BIO 475 - Parasitology
Spring 2009

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http://www4.nau.edu/isopod

Lecture 18

Phylum Nemata

A.k.a., Phylum Nematoda

General characteristics

1. widely distributed and unbelievably abundant!

Phylum Nemata

Nematodes are:

a. Free-living, commensal, parasitic.

b. Of tremendous economic importance.

c. The number of species defies description, evidently because their body form ***preadapts*** them to so many ecological niches.

"If all the matter in the universe except the nematodes were swept away, our world would still be dimly recognizable, and if, as disembodied spirits, we could then investigate it, we should find its mountains, hills, vales, rivers, lakes and oceans represented by a film of nematodes. The location of towns would be decipherable, since for every massing of human beings there would be a corresponding massing of certain nematodes. Trees would still stand in ghostly rows representing our streets and highways. The location of the various plants and animals would still be decipherable, and, had we sufficient knowledge, in many cases even their species could be determined by an examination of their erstwhile nematode parasites."

N.A. Cobb 1966.

Box Four

Characteristics of the Phylum Nematoda

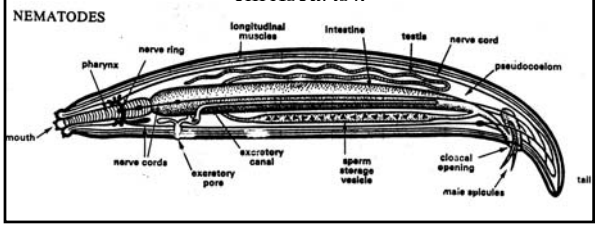
1. Triploblastic, bilateral, vermiform, unsegmented, pseudocoelomates
2. Body round in cross section and covered by a layered cuticle; growth in juveniles usually accompanied by molting
3. With unique cephalic sense organs called amphids; some have caudal sense organs called phasmids
4. Gut complete; mouth surrounded by six lips bearing sense organs (often reduced to three lips, or to a simple ring)
5. Most with unique excretory system, comprised of one or two renette cells or a set of collecting tubules
6. Without special circulatory or gas exchange structures
7. Body wall has only longitudinal muscles
8. Longitudinal muscle cells connected to longitudinal nerve cords by unique muscle arms
9. Epidermis produced into longitudinal cords housing nerve cords
10. Gonochoristic
11. Inhabit marine, freshwater, and terrestrial environments; some are free-living and some parasitic

Phylum Nemata

Body form

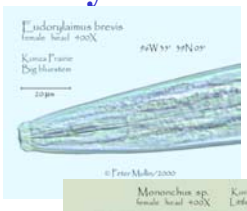
a. Slender, elongate, w/tapered ends, - good for interstitial environments.

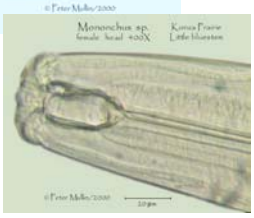
b. Mostly small; < 3mm with some exceptions (20-30 cm *Ascaris*).

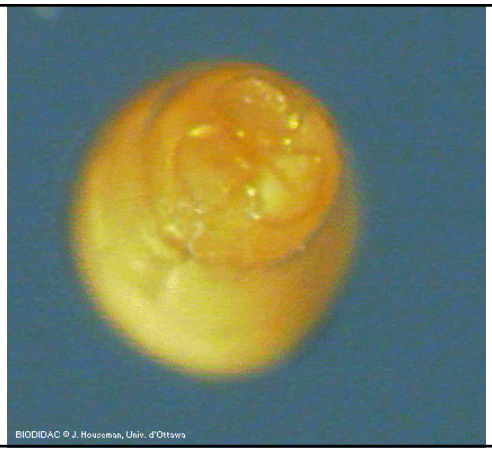


Nemata: Body Ends

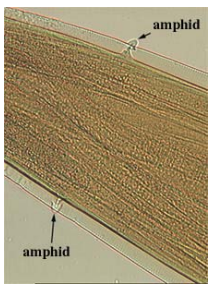
1. Anterior is radially symmetrical - 3 (or 6) lips.
   a. Suggests possible sessile ancestor.
   b. Sensory papillae.
   c. Chemosensory structures - ***amphids***
      1. Well-developed in free-living forms.

