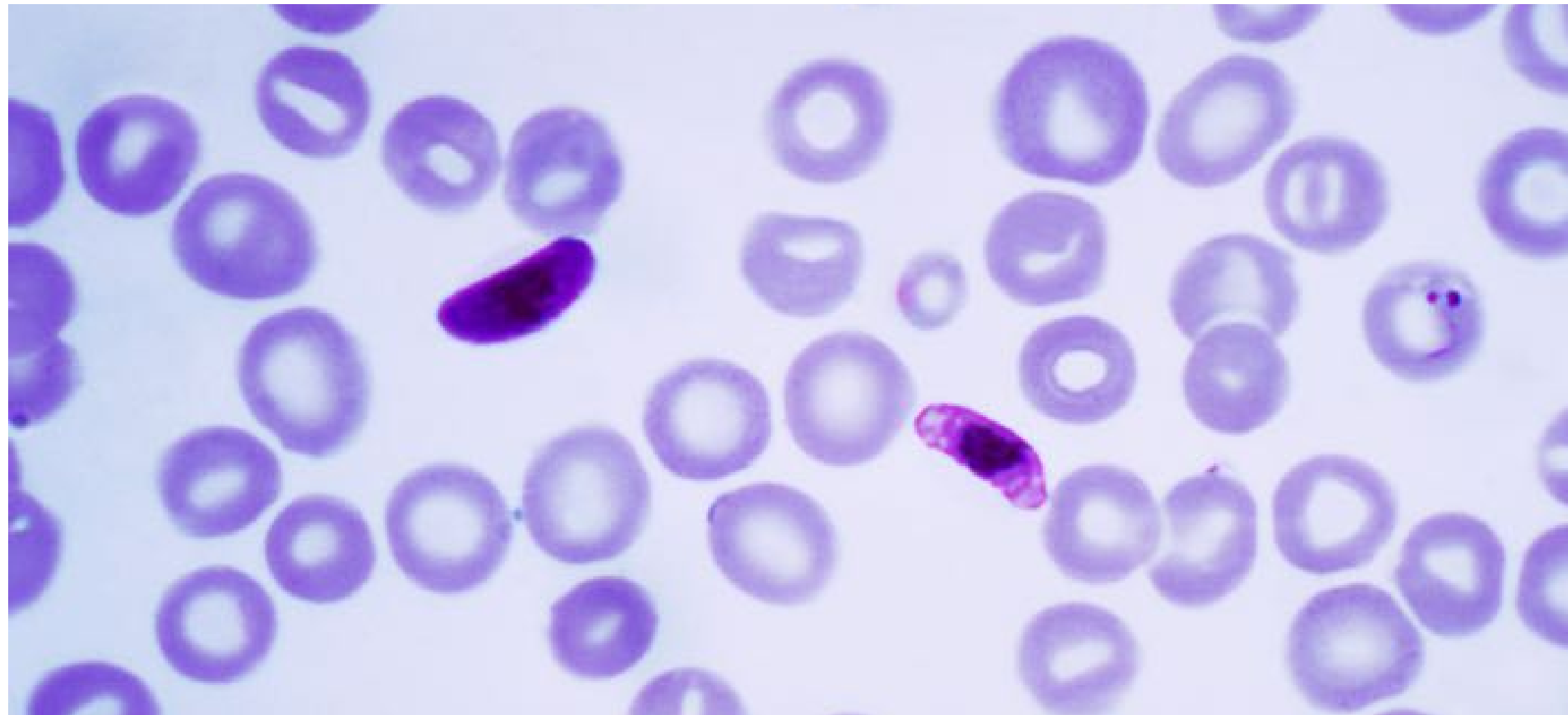


# HOW A PARASITE SHAPED HUMAN HISTORY

Megan McPherson

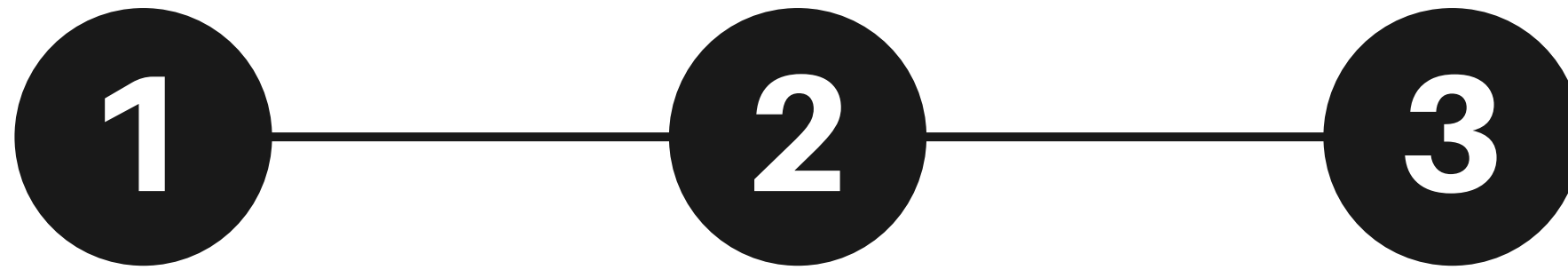


1. Macrogametocyte (left) and microgametocyte (right) of *P. falciparum*.



2. Arua, West Nile, Uganda.

# OUTLINE



Pathophysiology

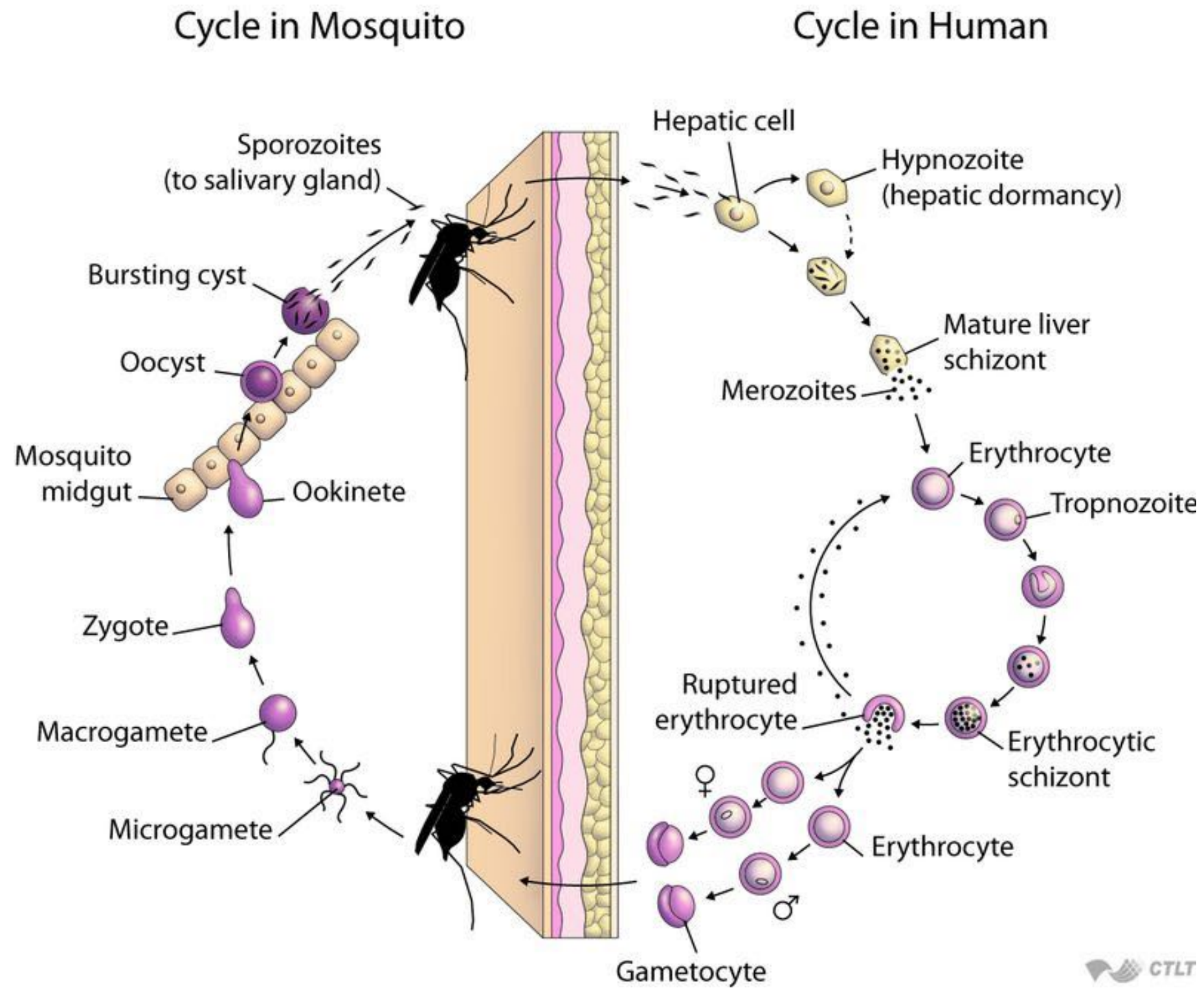
History

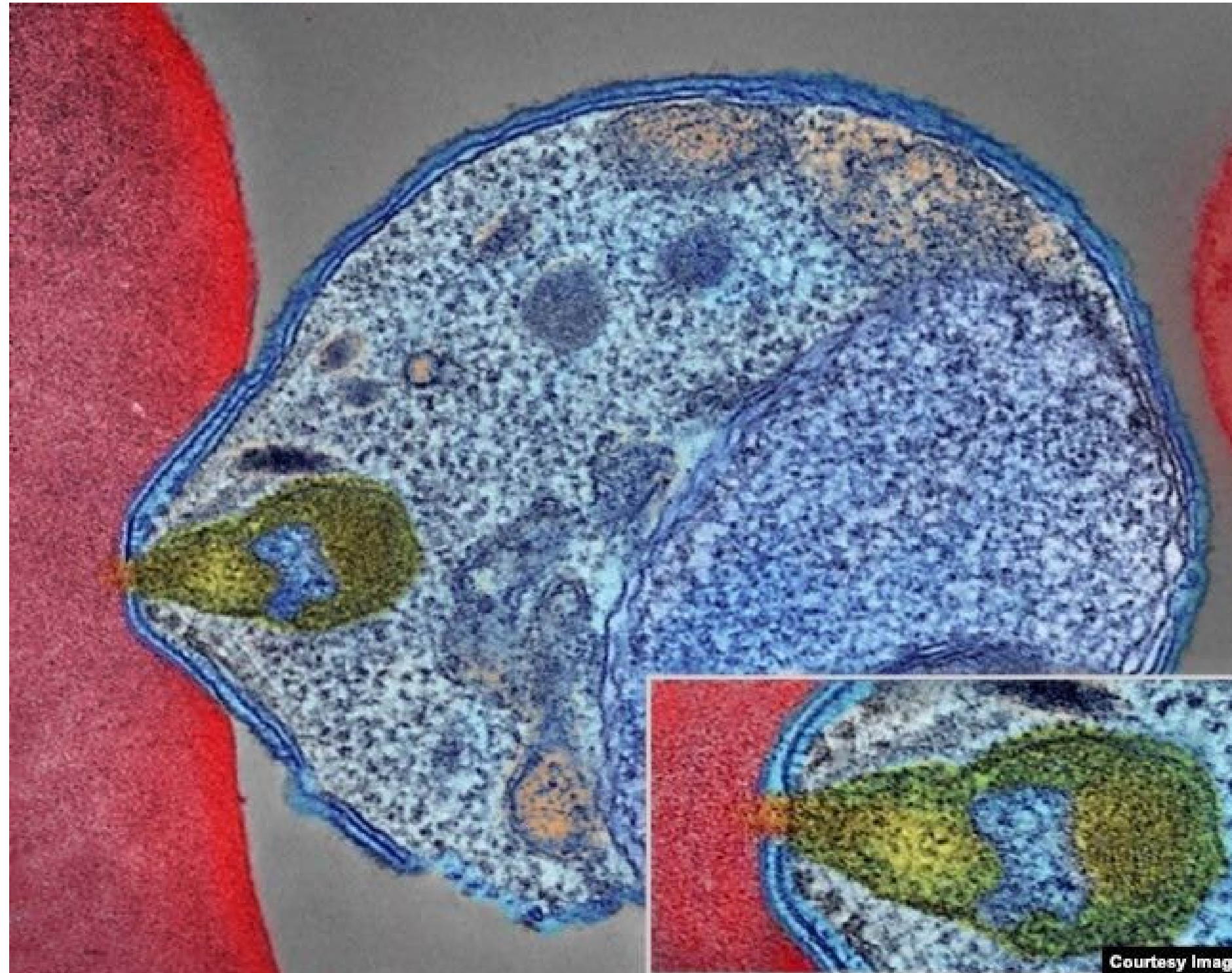
Present day



# **PATHOPHYSIOLOGY**







4. Plasmodium attaching to an erythrocyte.



## **HISTORY**



- Plasmodium has been present for up to 100 million years
- May have contributed to the extinction of dinosaurs
