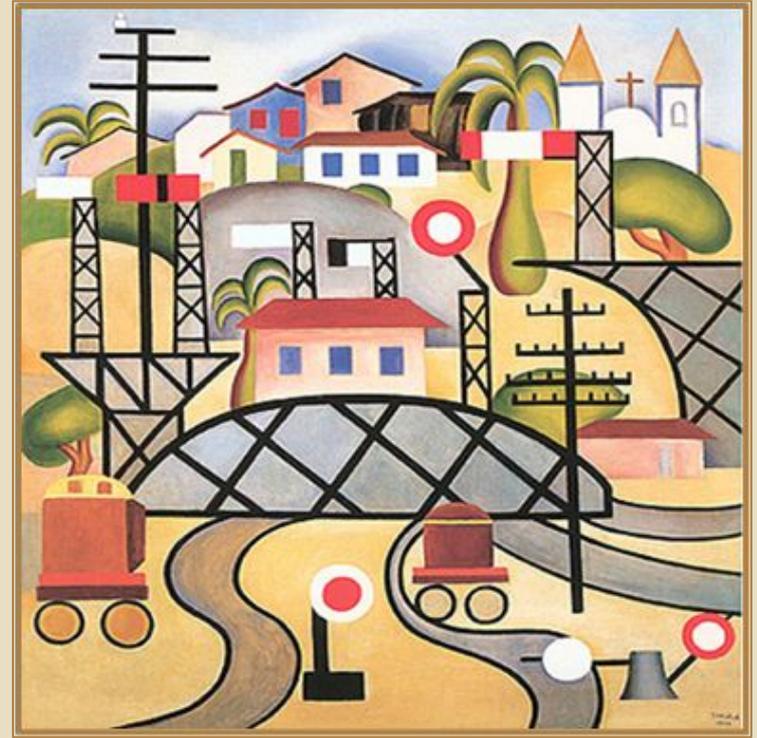
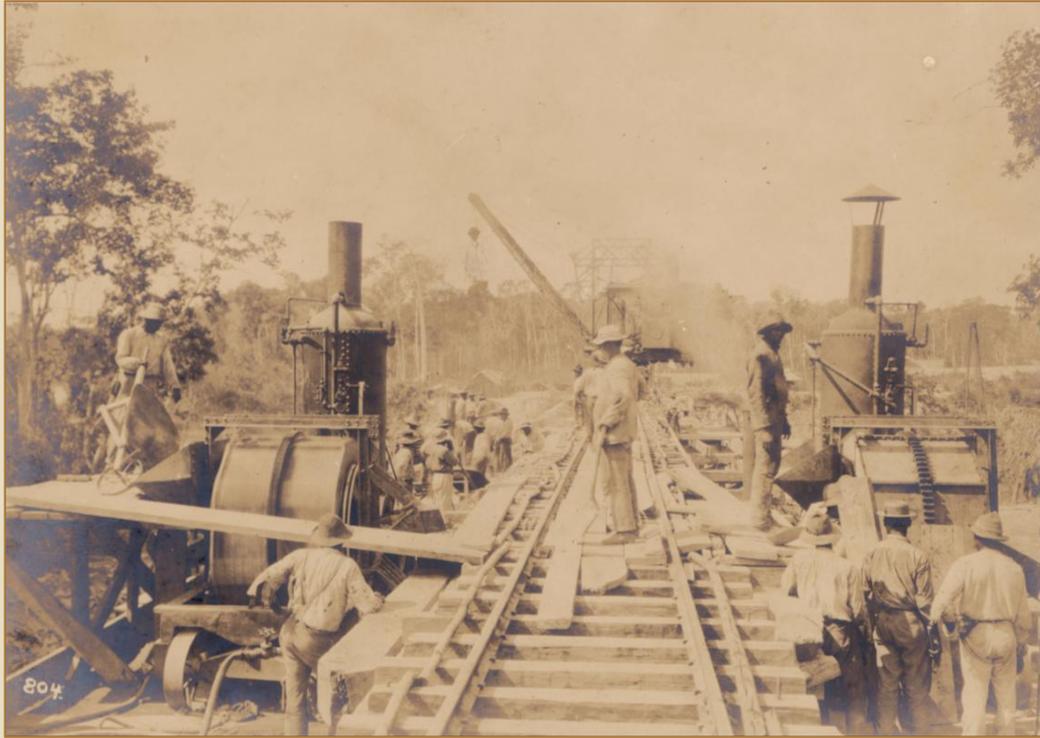


The railroad worker's disease

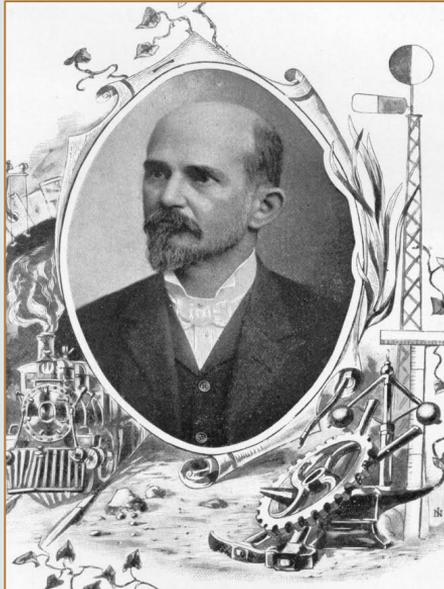


Nathália Helena Azevedo & Thiago Marinho Del Corso

Prologue

Brazil, Railroads and Malaria





Aarão Reis



Rio de Janeiro, 1907



Correio da Manhã

Director---EDMONDO BATTENCOURT

IMPRESSO DAS MÁQUINAS ROTATIVAS de Marinoni

Impresso em papel da Casa P. Veloso & C. — Bahia

ANNO VII—N. 2.087

RIO DE JANEIRO -- DOMINGO, 31 DE MARÇO DE 1907

Redacção—Rua do Ouvidor n. 117

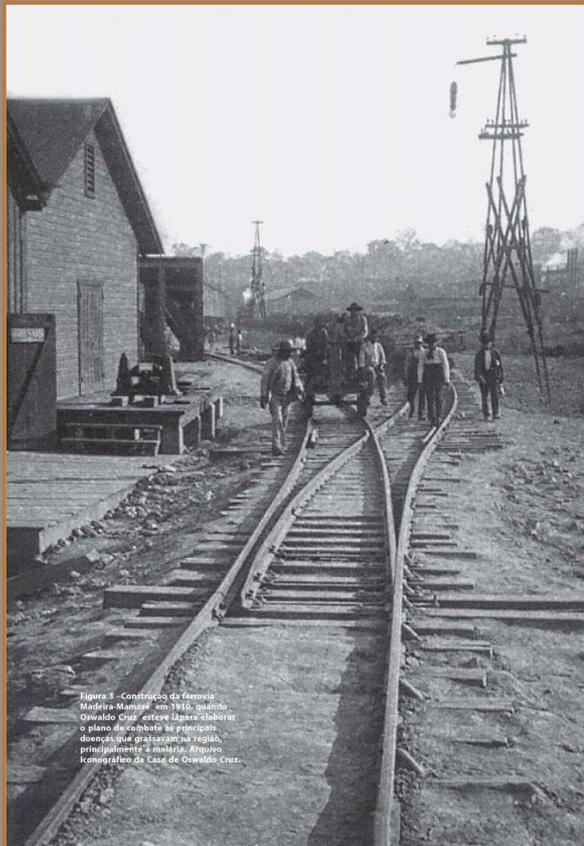
CORREIO DA MANHÃ

E. F. Central do Brasil

dr. Andre
rectores da
Humberto
ra Leite, in

— Submettemos á consideração do dr. Aarão Reis a seguinte carta, que nos foi hontem dirigida por uma importante firma commercial desta praça :

• Tão desenvolvida e interessante é a secção mantida pelo vosso conceituado jornal do que occorre na Estrada de Ferro Central do Brasil, que somos forçados a solicitar-vos, de preferencia, a publicação das seguintes linhas.





