

BIO 221
Invertebrate Zoology I
Spring 2010

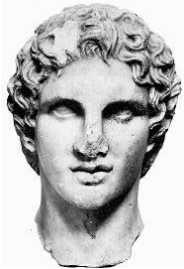
Stephen M. Shuster
Northern Arizona University

<http://www4.nau.edu/isopod>

Lecture 21

Phylum Nematomorpha

b. Alexander cut it with his sword and became King of Phrygia



Phylum
Entoprocta
(Kamptozoa)

General Characteristics

1. Usually colonial organisms with upright zooids.

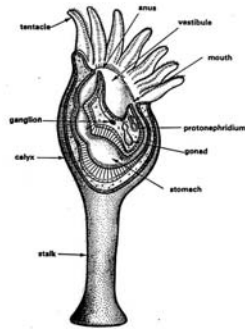
a. ciliated tentacles surrounding the mouth and anus.



Phylum Entoprocta

General Characteristics

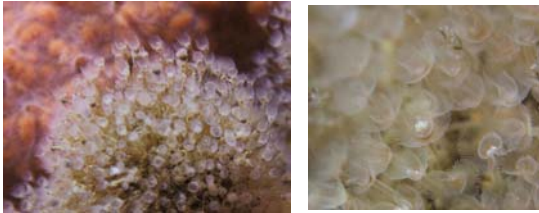
- b. Derivation of "entoproct" -anus within ring of tentacles.
- c. Kamptozoa - derived from flexible calyx that permits zoids to "nod."



Phylum Entoprocta

2. Appear related to other similar groups:

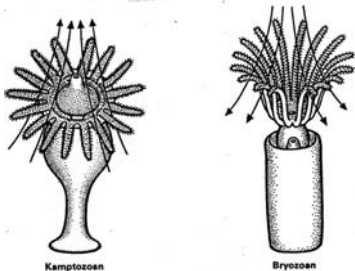
- a. Bryozoans - ectoprocts
- b. but similarity is ecological rather than evolutionary.



Phylum Entoprocta

Cilia draw water from *beneath* tentacles.

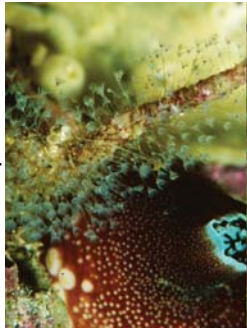
- a. Food swept to mouth, anus *within* ring of tentacles.



Phylum Entoprocta

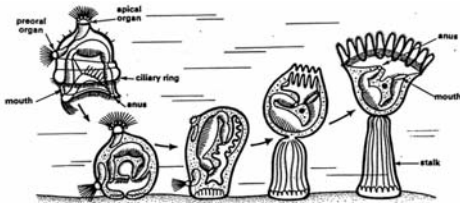
Reproduction

- a. Capable of reproduction by budding - hence colonial structure.
- b. Also sexual reproduction.



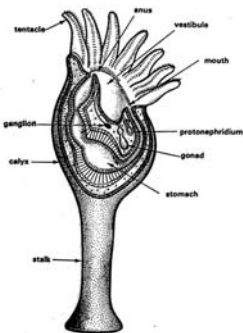
Phylum Entoprocta

1. Sperm released into water; internal fertilization.
3. Ciliated larva that is similar to that of annelids and molluscs.



Settlement and metamorphosis of a pedicellinid kamptozoon. The larva settles on the ciliary ring, and its sense organs disintegrate. The gut and associated organs rotate until they face into the overlying water. Tentacles develop and the young animal begins to feed. (Modified after C. Cori)

Phylum Entoprocta



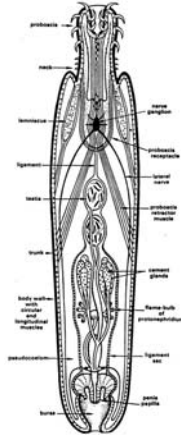
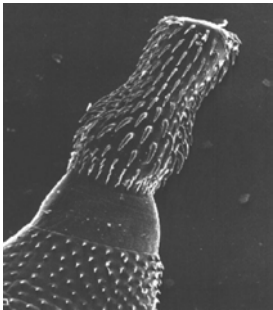
4. Some to suggest that entoprocts are highly derived, share a common ancestor with these groups.
- a. Lack of body cavity represents a neotenic character.

Box Seven

Characteristics of
the Phylum Acanthocephala

1. Triploblastic, bilateral, unsegmented, vermiform pseudocoelomates
2. Anterior end with hook-bearing proboscis
3. Epidermis contains a unique system of channels called the lacunar system
4. Gut absent
5. Protonephridia absent except in a few species
6. With unique system of ligaments and ligament sacs partially partitioning the body cavity
7. Gonochoristic
8. All are obligate parasites in vertebrates; many have complex life cycles