- Plasmodium's evolutionary divergence followed human evolution

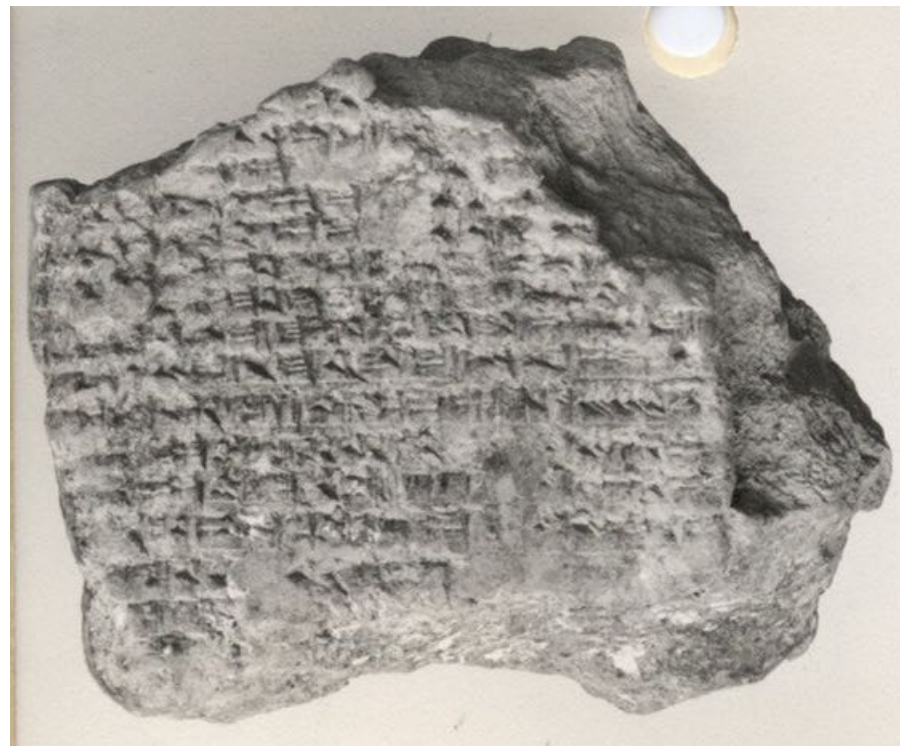


5. Dinosauria fossil in situ, Triassic Epoch.



## ENUMA ANU ENLIL (CUNEIFORM SCRIPT)

- Attributes malaria to a Babylonian goddess of destruction and pestilence
- Malaria also documented by ancient Chinese, Indian, Egyption and Greek civilisations



6. Enuma Anu Enlil, tablets 26 and 27.

## ANCIENT ROME

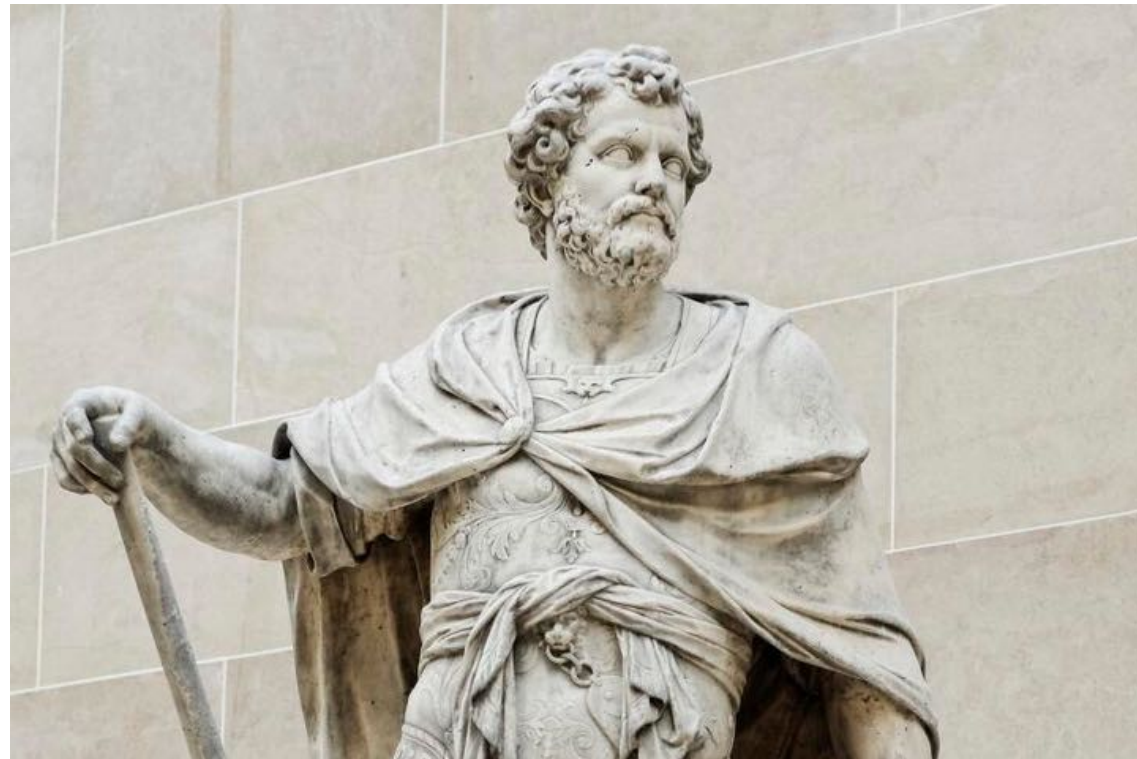
- One of the world's largest cities in 200 BCE
- High prevalence of malaria - "Roman Fever"
- Mosquito infested marshes surrounded the empire's borders