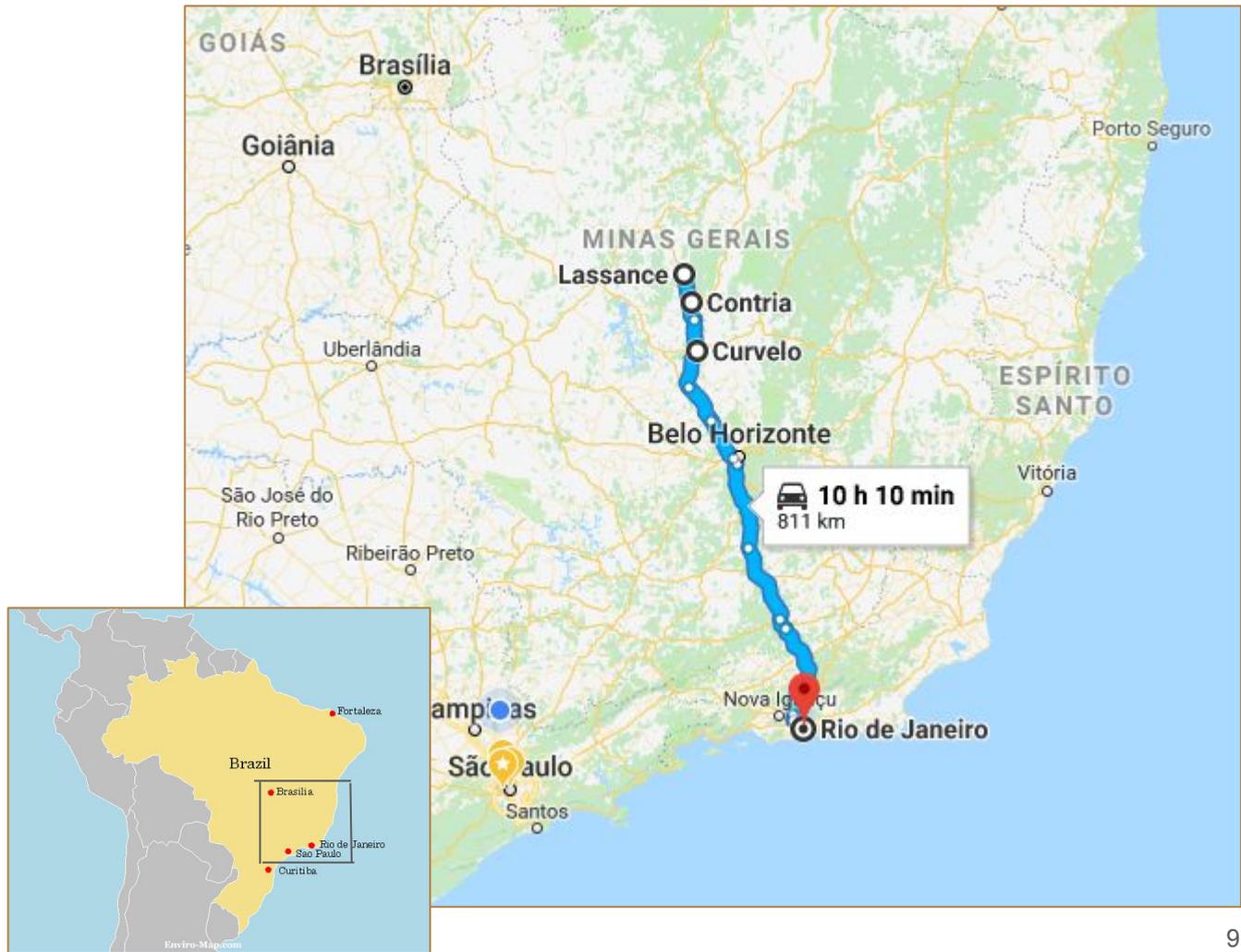
Hydroelectric project, São Paulo



[Think Question 1] As president of the railroad, what would be your response regarding the workers? What are your concerns, and what actions are available to you?