**Phylum
Acanthocephala**



Acanthocephala: Characteristics

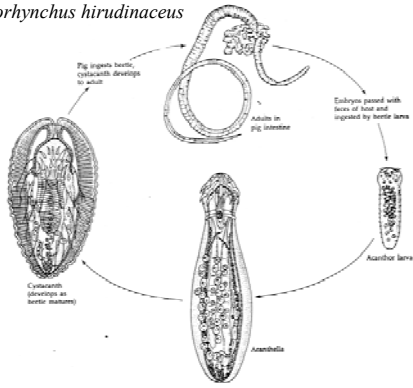
Examples:

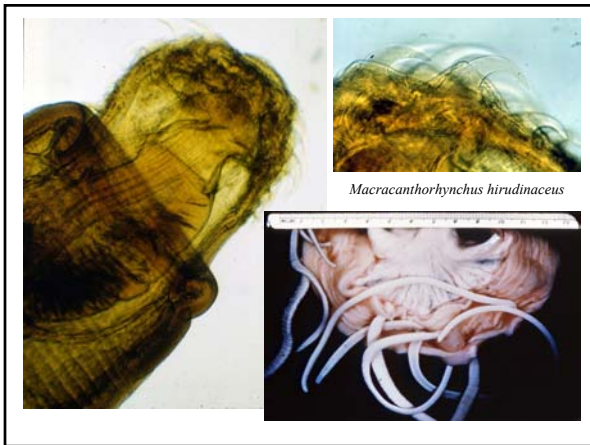
a. *Macracanthorhynchus*.

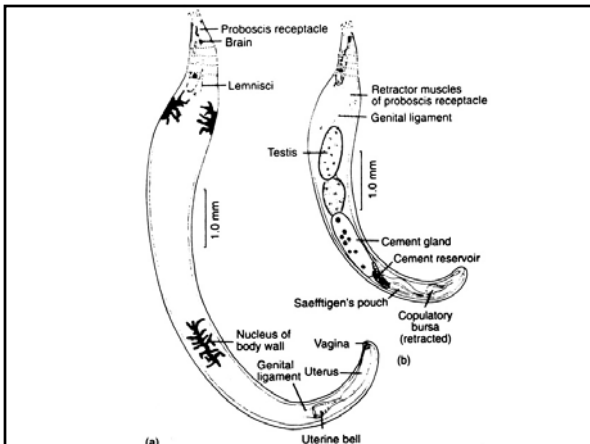


Eggs in pig feces

Macracanthorhynchus hirudinaceus

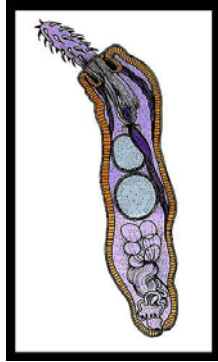






Acanthocephala: Sexual Dimorphism

1. Separate sexes, males < females
2. males compete with each other for access to mates.
 - a. competition includes cementing other males up
 - b. may favor early maturation - mature 1st, be cementer.



Acanthocephala: Sexual Dimorphism

3. females produce many eggs - dispersed in feces to be picked up by intermediate hosts
 - a. larger females produce more eggs
 - b. may favor longer period of growth, larger size at maturity.



Acanthocephala: Sexual Dimorphism

4. Thus, *sexual dimorphism* appears to be a consequence of two factors:

1. Selection favoring rapid maturation in males.
2. Selection favoring large size in females.
 - b. Result: large females, small males.

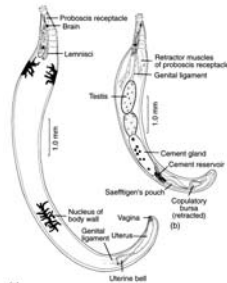


Figure 31.3 *Onchoporus aspidi*, illustrating basic acanthocephalan morphology. (a) Female; (b) male.
 From G. D. Schmitt and E. H. Hughes, "Acanthocephala of South American Fishes. Part I. *Onchoporus*" in *J. Parasitol.*, 56:429-433. Copyright © 1970 Journal of Parasitology. Reprinted by permission.



"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

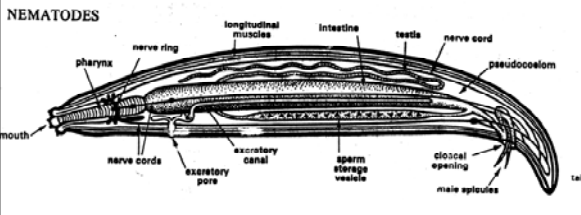
1. Triploblastic, bilateral, vermiform, unsegmented, pseudocoelomates
2. Body round in cross section and covered by a layered cuticle; growth in juveniles usually accompanied by molting
3. With unique cephalic sense organs called amphids; some have caudal sense organs called phasmids
4. Gut complete; 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

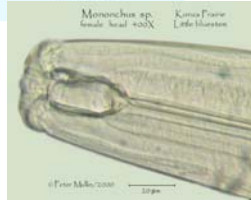
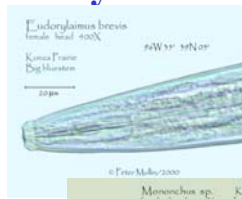
a. Slender, elongate, w/tapered ends, - good for interstitial environments.

