BIO 475 - Parasitology Spring 2009

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http://www4.nau.edu/isopod

Lecture 4

Evolutionary Questions

1. Host-parasite evolution

a. Host resistance/susceptibility.

1. An arms race between parasites and hosts.

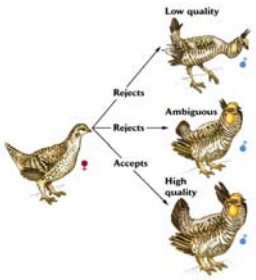
a. Selection is strong on each party to overcome the other.

b. Stronger on parasites than on hosts?

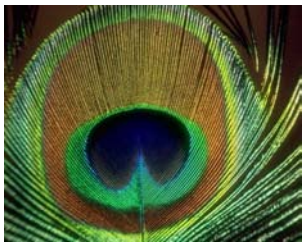
Aedes aegypti

Evolutionary Questions

2. A possible context for mate selection.
   a. Mate preferences/characters could become fixed.
   b. However, if parasite resistance is important,
1. Choice may be based on characters that reflect this ability.



Evolutionary Questions



Thus, characters as well as preferences change over time.

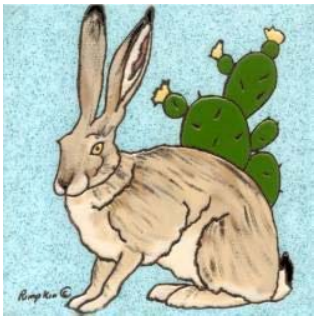
Possible example: bright coloration in birds.

Virulence

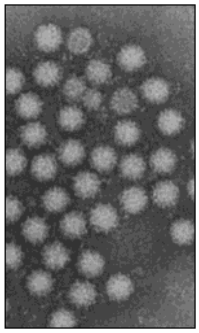
1. Some parasites are more harmful to the host than others.
2. ***Virulence*** estimates this degree of pathogenicity.
3. Often attributed to duration (in evolutionary terms) of association
4. Need not be so.

Myxoma example

1. Attempt to control rabbits introduced in Australia with a lethal virus.
2. transmission by fleas which only bite live rabbits.



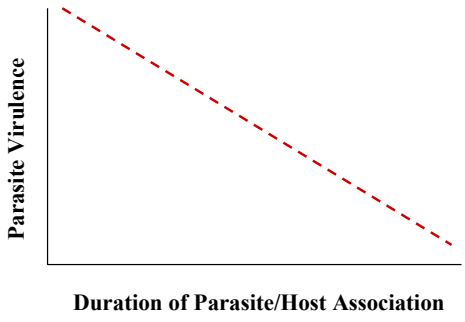
Myxoma Example



3. Led to the evolution of a less virulent virus.

b. Consistent with prediction that virulence should ***correlate negatively*** with duration of association.

Evolved Avirulence

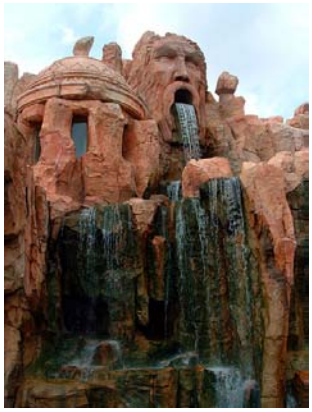


Evolutionary Questions

2. May not be true if parasite gains from being virulent.

a. transmission may be favored by host sacrifice.

Intermediate stages may need to be eaten.



Copious flows of host bodily fluids

Rapid Reproduction

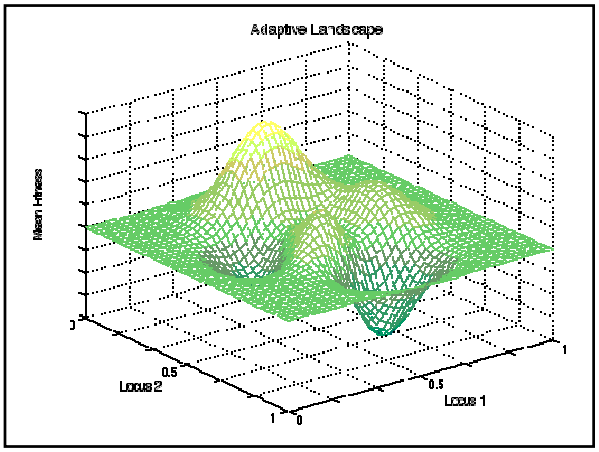
1. May kill host and remaining parasites, but this is balanced by early high transmission rate.