7. Artist's impression of ancient Rome.

## BATTLE OF ZAMA

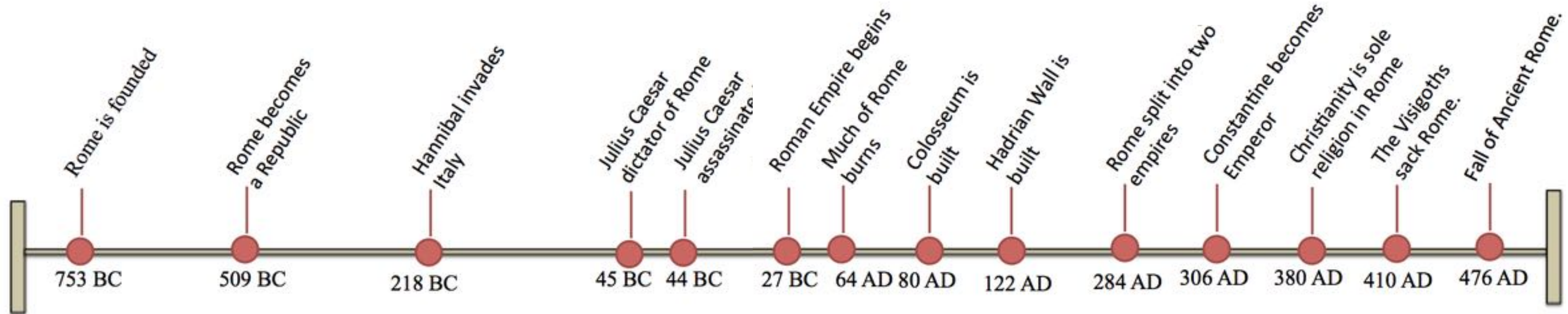
- Hannibal's army attacked Rome, defeated at Zama
- Malaria thought to have contributed to the defeat
- Hannibal's wife and son both killed by 'fever'
- Rome's survival influenced global religions and languages



8a. Hannibal



# BATTLE OF ZAMA



8b. Timeline of the Roman Republic and Roman Empire.



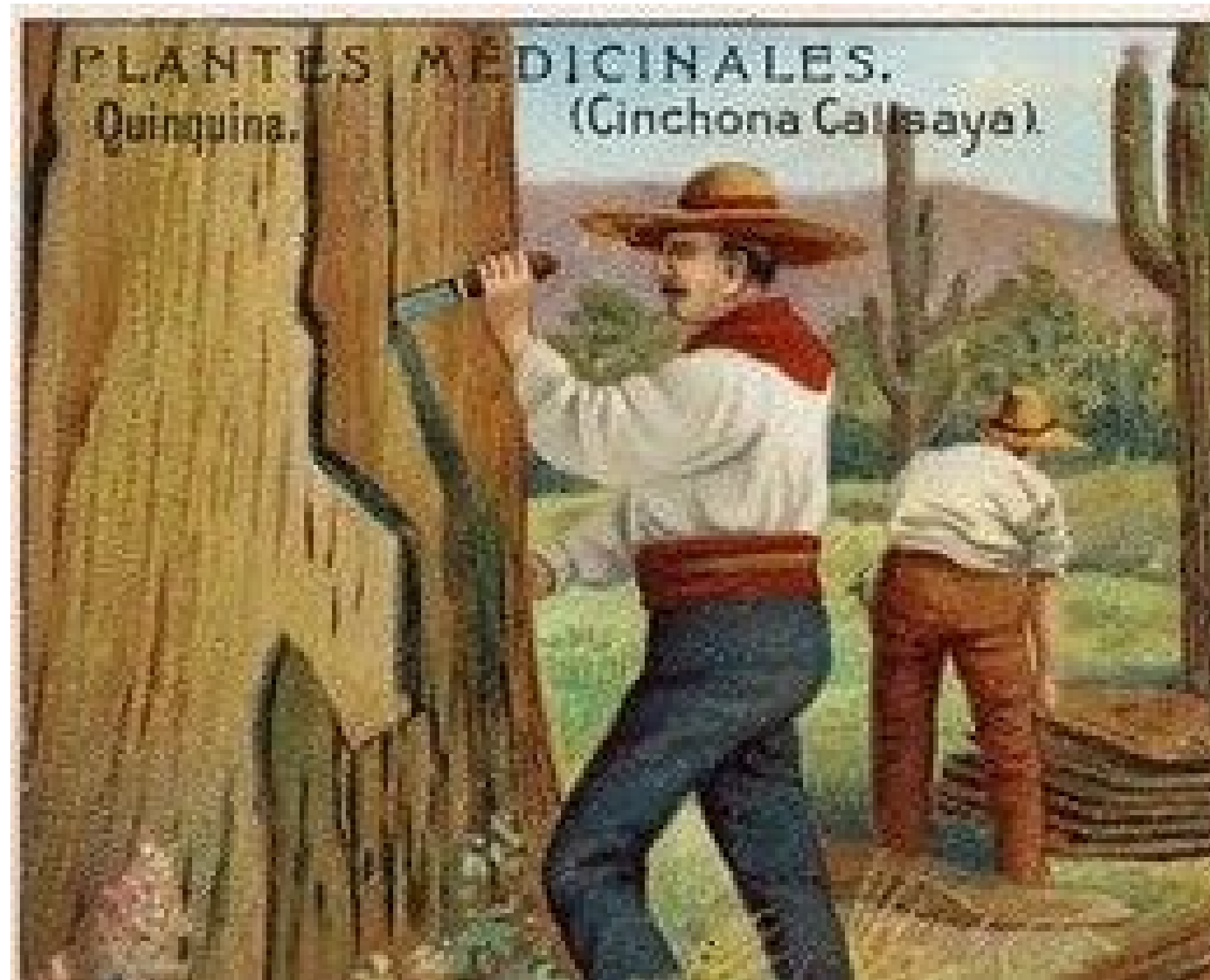
## CINCHONA BARK



9a. The gathering and drying of cinchona bark in a Peruvian forest. Wood engraving, by C. Laplante, c. 1867



## CINCHONA BARK



9b. Artists impression of Cinchona Bark harvesting.