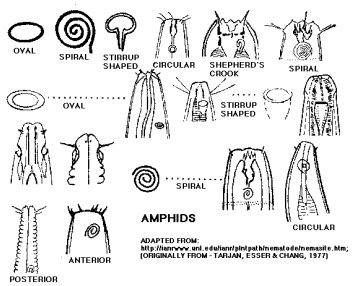






Nemata: Amphids



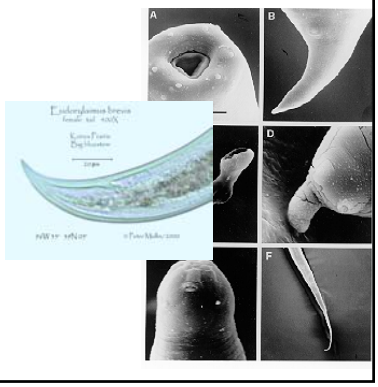


Nematata: Body Ends

2. Posterior – often with adhesive structures.

a. Some species with other sensory structures - ***phasmids***

1. Well-developed in parasites.



Cuticle and Body Wall

1. Cuticle is collagen and scleroprotein

a. Multiple layers, occasionally with annulation, spines, pores.

b. Secreted by epidermal cells

c. Must be shed during growth - typically in 4 molts.

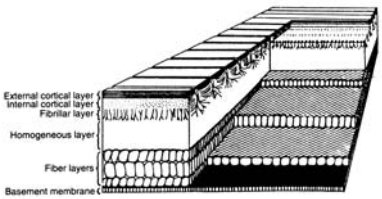
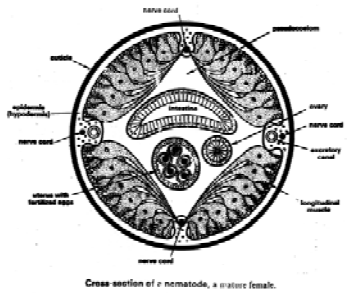


FIGURE 22.3

Diagram showing transverse, longitudinal, and tangential sections of the cuticle of *Ascaris*. The strands of each of the three fiber layers run at an angle of about 75° to the longitudinal axis of the worm, and the strands of the middle layer run about 135° from those of the inner and outer layers.

From A. F. Bird and K. Deutsch, "The structure of the cuticle of *Ascaris lumbricoides* var. *suis*," in *Parasitology* 47:319–329. Copyright © 1957. Reprinted with permission of the publisher.

Cuticle and Body Wall



Cross-section of a nematode, a mature female.

2. Fibers permit cuticle to flex (store potential energy) when stretched - assist locomotion.

3. Epidermal cords - thickenings that enclose

a. Dorsal and ventral nerve cords

b. Lateral excretory canals.

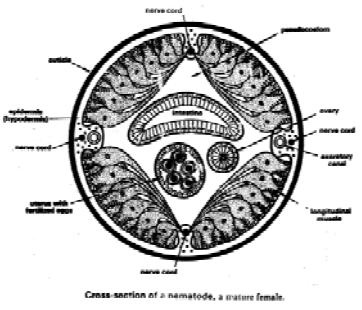
Musculature

1. no circular muscle - only longitudinal

2. muscles are obliquely striated - permits more rapid contraction.

3. Directly connected to dorsal and ventral nerves via "arms."

4. Unusual but highly successful locomotion



Cross-section of a nematode, a mature female.

Locomotion

a. Accomplished by interaction between musculature and ***pseudocoel***.

1. Internal pressure - 16-125 mm Hg (avg. = 70)

a. Maintains constant shape of worm

b. Exerts tension on cuticle

b. Longitudinal muscles produce local shortening.

Coordinated Movement

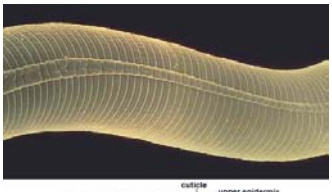
1. Displaced fluid stretches cuticle elsewhere.