Evolutionary Questions

2. Shifting Balance processes (Sewall Wright)
   a. parasites seem to be an ideal model for testing Wright's theory.

The Adaptive Landscape

1. Population is broken into small neighborhoods
2. Local selection and genetic drift cause neighborhood differentiation;
   a. Unique genetic combinations are pushed to 'adaptive peaks.'
3. Productive peaks send out migrants that invade and change genotypes of other neighborhoods.



Systematics Questions

1. Phylogenetic systematics is a good approach because it generates testable hypotheses

2. Prediction:

a. patterns of host radiation should dictate patterns of parasite radiation.

Egg-type on a tentative phylogeny of tachinids (see publications)

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Systematics Questions

b. Result: seems to be upheld (see book examples).

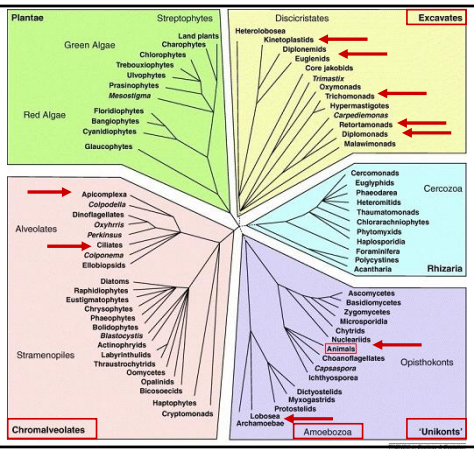
c. however, can be difficult because of difficulties in rooting tree.

Parasitic Protozoa

We will begin with the Supergroups Excavata, Amoebozoa and Chromalveolata

(formerly Sarcomastigophora Sporozoa and Chromista)

1. Includes flagellates, amoebae, apicomplexa, ciliates



Previous Classifications

1. Mastigophora - divided into 2 classes

a. Phytomastigophorea - plant like forms

1. includes Dinoflagellata

a. often have parasitic forms - or mutualistic ones.

2. other orders that also have associations with plants, animals.

Previous Classifications

2. Zoomastigophorea - animal like forms

a. many parasitic orders.

b. we will mention them in turn.

Phylum Euglenozoa

General Characteristics

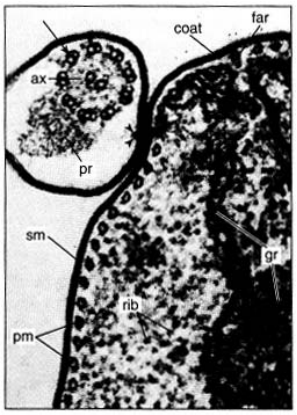
a. Cortical microtubules.

b. Flagellae with paraxial rod.

c. mitochondria with discoid cristae.

d. nucleoli persist during mitosis.

***Euglena* sp.**



Phylum Euglenozoa

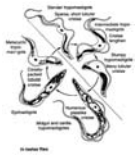
a. Cortical microtubules.

b. Flagellae with paraxial rod (pr).

Phylum Euglenozoa

c. Mitochondria with discoid cristae.

d. Nucleoli persist during mitosis.



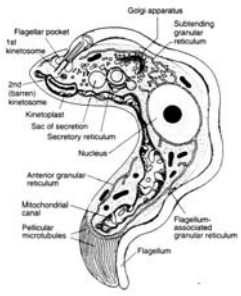


Figure 5.1
Diagram to show principal structures revealed by the electron microscope in the bloodstream trypomastigote form of the salivarian trypanosome, *Trypanosoma congolense*. It is shown cut in sagittal sections, except for most of the shaft of the flagellum and the anterior extremity of the body.