Cornélio Homem
Cantarino Motta, Chief
Engineer, Lassance





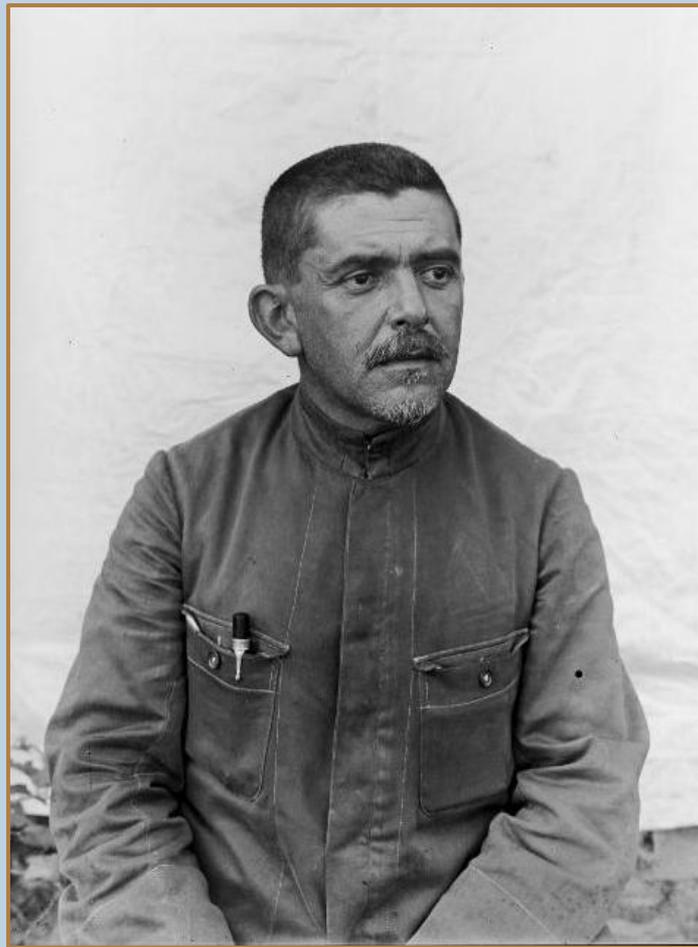
Cornélio Motta, Lassance



Manguinhos Institute, Rio de Janeiro



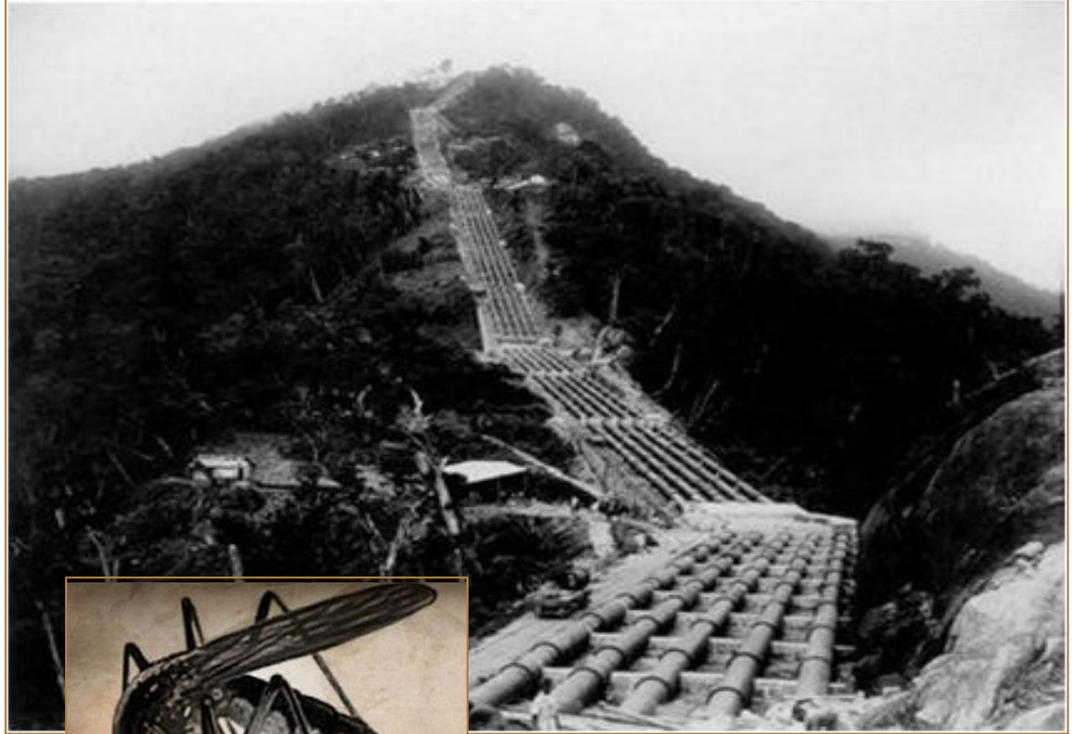
Oswaldo Cruz, Director



Belisário Penna



Carlos Ribeiro Justiniano



Chapter 1: The Lassance Disease



The physicians arrive in Lassance in June, 1907



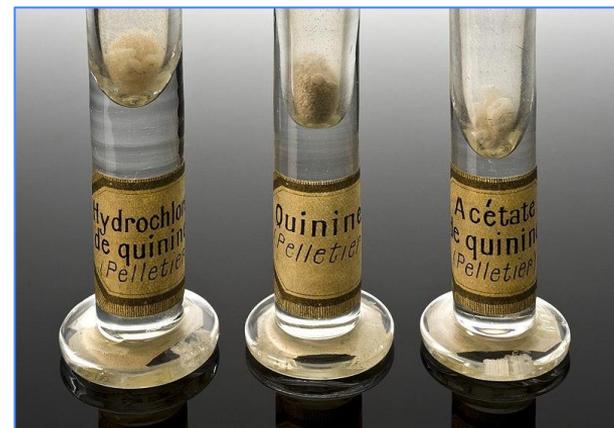
At the far right, Belisário Penna and Carlos Ribeiro

Carlos Ribeiro had his residence, office and laboratory in a train car

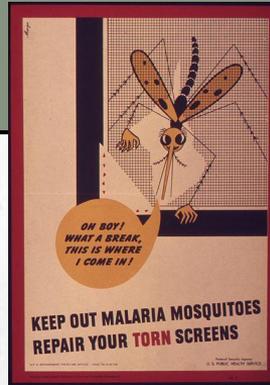




Lassance



The anti-malaria work in Lassance





Symptoms found in the sick population of Lassance vs. malaria

<i>Known Malaria Symptoms</i>	<ol style="list-style-type: none">1. single bite, symptoms appear after 8 to 25 days2. high fever, intense chills alternating with heat waves and profuse sweating (appears and disappears every 2 or 3 days)3. head and body pain4. appetite loss5. anemia with yellowish skin (jaundice) and fatigue6. liver and spleen enlargement7. vomiting8. encephalitis with retinal lesions (retinal bleaching)9. can lead to death
---------------------------------------	--

<i>Symptoms observed in Lassance</i>	<ol style="list-style-type: none">1. swelling near bite (chagoma)2. acute phase: symptoms usually go away within 3 to 8 weeks3. low fever (goes away after a few days)4. head and body pains (moderate)5. appetite loss (moderate)6. red spots on skin (exanthema)7. liver and spleen enlargement8. vomiting9. meningitis and encephalitis (uncommon complications)10. enlarged nerve ganglia11. swelling (edema)12. hardly leads to death
--	---

[Think Question 2] Given the list of symptoms, how would you determine if the railroad workers' disease in Lassance is a variant form of malaria or a different disease entirely? What additional information would you like to collect? What criteria would you apply before seeking an alternative treatment or remedy?



thyroid inflammation



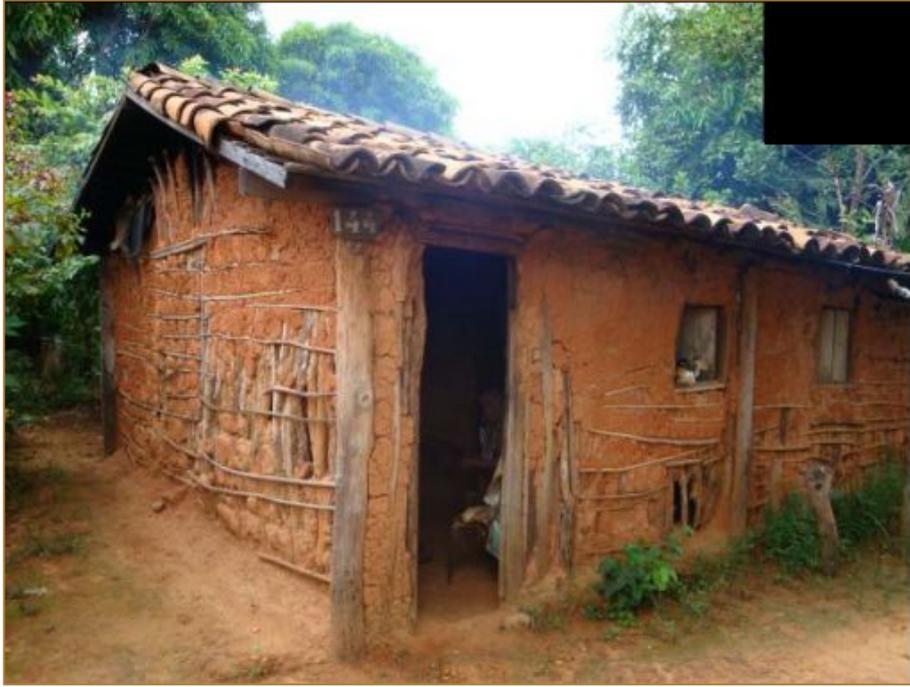
eye condition, known as
“Romaña's sign”

Chapter 2: Of insects and men

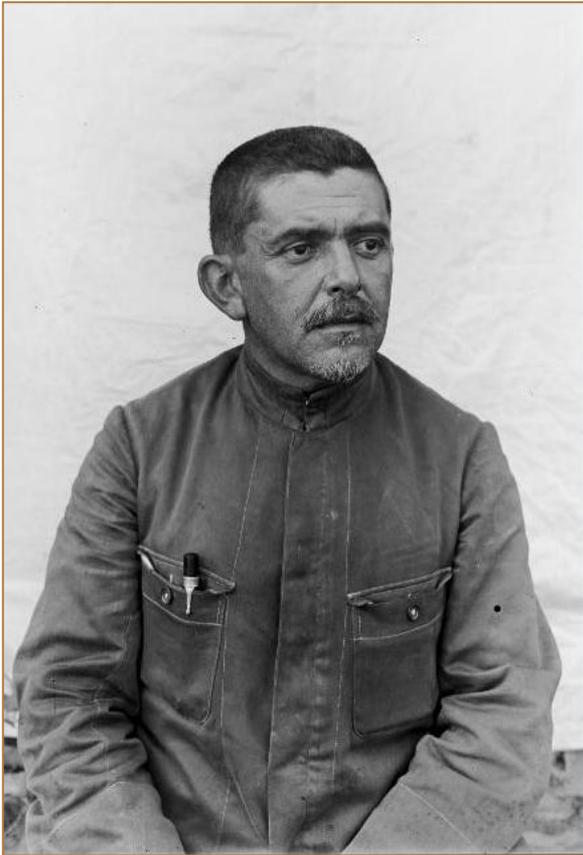




Cornélio Homem Cantarino Motta (center),
Carlos Ribeiro & Belisário Penna to the right



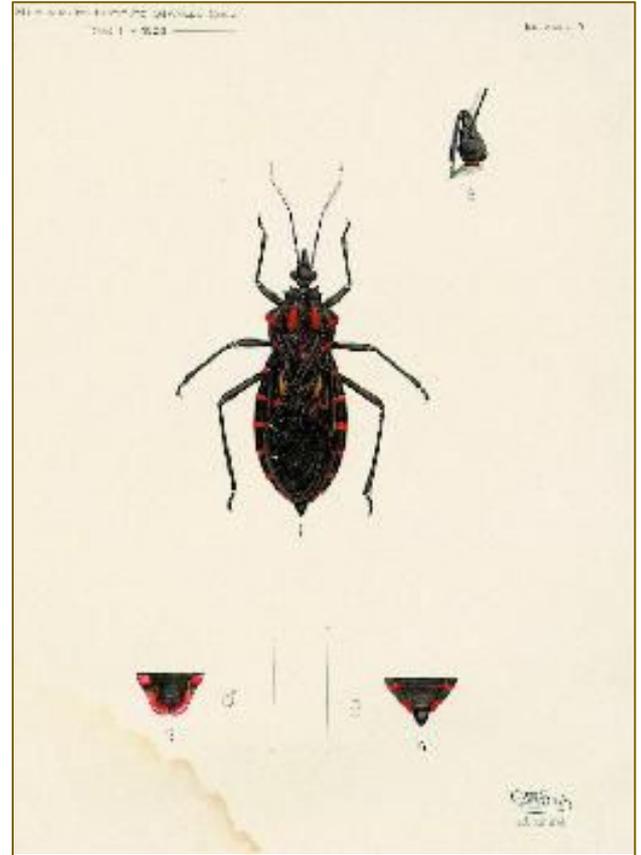
[Think Questions 3] Should Carlos take Cornélio's suggestion seriously? Give at least one reason for heeding his advice, and at least one reason for doubting it. What could you do to investigate Cornélio's information further?