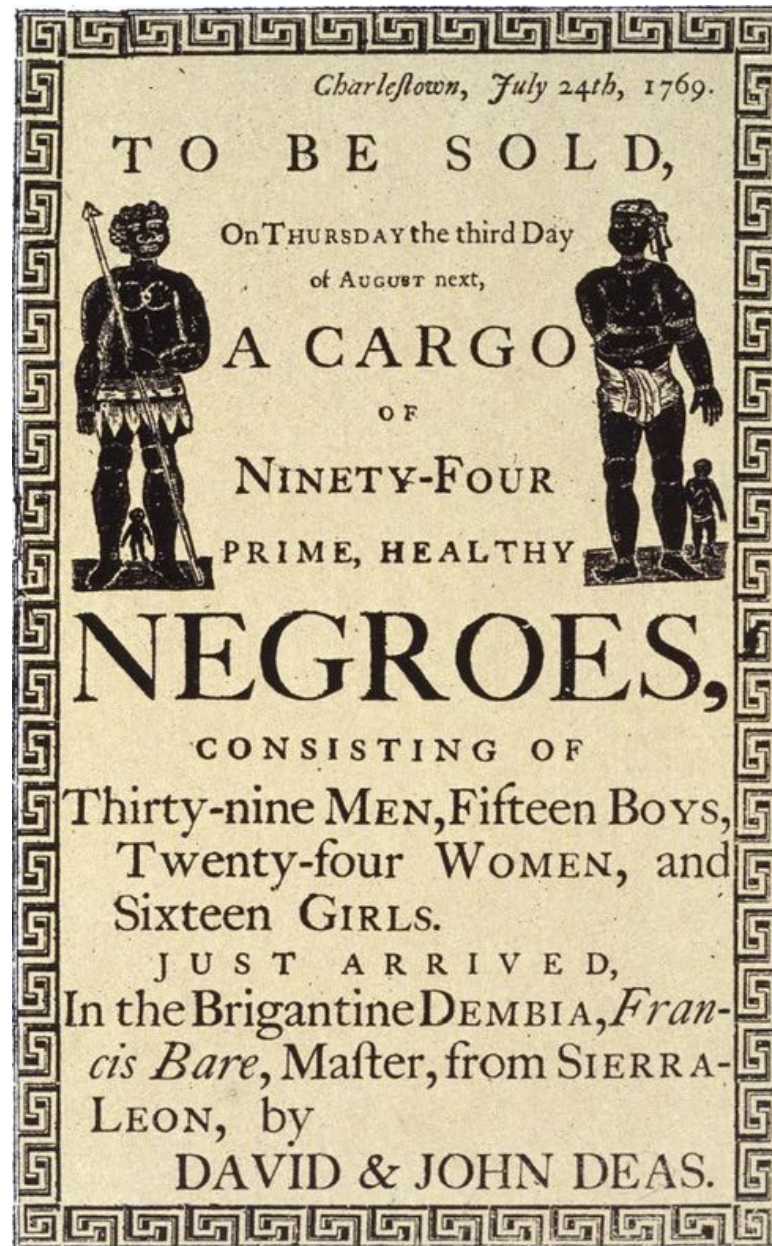
## CINCHONA BARK



9c. Rawhide bag for storing Cinchona bark, Peru.



9d. Dried and ground Cinchona bark.



10. Reproduction of a handbill advertising a slave auction in Charleston, British Province of South Carolina, 1769.

## TRANSATLANTIC SLAVE TRADE

- Sugar and tobacco plantations were infested with mosquitoes.
- African farmers had a degree of immunity to malaria.
- Increased demand for (and price of) African slaves.
- Shaped the racial contours still experienced today.





11. Bottle of Quinine produced by the British Empire.

## QUININE ISOLATED

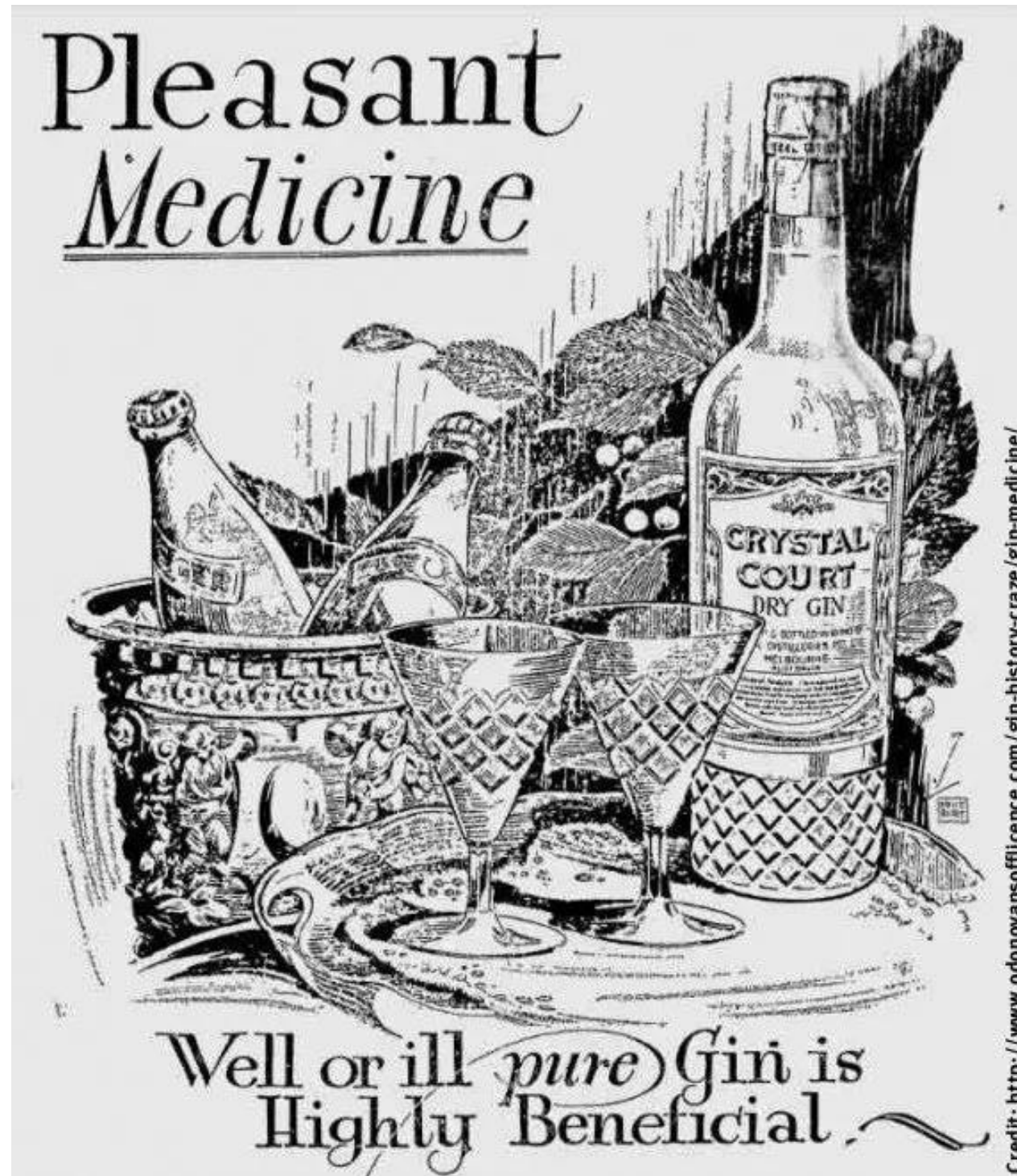
- £6.4m equivalent spent each year importing Cinchona bark to Britain to store for colonial troops (1848 -1861).
- Countries where quinine empowered colonisers:
  - Indonesia
  - Algeria
  - India
  - Jamaica
  - Much of South-East Asia
  - Much of West Africa
- *"One of the major tools of imperialism"* that powered the British Empire.<sup>1</sup>

- Cinchona tree - "*The tree that changed the world map*".<sup>2</sup>
- 700 tons of Cinchona bark used each year by British soldiers in India.
- All species of Cinchona now endangered.