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



Nemata: Body Ends

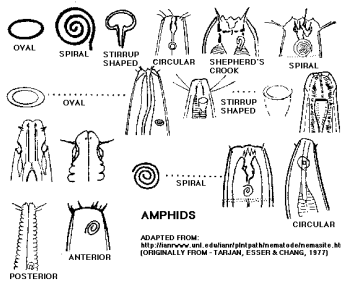
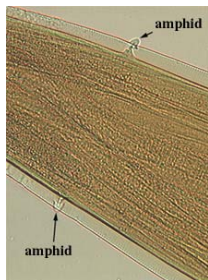
- 1. Anterior is radially symmetrical - 3 (or 6) lips.
- a. Suggests possible sessile ancestor.
- b. Sensory papillae.
- c. Chemosensory structures - *amphids*
- 1. Well-developed in free-living forms.





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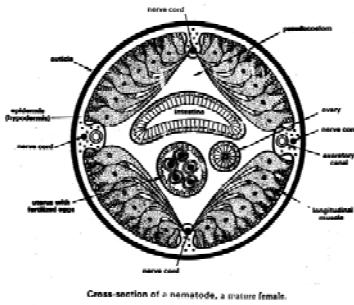
Nemata: Amphids



ADAPTED FROM: <http://www.ars.usda.gov/arsuserfiles/19152main.htm>, (ORIGINALLY FROM - TARJAN, ESSER & CHANG, 1977)

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



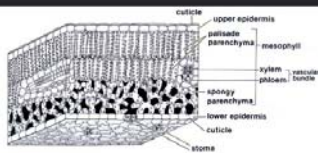
Locomotion

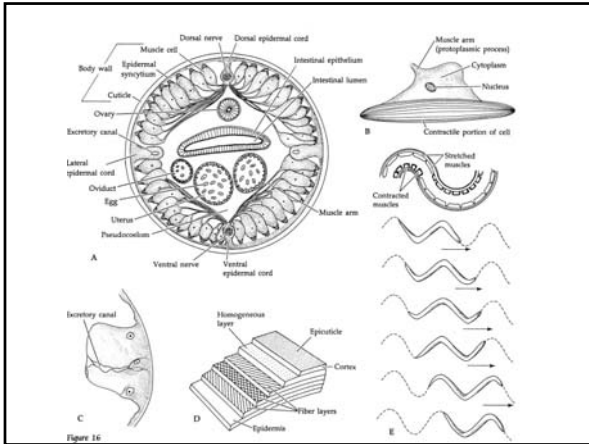


- a. Accomplished by interaction between musculature and *pseudocoel*.
1. Internal pressure - 16-125 mm Hg (avg. = 70)
 - a. Maintains constant shape of worm
 - b. Exerts tension on cuticle
 - a. Longitudinal muscles produce local shortening.

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.





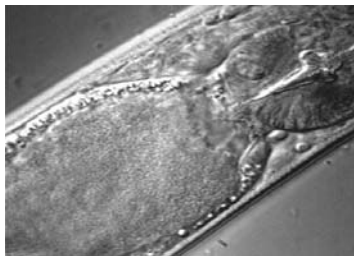
Other Consequences

- 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.



Nemata: 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

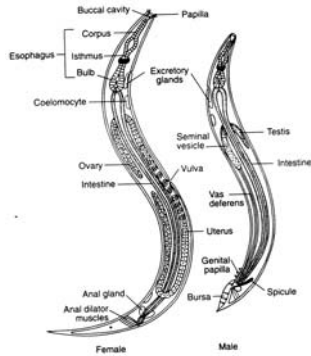
ADAPTED FROM:
<http://henryway.unl.edu/ianr/pintpalh/nematode/nemasite.htm>;
(ORIGINALLY FROM - TARJAN, ESSER & CHANG, 1977)

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.

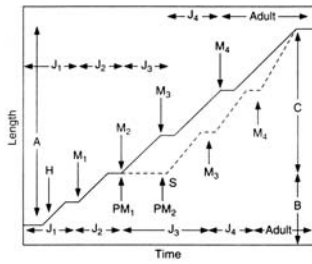
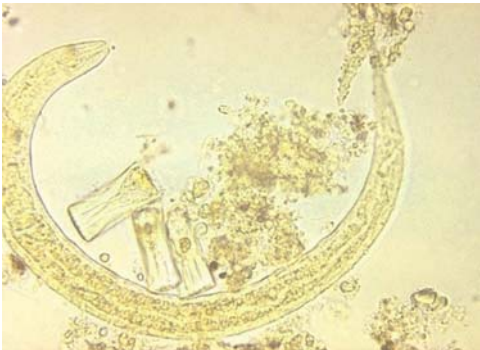


FIGURE 22.33
 Idealized form of the basic life cycle of nematodes. The life cycle of a free-living nematode is represented by a solid line. Hatching (H) is "spontaneous," and there are four molts (M_1 – M_4). The broken line represents a life cycle in which a change in environment is necessary to stimulate (S) the completion of the second molt (PM_1 , PM_2). (A–C) are different environments. (J_1 – J_4 are the juvenile stages.)
 Modified from W. P. Rogers and R. I. Somerville, "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.

Rhabditiform larva of a hookworm



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.

Caenorhabditis elegans