Belisário Penna



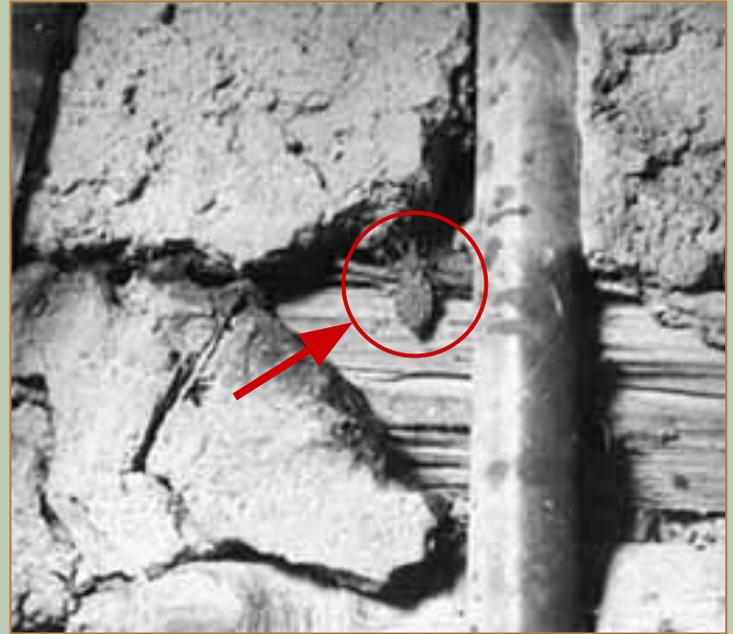
The insect stinging the residents
of the region of Lassance



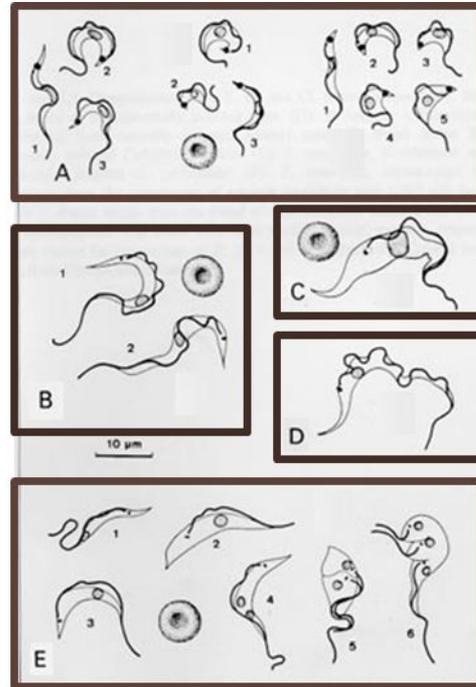
unknown Triatomina

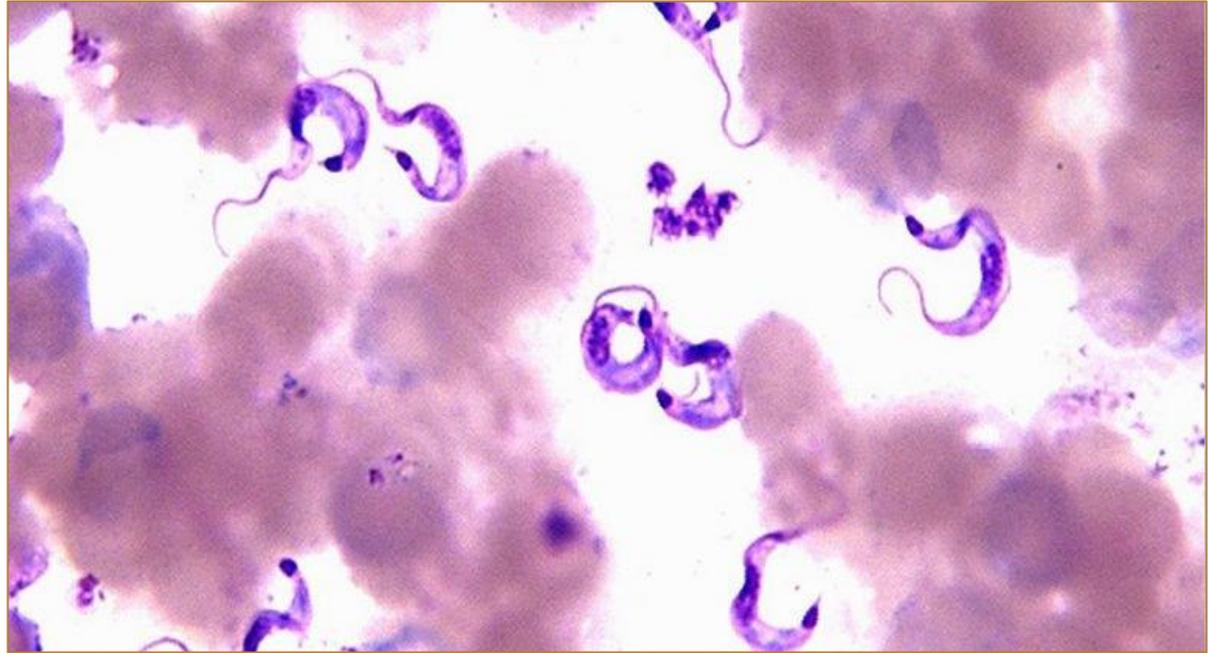
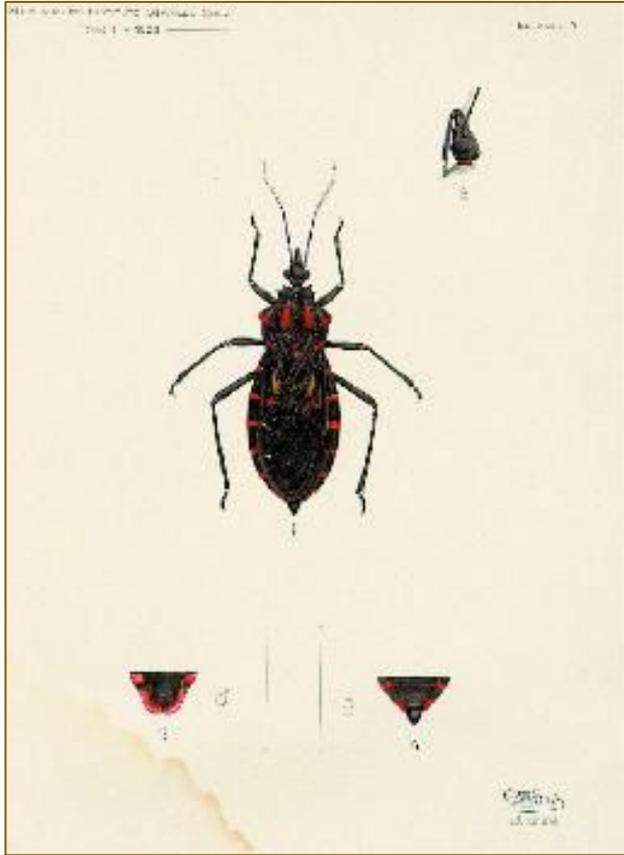


"the insect bites at night, hides in cracks, is common in unplastered and grass-covered houses where it reproduces freely, dislikes light, and disappears in the absence of people in the dwellings."

