae in the blood is periodic (day or night periodic or subperiodic) and should correspond to the most favorable vector (varies geographically), even for the same type of form
- Also the competence of the mosquito vector population, the same species varies geographically (*Culex quinquefasciatus* in India yes, in Africa no)!!!!
- Only *Brugia malayi* has zoonotic transmission (Langur monkeys), the other two species do not have animal reservoirs (anthroponoses)



Culex quinquefasciatus



Medically significant Arthropoda - Anophelinae and Culicinae

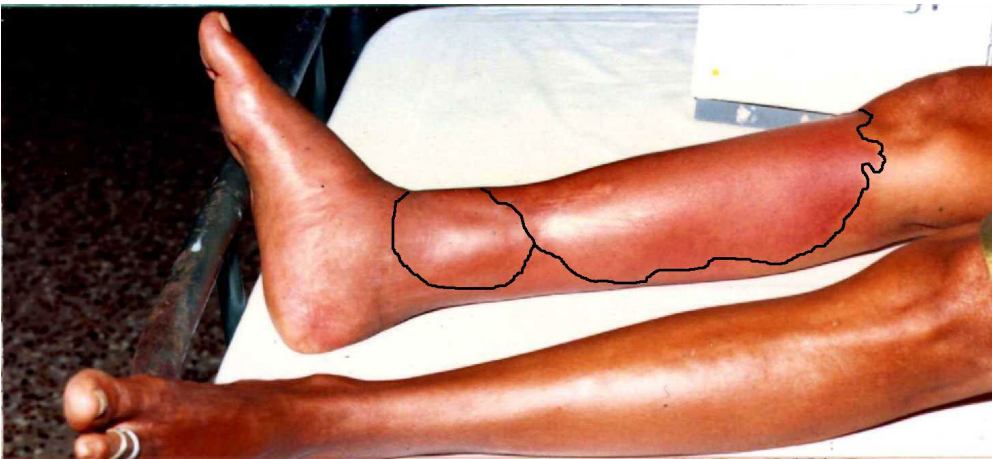
- **LYMPH FILARIOSIS (ELEPHANTIASIS) – SYMPTOMS**
- Associated with severe infection (forms need to find a mate to reproduce) – does not occur after one bite from an infected mosquito, but many bites
- Visible most often only after the onset of microfilariaemia, but possibly even before
- It is possible for people to have microfilariaemia, but not to show signs of the disease
- Acute and chronic phase of the disease



Medically significant Arthropoda - Anophelinae and Culicinae



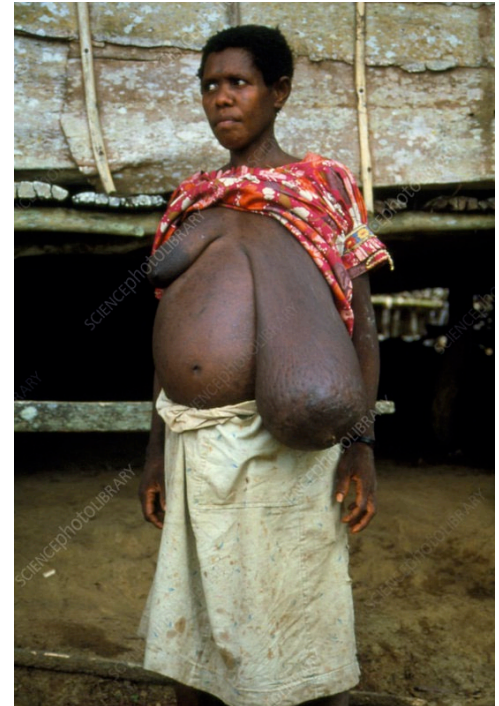
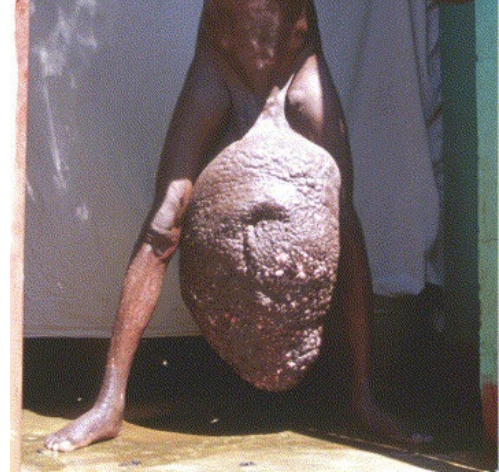
- **LYMPH FILARIOSIS (ELEPHANTIASIS) – SYMPTOMS**
- **ACUTE INFLAMMATORY FILARIZATION** - the first symptoms most often appear with microfilaremia, but not necessarily, it is characterized by episodes of fever (4-7 days, often recurring, seasonal), swelling, pain and inflammation of the lymph nodes and lymph vessels that are infected with the liver and this is called **ACUTE ADENOLIMPHANGITIS (ADL)** – inflammation of the lymphatic channels – over time the development of ulcers and abscesses – potential secondary bacterial infections