12. Soldiers drinking their daily dose of Quinine.





13. Print advertisement, Gin, early 20th C.

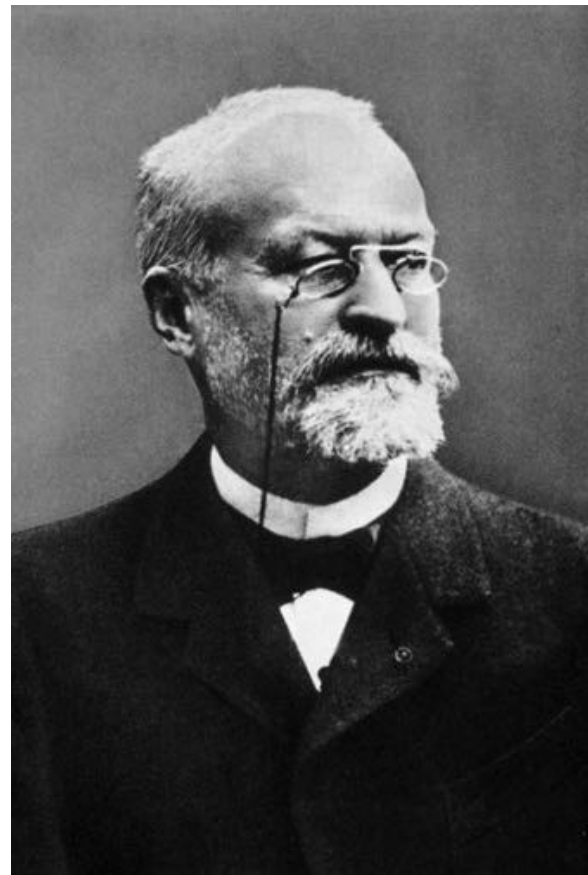


14. Ingredients list for Schweppes tonic, including natural Quinine.

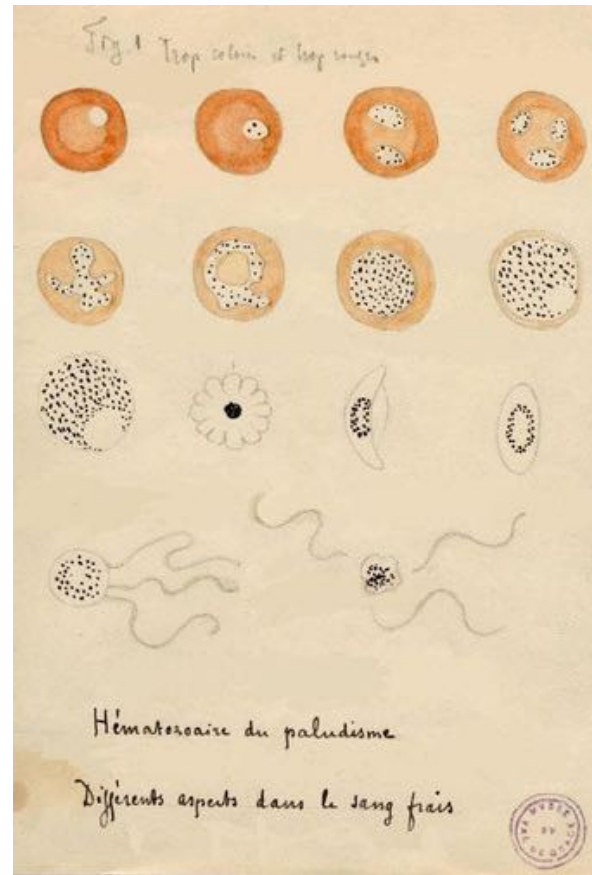


## PLASMODIUM PARASITE DISCOVERED

- Charles Laveran - military Doctor stationed in Algeria.
- Examined fresh blood from malaria patients and found black moving objects.



15. Dr. Charles Laveran.

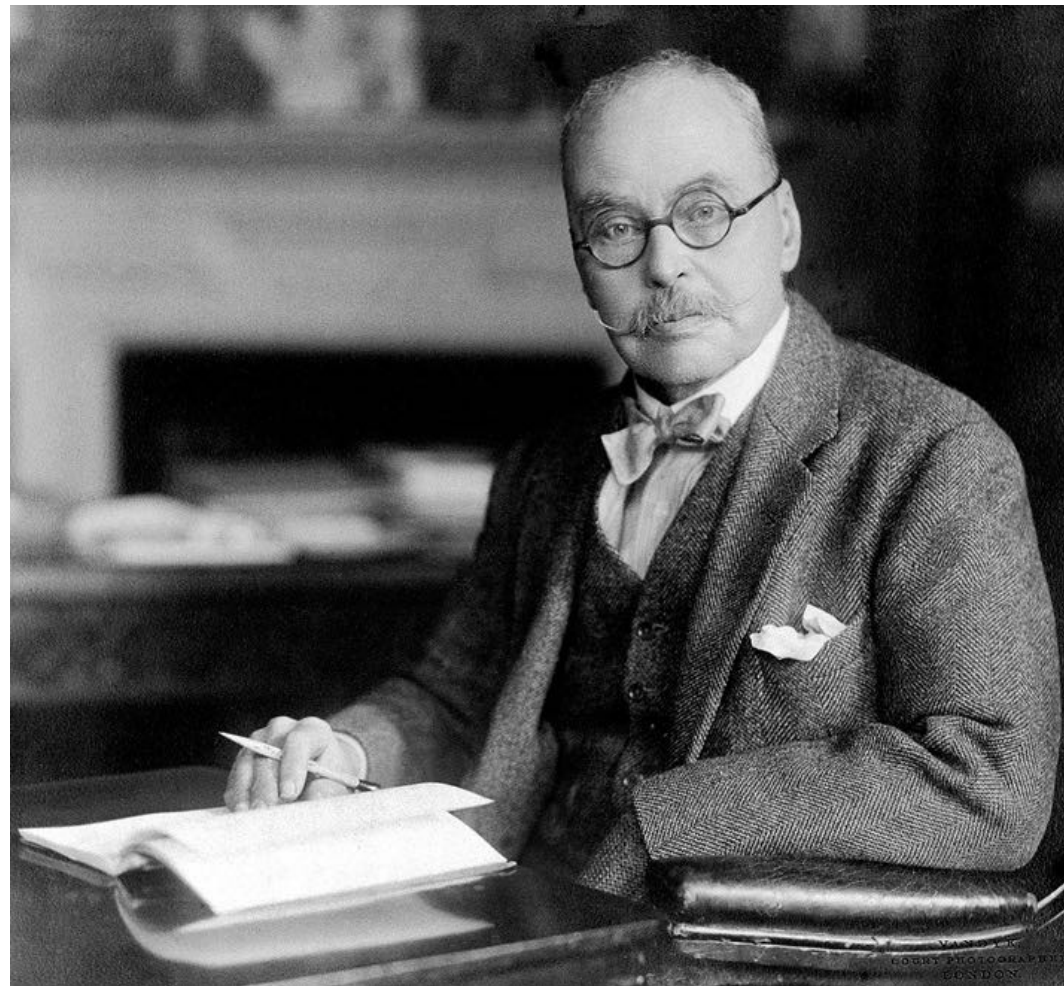


16. Laveran's journal showing different stages of Plasmodium falciparum from fresh blood (1880).

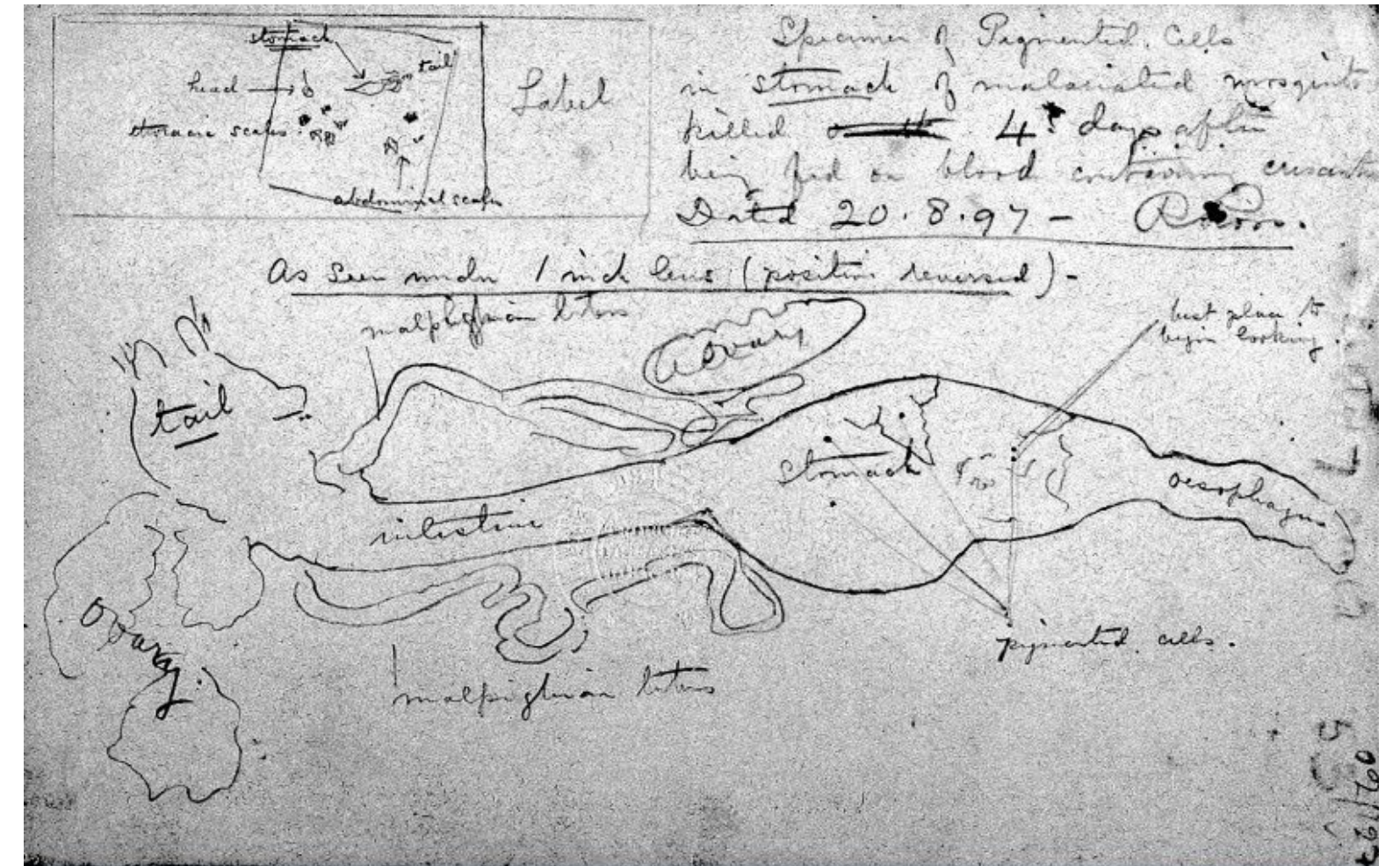


## MOSQUITO VECTOR DISCOVERED

- Sir Ronald Ross (British Doctor)
- First ever discovery of vector mediated disease



17. Sir Ronald Ross



18. Dissection of a malarial mosquito by Ronald Ross, 1987.

## BATTLE OF BATAAN, WORLD WAR II

- 100 million people died from malaria between 1900 and 1950.
- Germany and Japan seized much of the world's Quinine supply during WWII.
- America surrendered to Japan at Bataan - up to 85% of their army had malaria.
- *"They lost, not for want of ammunition, but for want of malaria pills."* - New York Times, 1944<sup>3</sup>



19. Hospital ward in Bataan, *circa* 1941.



THIS IS Ann..