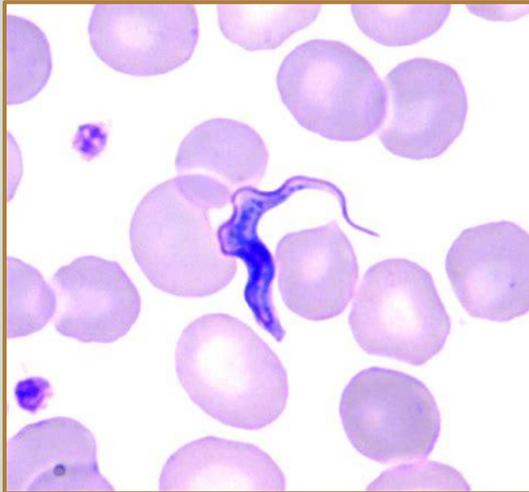
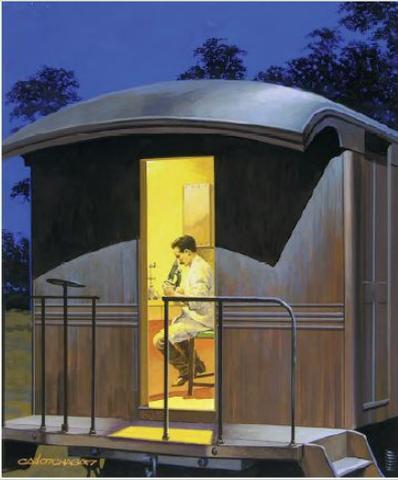


Chapter 3: Protozoa and Diseases



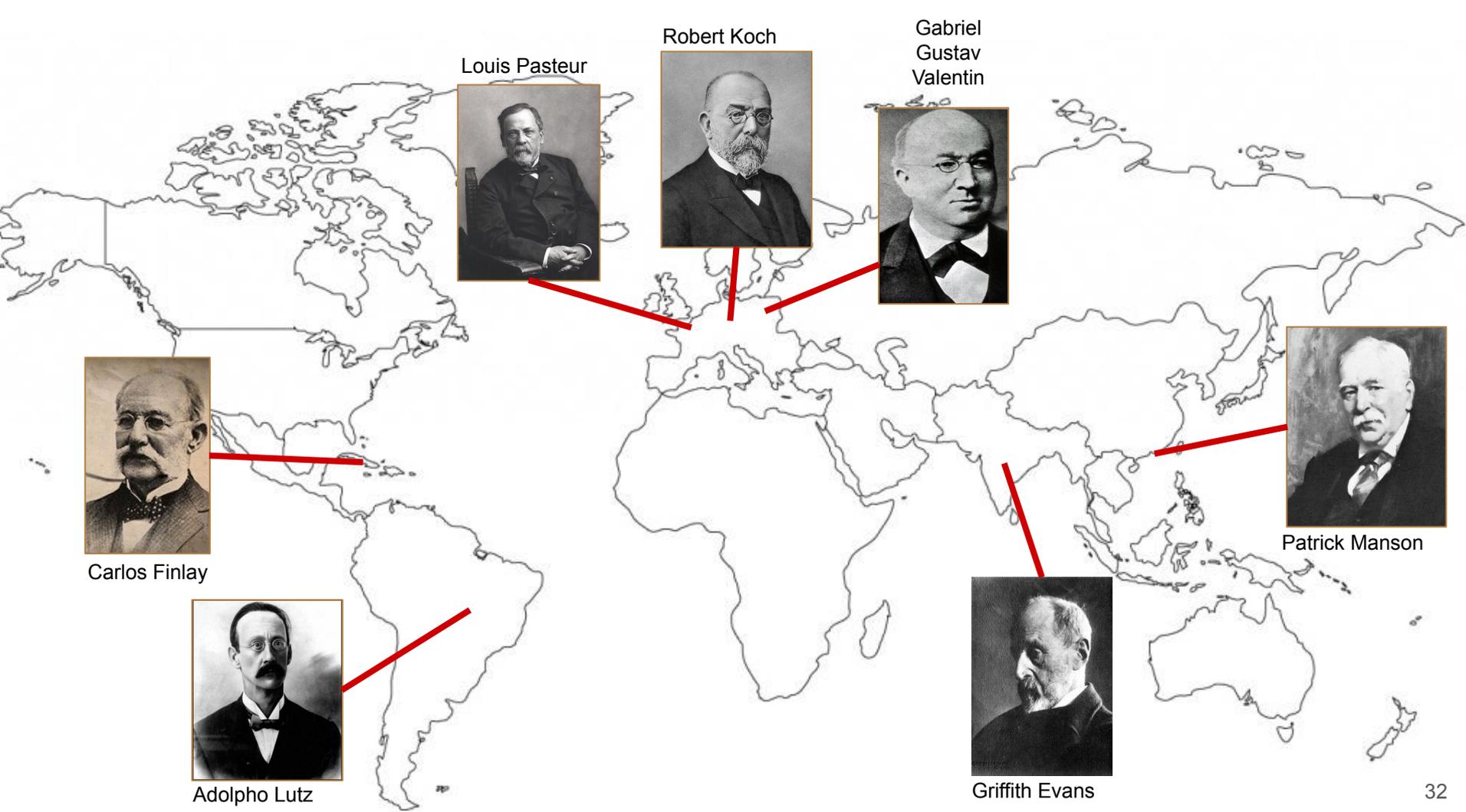


Protozoan Trypanosomide found in kissing bug stomach



Marmoset (*Callithrix penicillata*)

[Think Questions 4] How might you determine if the trypanosome forms observed in the kissing bug and the marmoset are different species or variants of the same species? What expertise and resources do you need for this investigation? How will you secure them?