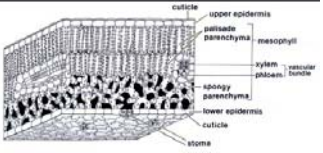
2. Release of musculature causes elastic recoil of stretched cuticle.

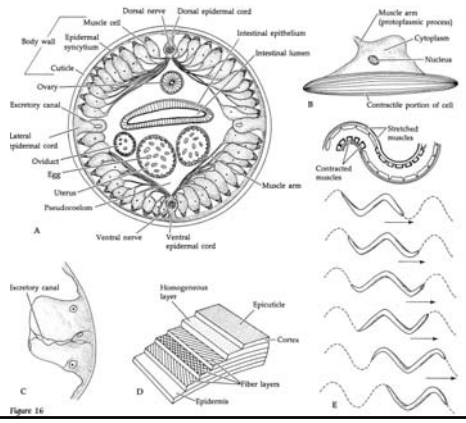
3. Sets up next contraction by opposing musculature.

c. Well-suited for movement in interstitial environments

1. Pre-adaptation for parasitic existence.







Other Consequences

a. Reduces need for reflex pathways - fluid transfers info on movement throughout body.

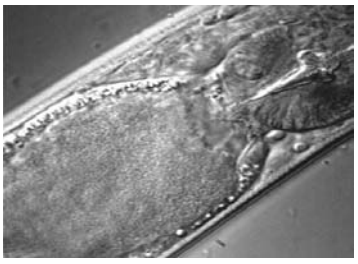
b. Sensory nervous system is reduced (amphids, phasmids).

Nemata: Gut

1. Diet and internal processing varies considerably

a. carnivorous, herbivorous, saprobic, etc.

b. oral end modified for various food types.



Nematata: Pharynx

c. Overall similarity - muscular pharynx

1. Pumps food into gut, against hydrostatic pressure of pseudocoel.

2. Pumping also is a preadaptation for parasitism.

3. Pharynx and anus have sphincter qualities.

Phylum Nemata

Excretion

1. unusual and sophisticated system; two types

a. renette cells

1. ancestral condition - well-developed in marine forms

2. gland cells on ventral pharynx opens at excretory pore near mouth

Phylum Nemata

b. H-tubule system

1. Appears more derived, renette cells reduced

2. Often in parasitic forms

2. mostly excrete NH_4^+, occasionally urea

a. Maintains pseudocoel pressure.

EXCRETORY PORE AND LARGE EXCRETORY GLAND

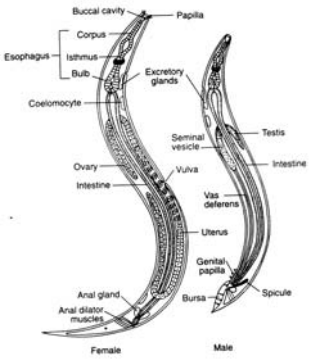
ADAPTED FROM:
http://ianrwww.unl.edu/ianr/plntpath/nematode/nemasite.htm;
(ORIGINALLY FROM - TARJAN, ESSER & CHANG, 1977)

Phylum Nemata

3. Reproduction - life cycles of parasitic nematodes

a. most species are ***gonochoristic*** (dioecious), often dimorphic.

1. females usually larger than males - fecundity selection.



Phylum Nemata

2. Often with competition, so males with claspers, etc.

b. copulation usually with spicules - male "intromittant" organ; mainly just to open female vulva.

c. Sperm are usually amoeboid - adaptation to permit movement within pressurized pseudocoelom.

Phylum Nemata

Life cycles

1. Generalized:

a. Eggs hatch -> go through 4 larval molts -> adult.

2. Parasites – often more specialized

a. Variation associated with infective stages of larvae.

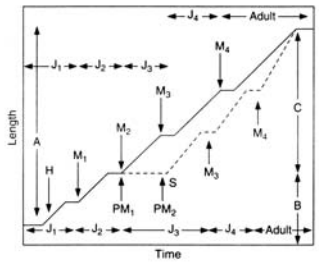


FIGURE 22.33

Idealized form of the basic life cycle of nematodes. The life cycle of a free-living nematode is represented by a solid line. Hatching (**H**) is "spontaneous," and there are four molts (M_1–M_4). The broken line represents a life cycle in which a change in environment is necessary to stimulate (**S**) the completion of the second molt (PM_2). (**A–C**) are different environments. (J_1–J_4 are the juvenile stages.)