*Her full name is Anopheles Mosquito and she's dying to meet you!*

Her trade is dishing out MALARIA! If you'll take a look at the map below you can see where she hangs out.

*...she drinks blood!*

She can knock you flat so you're no good to your country, your outfit or yourself. You've got the dope, the nets and stuff to lick her if you will USE IT.

Use a little horse sense and you can lick Ann. Get sloppy and careless about her and she'll bat you down just as surely as a bomb, a bullet or a shell.



Atlantic Ocean

EUROPE

ASIA

Pacific Ocean

JAPAN

INDIA

CHINA

AFRICA

INDIAN OCEAN

NEW GUINEA

AUSTRALIA

SOUTH AMERICA

NORTH AMERICA

PANAMA

Malaria is found wherever you see red on this map. Your chances of catching it are:

- HIGH
- MODERATE
- LOW

20. Poster illustrated by Theodor "Seuss" Geisel for the War Department as part of a campaign against malaria, 1943.

*The* **Winged**  
**Scourge**



## MALARIA ERADICATED IN THE USA

- CDC founded (1946) and National Malaria Eradication Program launched.
- DDT used widely across the USA, India, Brazil, South Africa, and Mexico.
- *"DDT was the atomic bomb of the insect world"*<sup>4</sup>



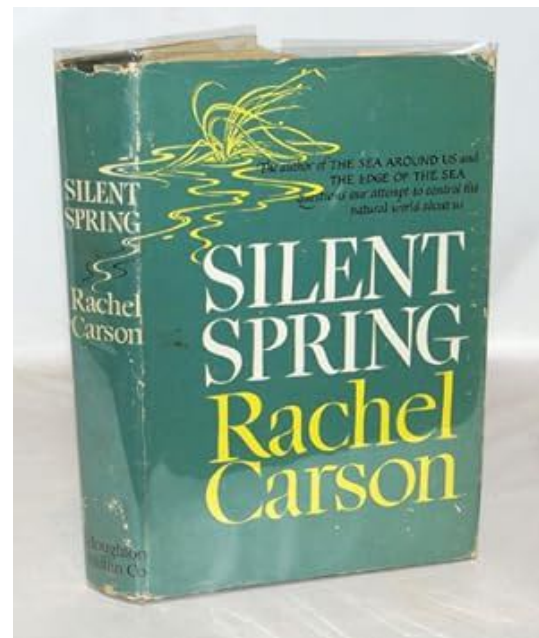
21. A Stearman bi-plane spraying DDT during malaria control operations in Savannah, GA, USA.

## DDT BANNED IN THE USA

- DDT linked to endocrine disruption, reproductive and developmental issues, birth defects and infertility.
- *Silent Spring* by Rachel Carson (1962) contributed to initiation of a government investigation into pesticides.
- USA banned DDT in 1972, many other countries followed suit.
- New Zealand banned DDT in 1989.



22. Rachel Carson.



23. Silent Spring, 1962.



## ARTEMISININ DISCOVERED

- Plasmodium developed resistance to Quinine in the 1960's.
- The Chinese government funded research to find a cure for malaria (during the Vietnam war).
- Tu Youyou discovered Artemisinin in 1971.
- Awarded the Nobel Prize in Medicine, 2015.