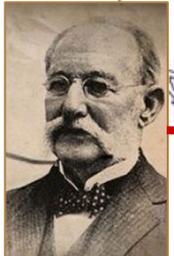
Louis Pasteur



Robert Koch



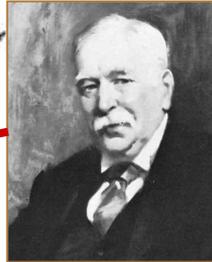
Gabriel Gustav Valentin



Carlos Finlay



Adolpho Lutz



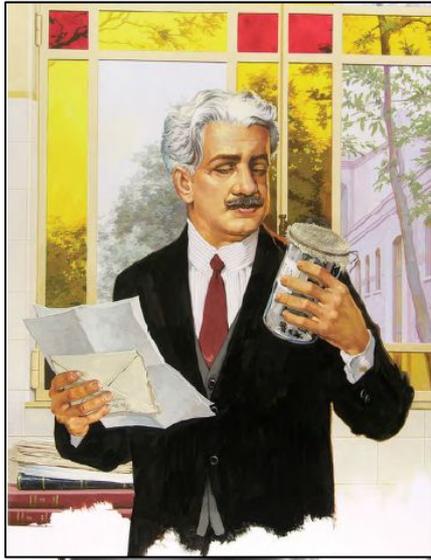
Patrick Manson



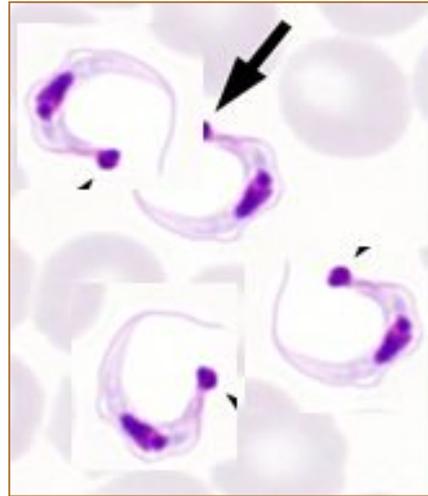
Griffith Evans

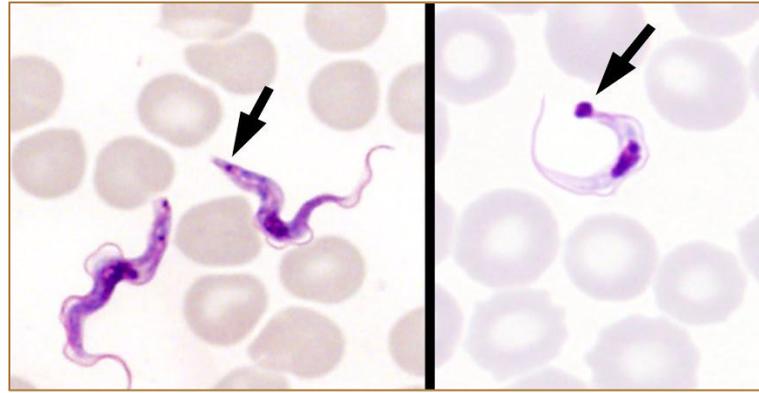
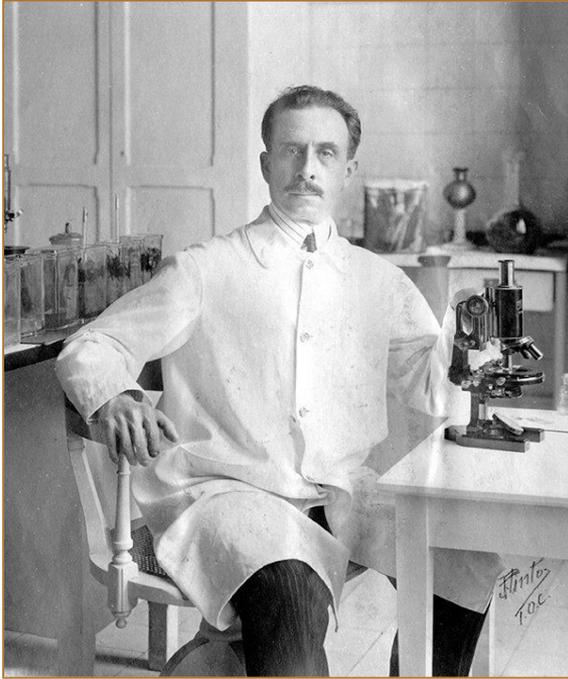


Manguinhos Institute



After
30 days





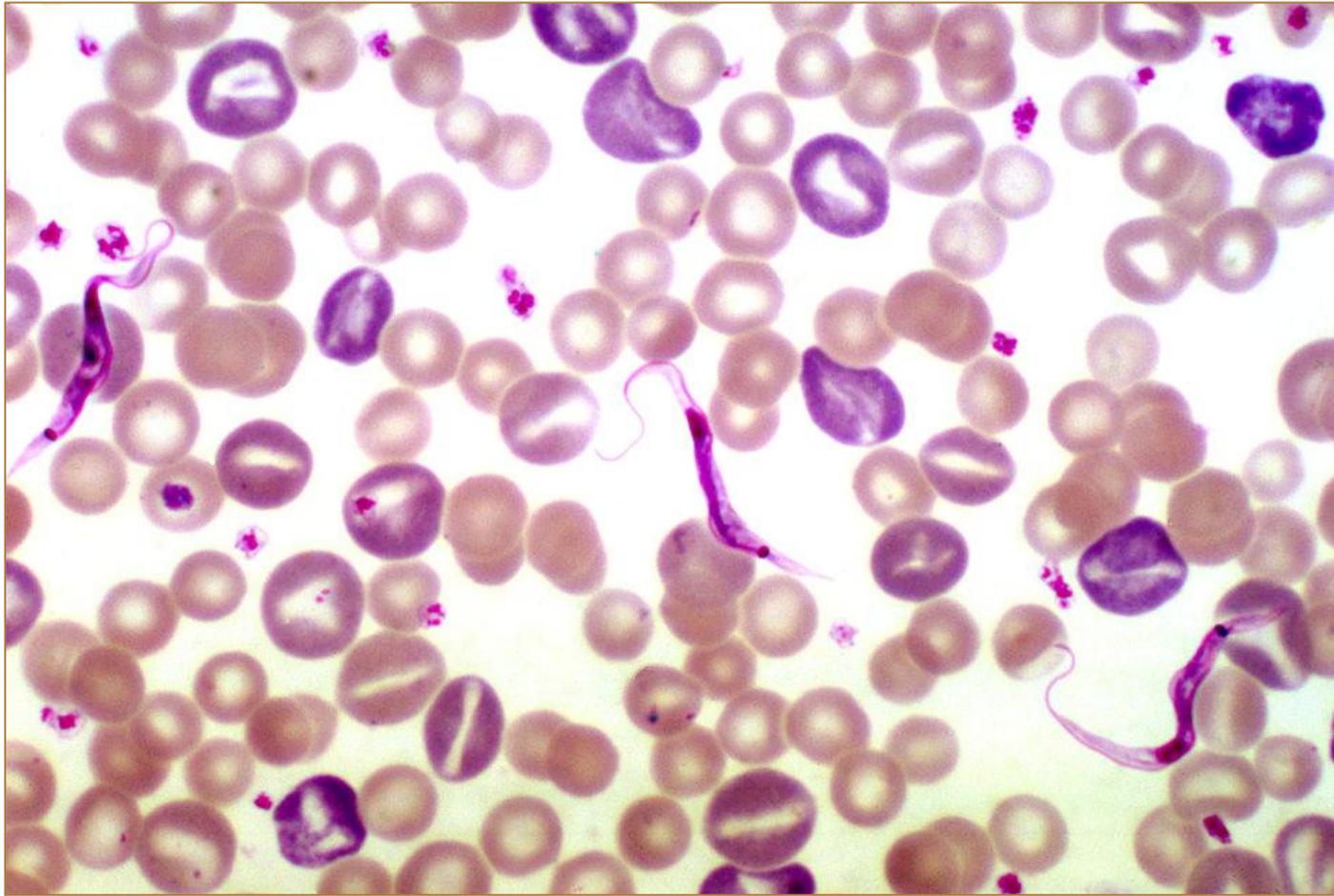
Trypanosoma minasense
found in marmoset's blood in the wild



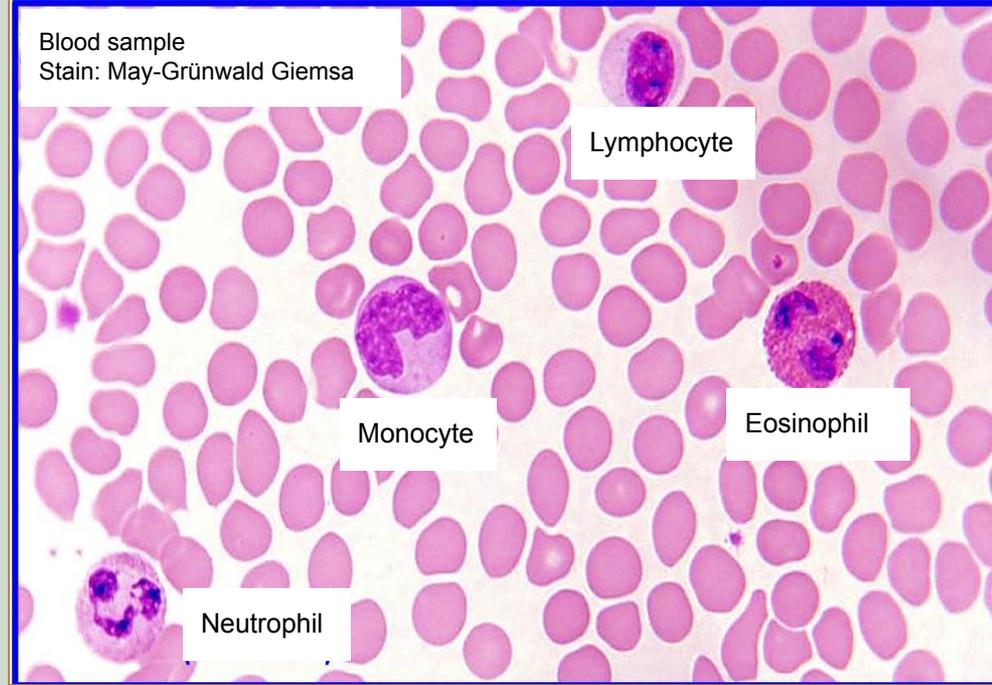
Trypanosoma cruzi
found in the kissing bug and in marmosets infected by them



[Think Question 5] How can you confirm that the disease in the marmoset is the same as that in the Lassance group after ruling out one of the trypanosomes as pathogenic?