Phylum Euglenozoa

2. Many different orders.

a. Most are free living; often with chloroplasts.

b. Subphylum Kinetoplasta (or Class Kinetoplastea)

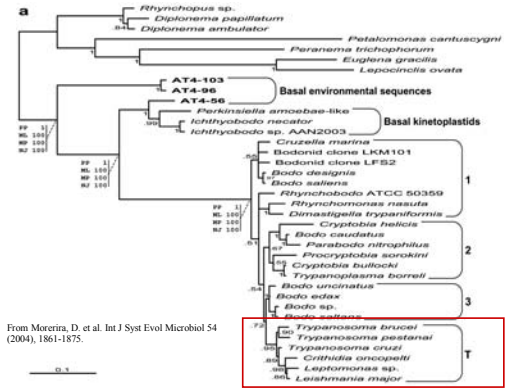
1. Diverged from rest of group 1 *billion* years ago!

2. Distinct with unique mitochondrion

3. Also usually with undulating membranes.

TRYPOMASTIGOTE
Genus *Trypanosoma*

Kinetoplastean Phylogeny



From Moreira, D. et al. Int J Syst Evol Microbiol 54 (2004), 1861-1875.

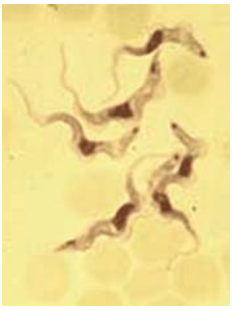
Order Kinetoplastida

1.May be revised to be a subclass (Metakinetoplastina)

2. Includes **Trypanosomes**

a.Maybe soon, Order Trypanosomatida

b. We will begin with this group because it is *well known* and serves to show *diversity of parasitic forms.*



Order Kinetoplastida

2. Evolution

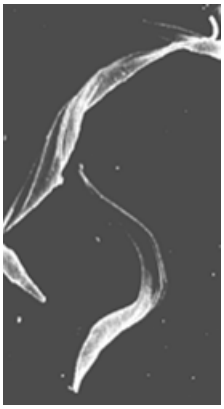
a. Appear commonly in plants and sap-feeding insects.

1. *Phytomonas, Crithidia*

b. Transmission appears mainly by transport within body of insects.

c. Variable stages occur within *different hosts*.

CHOANOMASTIGOTE
Genus *Crithidia*

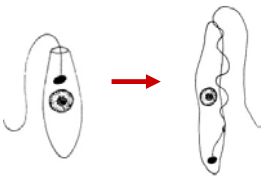


Host Shifts

d. This tendency to shift between hosts is described by 2 terms:

1. monoxenous - single host.

2. heteroxenous - more than one host.



Hemoflagellates

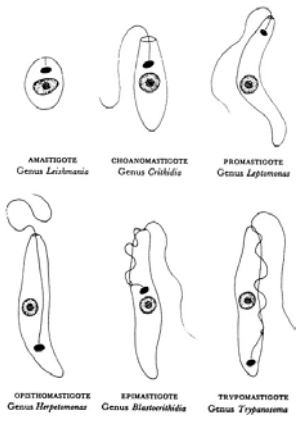
1. Current hypothesis is that parasitic forms on vertebrates evolved from ancestral insect gut parasites.

a.Forms specialized for vertebrate blood are called **hemoflagellates**; (also haemoflagellates)

Body Forms

1. Worth mentioning because these forms are typical of certain genera.

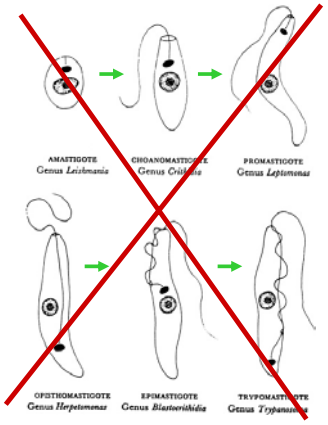
a. Also, some genera have these forms included in their development as parasites.



However,

1.These DO NOT necessarily represent an evolutionary progression!

2. The existence of certain stages within a life cycle suggests *adaptation to particular environments.*

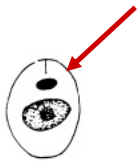


Amastigote - no flagellum

1. But, retains kinetosome, kinetoplast and axoneme.

2. Example: *Leishmania*

a. Parasite of humans, other mammals.