23a. Tu Youyou



23b. Artemisinin

**3**

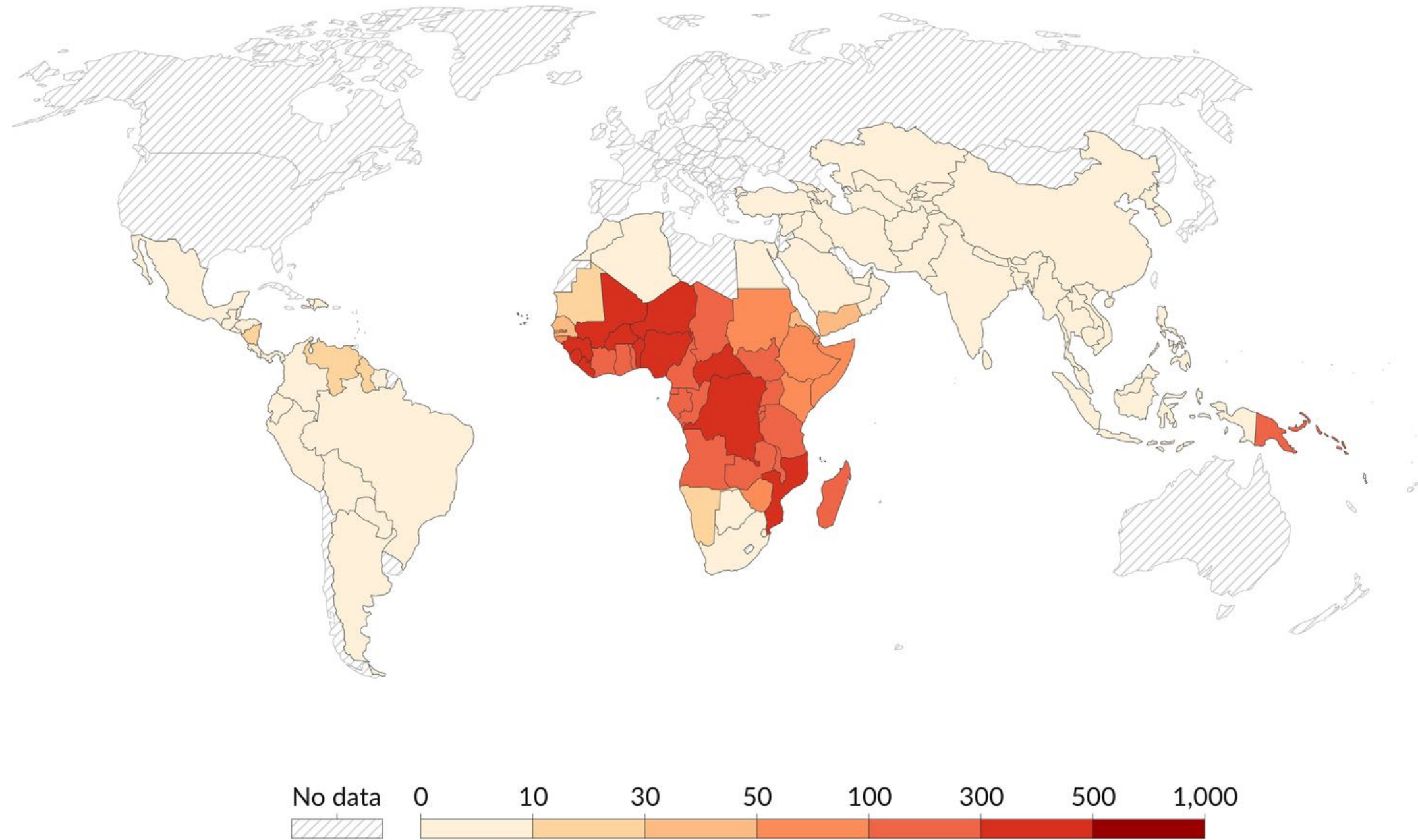
**PRESENT DAY**



# INCIDENCE OF MALARIA, 2020



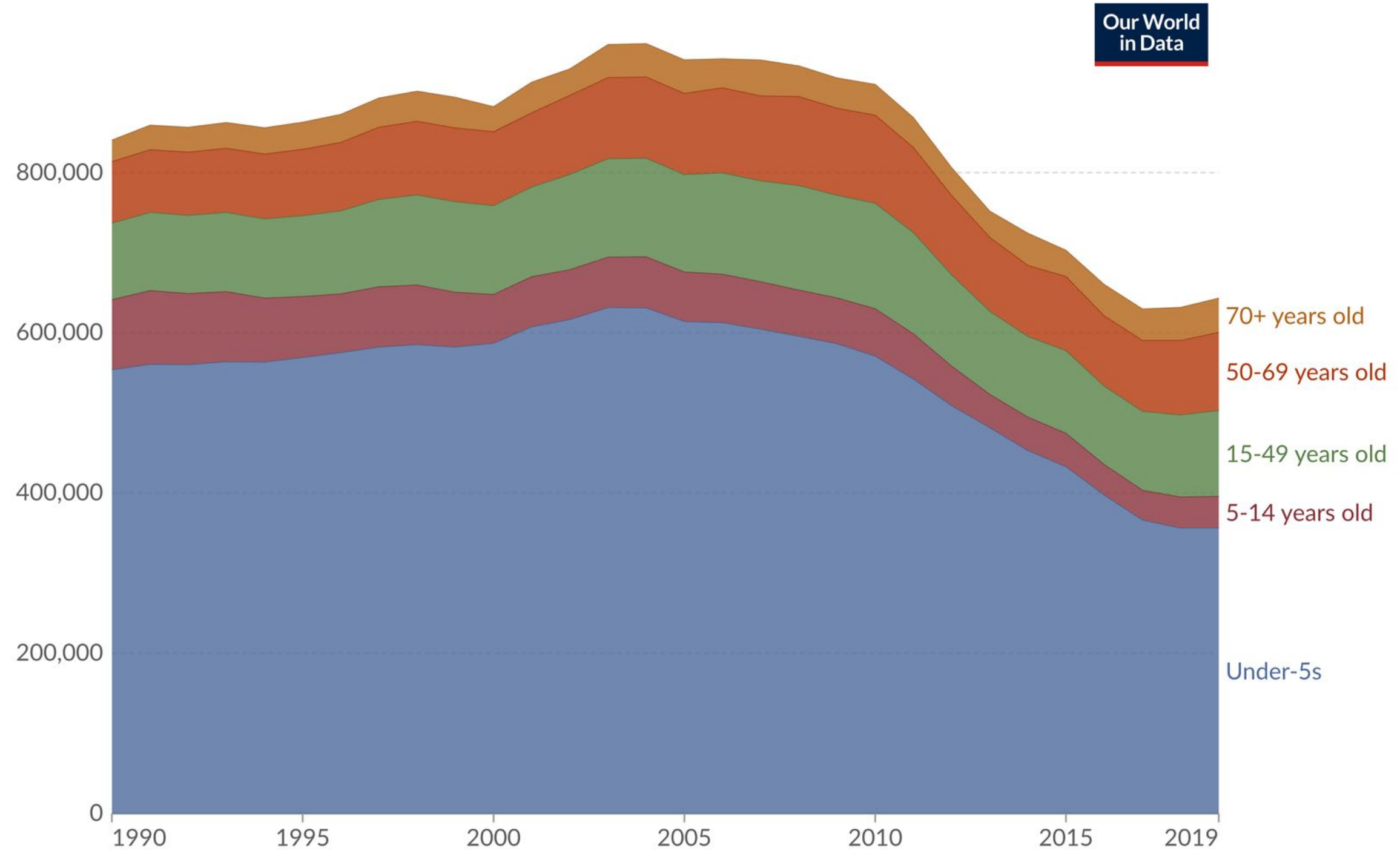
Number of new cases per 1000 population, per year.



25. Data source: World Health Organization (via World Bank).

# GLOBAL MALARIA DEATHS BY AGE

Estimated annual deaths from malaria.

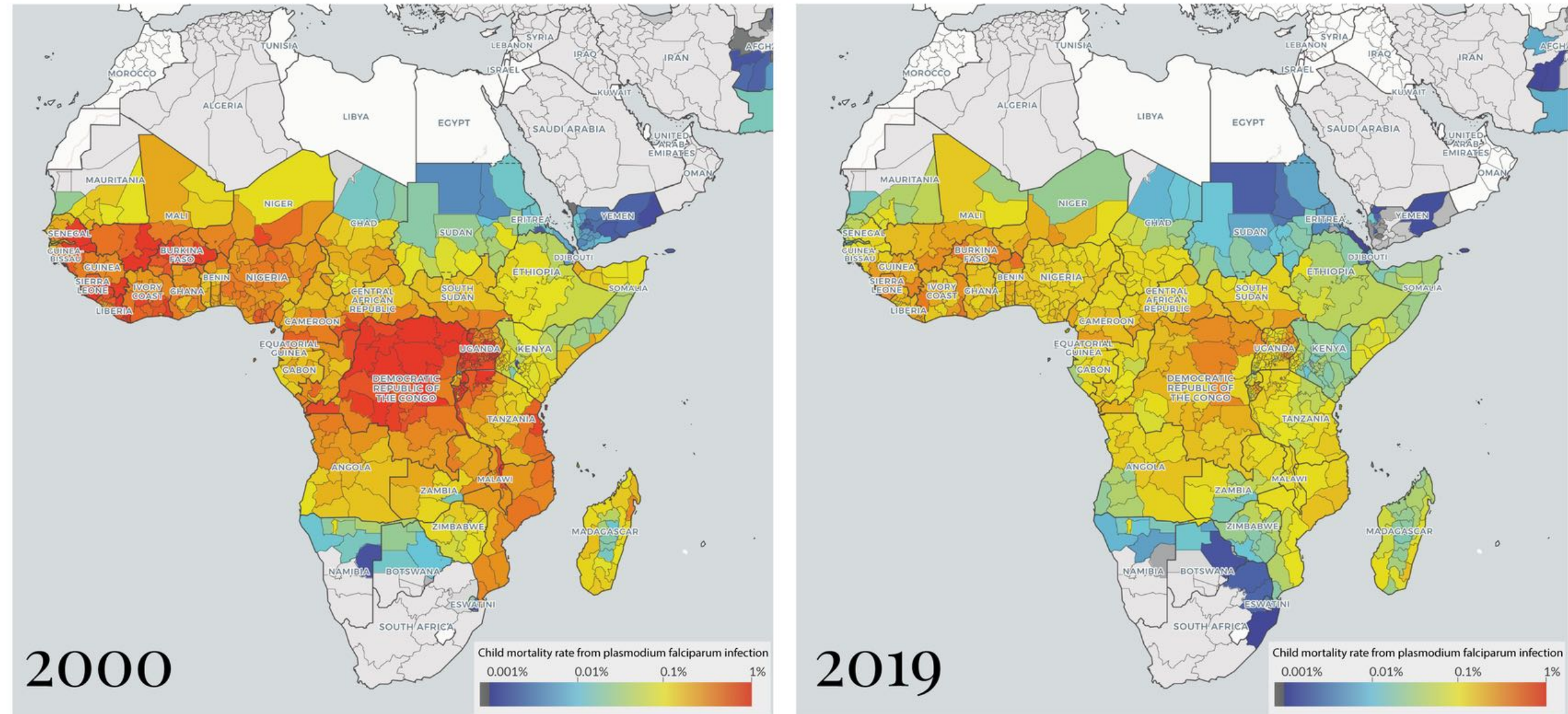


26. Data source: IHME, Global Burden of Disease.



# Malaria mortality rate of children in 2000 and 2019

Shown is the mortality rate of children younger than 5 years due to malaria (caused by plasmodium falciparum)



27. Data source: IHME, Atlas Project.





28. Malindi, Kenya

## BURDEN OF DISEASE

- 100 million people estimated to be currently living with secondary complications.
- Recurrent infections:
  - Persistent anaemia
  - Developmental delays
  - Malnutrition
  - Organ failure
  - Premature adult death





28. Malindi, Kenya

## PREVENTATIVE INTERVENTIONS

- Sleep under insecticide-treated nets
- Avoid stagnant water
- Remain indoors during dawn and dusk
- Wear long-sleeved clothing