Trypanosoma cruzi



Blood sample without protozoa, under a microscope

[Think Question 6] Should the blood investigations be abandoned or continued? If so, for how long? What factors guide your decision?



Berenice



[Think Question 7] In what ways does this finding change the course of the investigation? How might such unexpected events affect how you plan and conduct scientific investigations?

[Think Question 8] Is the presence of *T. cruzi* in the patient's blood in this one case sufficient to show that it causes the disease? If not, why not? How else might you link together the relevant evidence about the protozoa in kissing bugs, patients' blood, and other animals?



Manguinhos Institute



Manguinhos lab



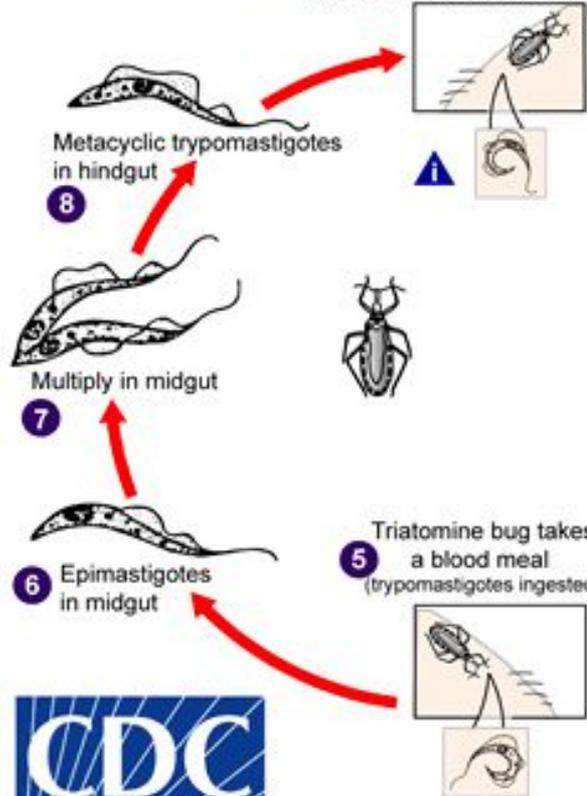
Results of experiments performed by Carlos in mid-1909

Experiment	Origin of infected blood	Animals for inoculation of infected blood	Observations after inoculation	Interpretation of results by Carlos
A	Child A	2 guinea pigs and 1 marmoset	<p>The guinea pigs die 6 days after inoculation.</p> <p>The marmoset shows trypanosomes in the lung and peripheral circulation after 8 days.</p>	(+) Guinea pigs die of the disease caused by the protozoa of the child's blood. The marmoset is also contaminated with the disease.
B	Child B in severe condition and with many symptoms, but blood without visible <i>T. cruzi</i> .	2 guinea pigs	One guinea pig dies and another has trypanosomes in the lung 9 days after inoculation, but has no parasites in the peripheral blood.	(+) One guinea pig dies accidentally and the other is in the early stage of the disease caused by the child's blood.
C	Child C in severe condition and with many symptoms, but blood without <i>T. cruzi</i> .	guinea pigs	<p>After 20 days, the guinea pigs show trypanosomes in the peripheral circulation.</p> <p>After 2 months of infection, some are alive and with intense infection.</p>	(+) The guinea pigs are contaminated by the child's blood, but show differing degrees of infection and resistance.

[Think Question 9] What do you conclude from these experiments, combined with all the other evidence gathered through Carlos's work?

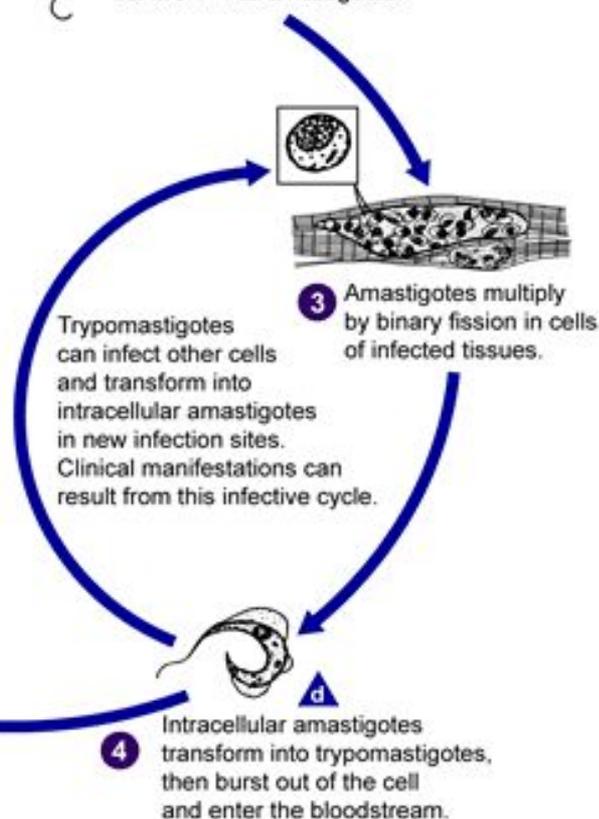
Triatomine Bug Stages

- 1** Triatomine bug takes a blood meal (passes metacyclic trypomastigotes in feces, trypomastigotes enter bite wound or mucosal membranes, such as the conjunctiva)



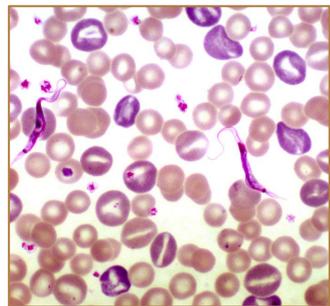
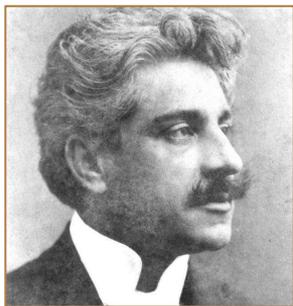
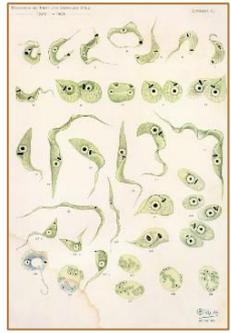
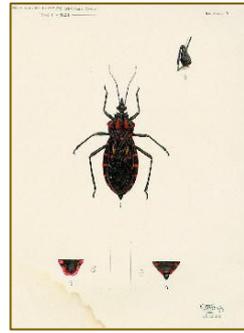
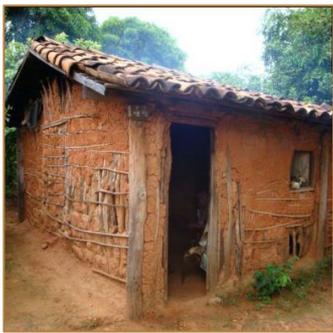
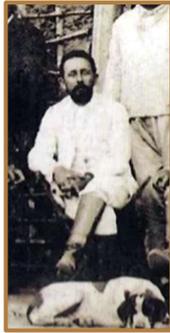
Human Stages

- 2** Metacyclic trypomastigotes penetrate various cells at bite wound site. Inside cells they transform into amastigotes.



i = Infective Stage
d = Diagnostic Stage

[THINK Question 10] What types of scientific work were needed to generate this evidence, and how was each important?