AMASTIGOTE
Genus *Leishmania*

Choanomastigote

CHOANOMASTIGOTE
Genus *Crithidia*

1. Flagellum emerges from a pocket

2. Example: *Crithidia*

a. tiny intestinal parasite of insects.

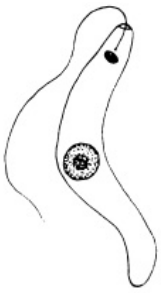
Promastigote

1. Flagellum is located at anterior end.

2. Example: *Leptomonas*

a. Parasite of insects and other invertebrates.

b. Of no known medical importance.



PROMASTIGOTE
Genus *Leptomonas*

Promastigote to Amastigote

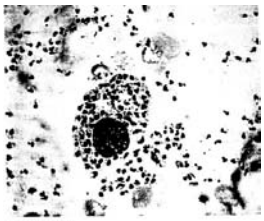


FIGURE 5.17
Spleen smear showing numerous intracellular and extracellular amastigotes of *Leishmania donovani*.

2. However, in parasitic species in vertebrate hosts, this stage in parasitic species is phagocytized by macrophages.

a. They transform into *amastigotes* that remain within the cell.

b. e.g., *Leishmania*

Epimastigote

1. Flagellum on side of cell, sometimes with undulating membrane

1. example: *Blastocrithidia*

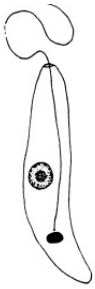
a. Monoxenous parasite of insects

b. Often found in guts of water striders

EPIMASTIGOTE
Genus *Blastocrithidia*

Gerris remigis

Opisthomastigote



OPISTHOMASTIGOTE
Genus *Herpetomonas*

1. Flagellum posterior with deep pocket.

2. Example: *Herpetomonas*

a. Monoxenous in insects.

b. Goes through other stages as well.

Trypomastigote

1. Flagellum posterior with undulating membrane.

2. Example *Trypanosoma.*

a. Parasite in insects and vertebrates.

TRYPOMASTIGOTE
Genus *Trypanosoma*

Trypanosomes of Importance to Humans

1. Two main genera:
   a. *Leishmania*
2. Known by various disease names (wherever the British army happened to be at the time).

Leishmaniasis: a.k.a

a. kala azar
b. oriental sore
c. (Aleppo; Jerico; Delhi) boil.
d. Baghdad button
e. Dum-Dum fever.

Leishmaniasis

2. Tends to be intracellular - in tissues.
3. Produces lesions in skin or viscera.

Cutaneous Leishmaniasis

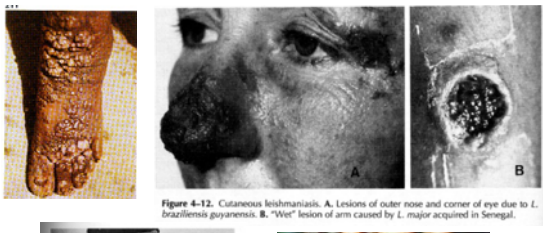
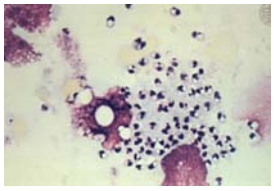


Figure 4–12. Cutaneous leishmaniasis. **A.** Lesions of outer nose and corner of eye due to *L. braziliensis guyanensis*. **B.** "Wet" lesion of arm caused by *L. major* acquired in Senegal.

Visceral Leishmaniasis

Discovery of the Disease



Kala Azar or Black Fever has existed in India and China for centuries. In 1900 when William Leishman, a Scottish army doctor, found *Leishmania donovani* in stained smears from the spleen of a soldier suffering from a fever contracted at Dum-Dum in India.

His observations were published in 1903. At the same time Charles Donovan, a Professor of Physiology at Madras University, described a similar parasite in smears made from a splenic biopsy.

Prior to Leishman and Donovan's discovery kala azar was considered to be a communicable malaria-like disease that showed relapses, emaciation, as well as enlargement of the liver and spleen, and spread slowly across the continents along the trade routes.