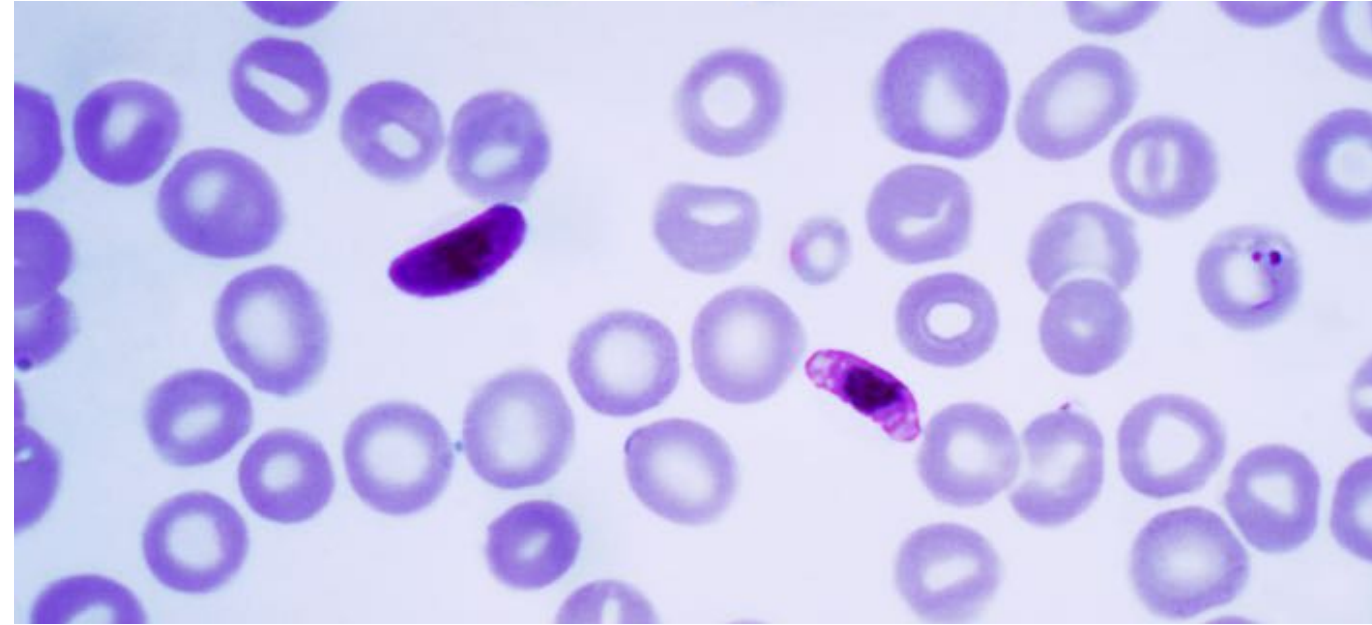




29. RTS-S vaccine roll-out in sub-Saharan Africa.

## FIRST GENERATION VACCINE

- Prequalified by WHO in 2022.
- Received by 1.5 million children (as of April 2023).
- 18 million doses of currently allocated to Africa (population 1.2 billion).
- Only works against one of the five species of Plasmodium that infect humans.
- Next-generation sequencing shows Plasmodium is mutating rapidly.



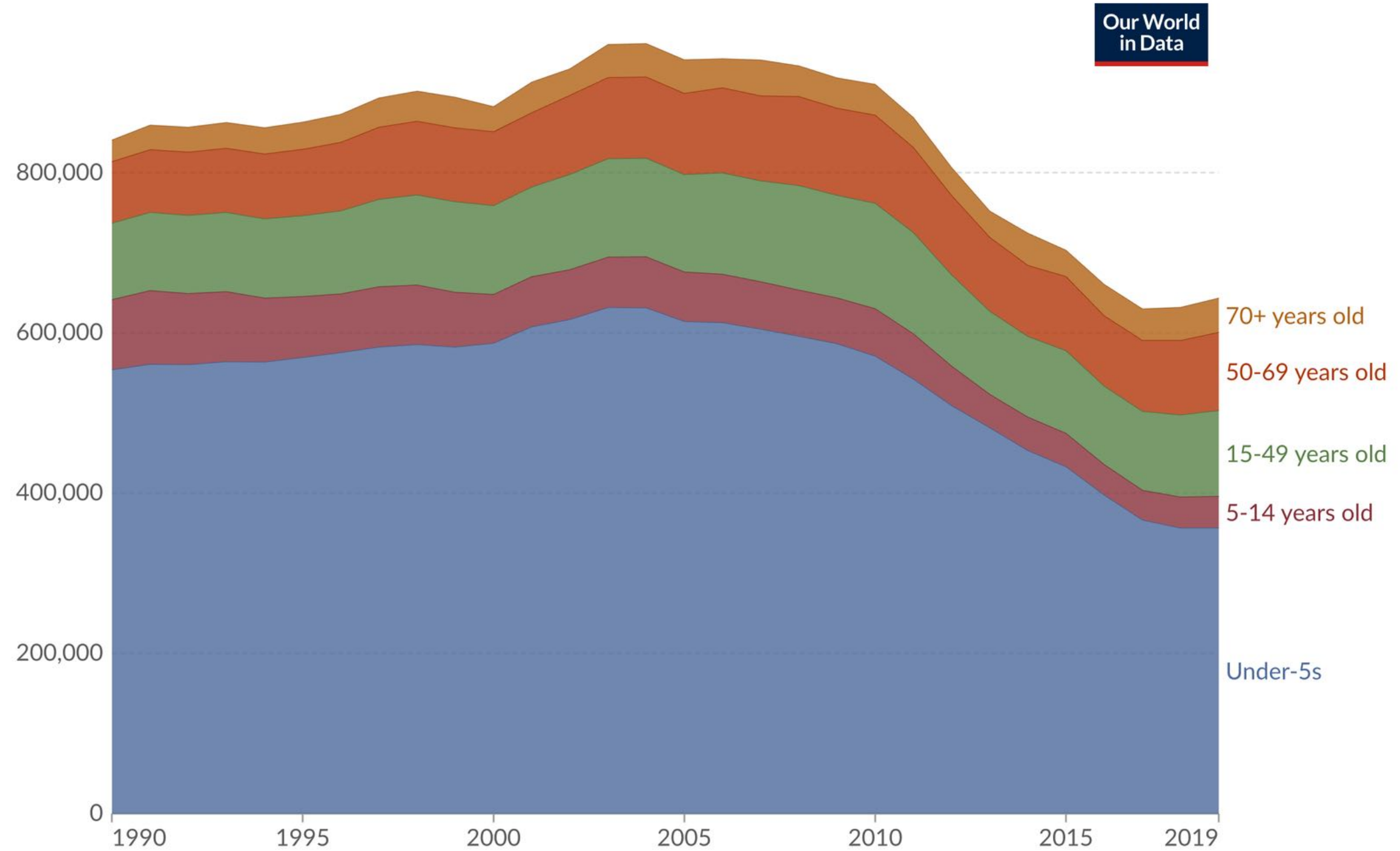
1. Plasmodium falciparum.

## WILL PLASMODIUM CONTINUE TO SHAPE HUMANITY?

- Commercial interests are involved.
- New generation vaccines under development.
- Estimated that malaria could be eliminated within a generation with an additional 2.7 billion dollars per year.

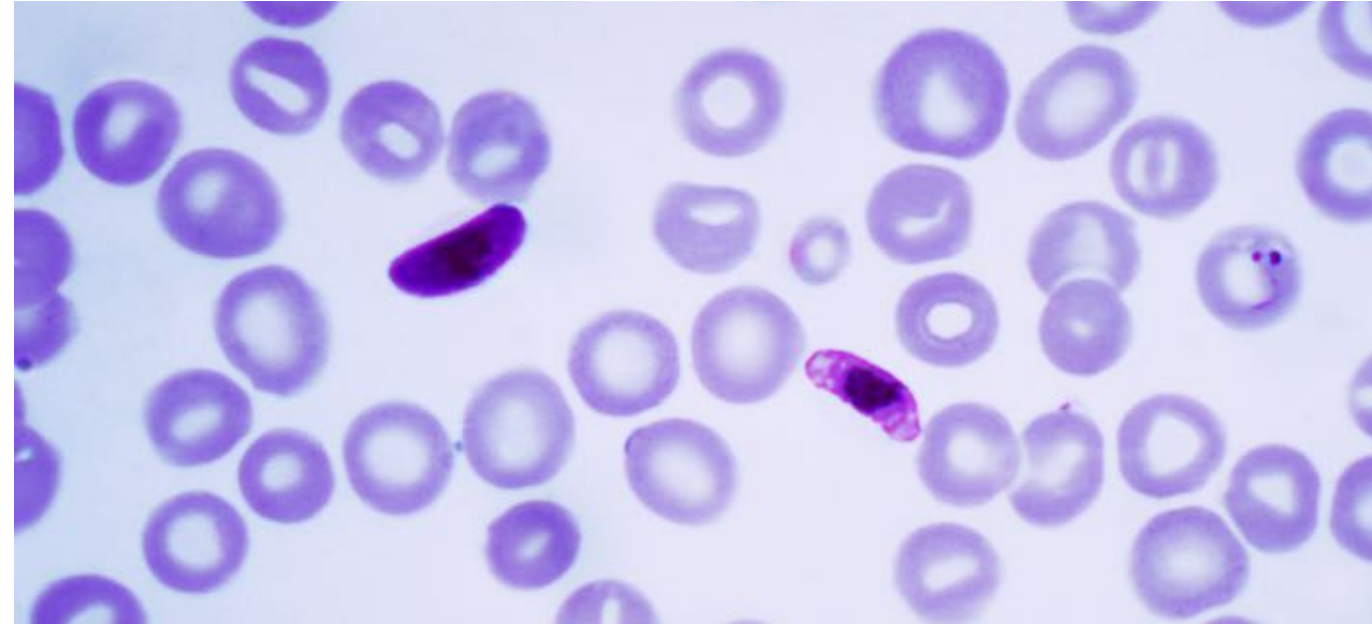
# GLOBAL MALARIA DEATHS BY AGE

Estimated annual deaths from malaria.



26. Data source: IHME, Global Burden of Disease.





1. Plasmodium falciparum.

**WILL PLASMODIUM CONTINUE TO SHAPE HUMANITY?**