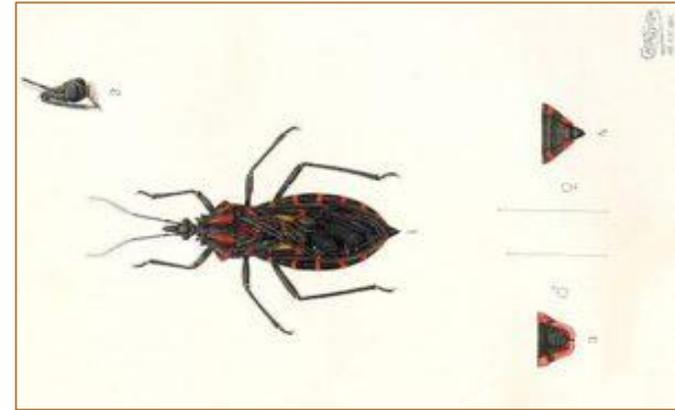


Chapter 4.

Celebrating a triple discovery



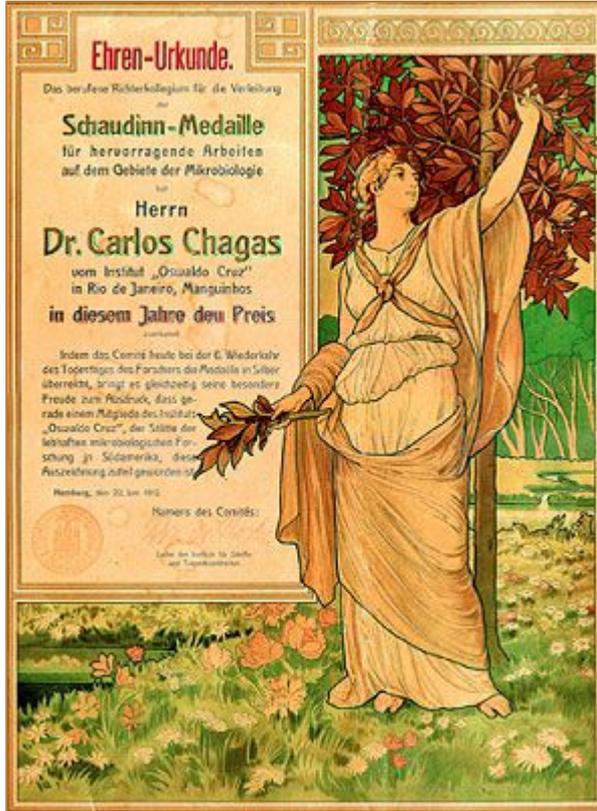
Carlos Ribeiro Justiniano das Chagas's “Triple Discovery”



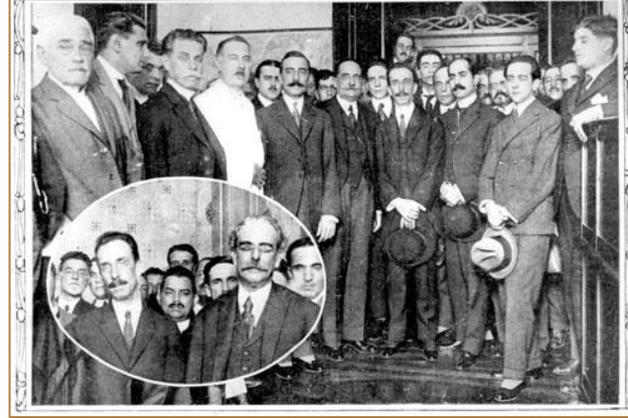
[Think Question 11] Imagine the impact of Chagas's investigations and conclusions on the science of studying diseases. How might understanding the history of this one case shape public policy on funding science and using its results?



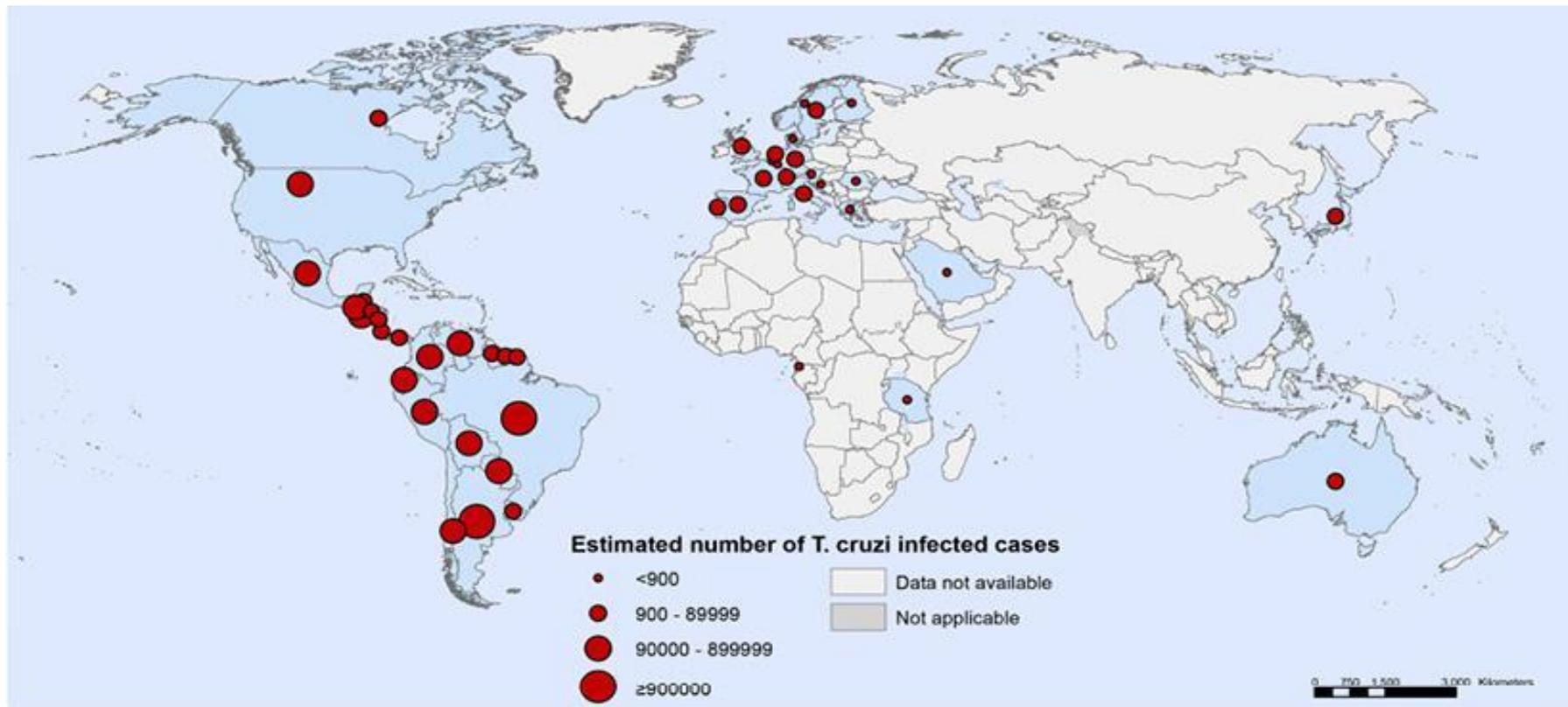
[Think Question 12] Why and how awards are important (and from whom)? What level of recognition does a discovery like this deserve?



Aposse do Dr. Carlos Chagas
Dois vezes Sucessor do Dr. Oswaldo Cruz



Global Distribution of Chagas disease, based on 2018 estimates



The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

Data Source: World Health Organization
Map Production: WHO/UCN/NTD
World Health Organization



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Lassance today

[Think Question 13] Discuss how the case of Carlos Chagas & the Railroad Workers' Disease illustrates various features about science and how it works:

- A. The role of political and economic factors in supporting scientific research (THINK 1, 10, 11)
- B. The role of personal background, motivations and skills (THINK 3, 10)
- C. The role of analogy (e.g., comparisons between diseases) (THINK 2, 4, 8, 9, 10)
- D. The role of local or anecdotal knowledge versus systematic investigation (THINK 3)
- E. The role of chance or contingency (THINK 3, 7, 8, 10)
- F. The role of patience and persistence (THINK 6, 7, 10)
- G. The role of collaboration (THINK 8, 10, 12)
- H. The relationship between laboratory studies and field studies (THINK 2, 4, 5, 6, 8, 9, 10)
- I. The application of research knowledge to public health (THINK 11)
- J. Incentives and rewards (THINK 12)