Medically significant Arthropoda - Anophelinae and Culicinae



- **LYMPH FILARIOSIS (ELEPHANTIASIS) – SYMPTOMS**
- **CHRONIC FILARIOSIS** - Appears years after the original infection, over 15 years and even after the filarian nematods die
- Accumulation of lymph in the tissues - in the scrotum (scrotal hydrocele), breasts, extremities (elephantiasis)



Medically significant Arthropoda - Anophelinae and Culicinae



- **LYMPH FILARIOSIS (ELEPHANTIASIS) – SYMPTOMS**
- **CHRONIC FILARIOSIS** - Appears years after the original infection, over 15 years and even after the forms die
- In addition to swelling of parts of the body, a warty appearance of the extremities is also possible with frequent bacterial and fungal infections
- Due to excessive sensitivity to parasitic antigens, **TROPICAL PULMONARY EOSINOPHILIA** can occur (increased production of eosinophils, cough, bronchospasm)



Medically significant Arthropoda - Anophelinae and Culicinae

- **LYMPH FILARIOSIS (ELEPHANTIASIS) – DIAGNOSIS**
- Chronic symptoms are easily diagnosed
- **But only an early diagnosis of the disease enables treatment with drugs before chronic symptoms appear!!!**
- Acute symptoms can be mistaken for some other diseases
- Blood smears from blood that must be taken at the right moment (day-night period) - used to be the most common method of proof, but some infected people do not necessarily have microfilariae in their blood
- Today - Immunochromatographic rapid tests, PCR and other techniques based on the reaction of surface antigens and antibodies - much safer tests than blood smears



Medically significant Arthropoda - Anophelinae and Culicinae

- **LYMPH FILARIOSIS (ELEPHANTIASIS) – TREATMENT**
- Antifilarial combination drugs: Albendazole + Diethylcarbamazine (DEC) or Albendazole + Ivermectin are most often given (one dose) - kill most adults and all microfilariae - effective for 1 year
- They are used in prevention as a prophylaxis - in some endemic areas, DEC has even been used as a supplement to edible salt
- The disease causes permanent damage, especially if not treated in time
- Surgery for scrotal hydrocele
- Wrapping the swollen limbs and daily washing with antibiotics reduces the symptoms of elephantiasis



Medically significant Arthropoda - Anophelinae and Culicinae



• LYMPH FILARIOSIS (ELEPHANTIASIS)

- In 2000, WHO launched the Global Program to Eliminate Lymphatic Filariasis (GPELF) by 2020
- Stop transmission with mass prophylaxis, 1 dose/year. through 5 years
- By 2015, 64 out of 72 endemic countries had implemented the program (6.2 billion doses distributed > 820 million people)
- Strategic plan 2010-2020 – vector control
- Rapid/Inexpensive diagnostic tests to confirm the success of mass prophylaxis
- Transmission has fallen by 43% since 2000!

Medically significant Arthropoda - Anophelinae and Culicinae

• LYMPH FILARIOSIS (ELEPHANTIASIS)

- In 2000, 40 million people showed clinical signs of the disease and 120 million people were infected (mostly in Southeast Asia and Africa)
- There are no recent estimates, but transmission has been significantly reduced and it is potentially possible to eradicate the disease in the foreseeable future
- Vector control similar to malaria (reduction of breeding sites, use of mosquito nets (ITN)) - but not effective for all vectors, why?