Modified from W. P. Rogers and R. I. Sommerville, "The infective stage of nematode parasites and its significance in parasitism," in *Advances in Parasitology*, Vol. 1. Edited by B. Dawes. Copyright © 1963 Academic Press, Inc., New York, NY.

Nemata: Systematics

Morphological classification is based on habits and location of sensory structures.

1. Aphasmida - Adenophorea (mainly free living)

a. Have amphids, lack phasmids

2. Phasmida - Secernentea (lots of parasites)

a. have phasmids and amphids.

Phylum Nemata

Class Enoplea (=Adenophora, Aphasmidea)

A. Characteristics:

1. long, thin nonmuscular pharynx composed of large cells

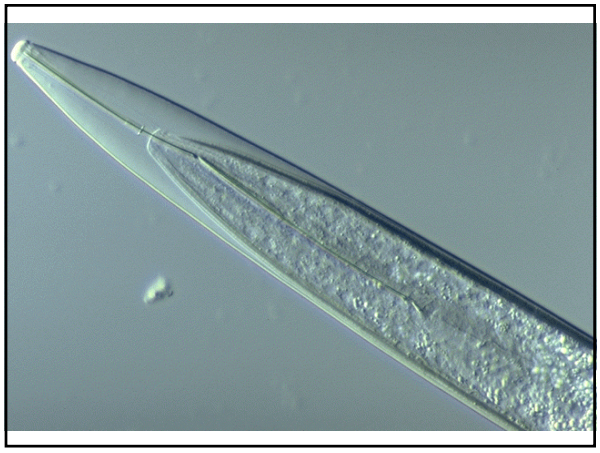
a. called *stichosome*.

2. Simple mouth without lips

3. Anterior body is thinner than posterior

4. Amphids rather than phasmids

4. Parasitic species in birds and mammals.



Order Trichurida

a. *Trichuris trichiura* - whipworm

1. human intestinal parasite

2. lives in tropical habitats, causes anemia

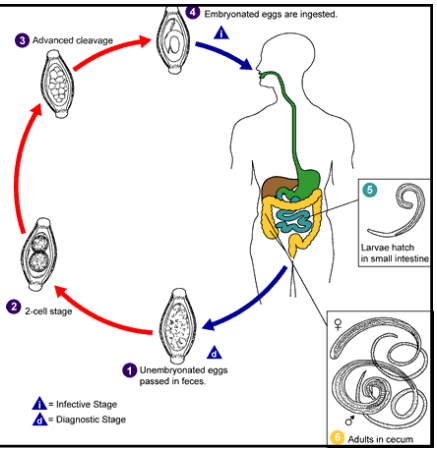
3. life cycle

a. egg -> voided in feces -> eggs ingested -> larva hatches

in gut -> adult worms develop

4. Identified from Pre-Spanish Conquest Andean Mummies.

Trichurus trichiura **Life Cycle**

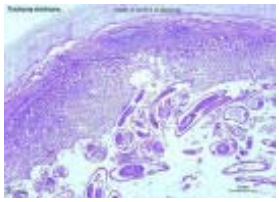


Trichuris trichiura

b. note eggs - double plugs

Trichuris spp.

- Over 60 species of *Trichuris* have been documented, and each has been found to undergo a similar life cycle.
- the human whipworm (T. trichiura) and canine whipworm (*T. vulpis*) display a relatively high degree of host specificity, with canine whipworms only rarely occurring in humans.



Trichuris trichiura

- Females are capable of producing more than 10,000 eggs in a single day, which are passed out of the host's body with digestive waste and require a warm, moist environment to continue development into the embryonic stage.

Trichuris trichiura

- Infection is acquired through the accidental ingestion of eggs and embryos. Because these parasites do not actually multiply within the host, every individual worm inside a host represents an independent infection event.