Cycloneuralia

The rest of the cuticle-bearers

Cycloneuralia

- These five phyla (the nematodes, nematomphorans, kinorhynchs, locifera, and priapulids) have brains that encircle the pharynx like a collar. Cycloneuralia share a loss of locomotory cilia (Aquinaldo et al. 1997).

Phylum Nematoda

- ~ 20,000 species of roundworms described
- Possibly 4-50 X more remain undescribed
- Extremely abundant! Million per square meter of aquatic sediment and nearly as abundant in soil and leaf litter. In terms of individuals, nematodes account for an estimated four of every five animals in the world.
- How does the success of nematodes differ from that of arthropods?
Nathan A. Cobb

"In short, 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."

from "Nematodes and Their Relationships", 1915

Characteristics

- Obviously from the common name they are vermiform and round. But why round?

- Non-cellular molting cuticle (but of collagen rather than chitin).

Characteristics

- Lack circular muscle. Is annelid-like motion possible? How does this affect the design of the digestive system?

- No organized respiratory or circulatory system. Sensory system simple with chemoreceptors at both ends and general body surface appears to be light sensitive.
Life History
- Life cycles relatively simple in free-living groups being one of the few invertebrates with no true larval stage.

Parasitism
- Parasitism has evolved several times within the nematodes (Blaxter et al, 1998) (Why?) and hosts vary widely.

Numerous Ways Health Is Affected
- Indirect effects due to competition for nutrients in the intestines of their host, as with many pinworms and large roundworms of the intestine, direct effects as with hookworms.
- Block lymphatic system as with elephantiasis.
- Migrate through host as with *Onchocerca* in eyes results in river blindness (though the story may be more complex).
Affects on Health
- Acts as a ‘viral animal’ as with *Trichinella*. (e.g. vascular endothelial growth factor that promotes blood vessel growth, normally to heal wounds, provides greater nutrition for the parasite).
- Affects hosts’ behavior in ways that improve chances of completing parasitic lifecycle:
  - A nematode free-living in streams, infects aquatic larvae of mayflies and this nematode changes mayfly males into females (both anatomically and behaviorally) thus ensuring the adult parasite a chance for finding a mate and host for its offspring.
  - *Dracunculus* (guinea worm) causing dracunculiasis drives its human host to water where the Guinea worm’s intermediate vector (copepod zooplankton) reside.

Effects that are often overlooked
- Affects the poorest people of poorest nations (public health, not medicine, has largely decreased parasites in USA).
- Often the infection is not outright fatal.
- Sometimes nematodes are the victim

Beneficial Nematodes
- Pest control
- Research model in developmental biology
Phylum Nematamorpha

- The horse hair worms
- Also known as Gordian worms.
- ~325 species

Characteristics

- Similar to Nematoda except:
  - no excretory system
  - lack eutely (cell number consistency thru life)
  - lack functional digestive tract (adults do not feed, living inactive lives using the nutrients acquired during juveniles as parasites on arthropods)

Larval nematomorphan shown above; note eversible introvert.

Cephalorhyncha

- These three phyla (kinorhynchs, locifera, and priapulids) have a spiny proboscis which can be everted (turned inside out) to gather food using the spines. Collectively they are known as the Cephalorhyncha, or "beak"-head.
Phylum Kinorhyncha

- “movable snout”
- ~150 species

Characteristics

- Molting chitinous cuticle.

- Eversible introvert on anterior end (as in prapulids, locifera, and nentamorphan larvac).

Characteristics

- Cuticle, musculature, and nervous system distinctly segmented (13) unlike most other cycloneuralians

- Ring of curved spines (scalids) on first segment and spines and adhesive tubes on trunk; used for crawling

- Micofaunal in interstitial spaces (i.e. small < 1mm)
Phylogeny

- The Kinorhyncha have traditionally been allied to the Rotifera due to some morphological similarities (e.g. cuticle, protonephridia and syncitial epidermis).
- Their digestive tract and musculature is more similar to Nematodes. Now, molecular sequence data indicate a close relationship with other Ecdysozoa, Cycloneulidae, and Cephalorhyncha (increasing closeness respectively). In light of these findings, morphological data have been re-examined.
- What morphological characteristics support relationship with other Ecdysozoa, Cycloneulidae, and Cephalorhyncha?

Phylum Loricifera

- 'Armor bearing'
- >100 species but most have not yet been formally described.
- Discovered in 1983 off the French coast (2nd newest phylum) accidentally.

Characteristics

- Molting chitonous cuticle forms 6 plates (Lorica) (resembling some rotifers), hence name.
- Eversible introvert on anterior end (as in kinorhynchs locifera, and nematomorphan larvae).
- Ring of curved spines (scalids) on first segment. Discrete 'head' and 'neck'.
- Micofaunal in marine and freshwater interstitial spaces (i.e. small) but exclusively subtidal making them more elusive.
Phylogeny

- Only one living Loricifera has been observed so they have not been sequenced (Aquinaldo et al. 1997).
- However, several morphological characteristics link the Loricifera other two cephalorhyncha phyla and other ecdyzoans (such as).
- Higgin larva shares morphology with juvenile priapulids, nematomorphs and kinorhynchs (but also with rotifers). The three cephalorhyncha may be united into a single phylum in the near future.

Phylum Priapulida

- “penis” worms
- Named for Priapus, a fertility god from Asia Minor
- ~ 15 living species but a much more conspicuous part of the Cambrian fauna. *What taxon has been highly successful in replacing their niche (marine sediments), and why might this be?*

Characteristics

- Molting chitonous cuticle.
- *Eversible introvert on anterior end* (as in kinorhynchs locifera, and nematomorphan larvae).
- Body cavity large and with hemerythrin bearing blood cells (acts as circulatory system as in nematodes but no cells in nematodes).
- Benthic, inhabiting marine sediments, Typically carnivorous.
- The larval form has a characteristic lorida (similar to that found in adult Loricifera).
Phylogeny

- Priapulids were originally grouped with the echiuran polychaetes and sipunculids.
- Now, molecular sequence data and many morphological characteristics indicate a close relationship with other ecdyzoan, cycloneulia, and cephalorhyncha (increasing closeness respectively). What morphological characteristics support relationship with other ecdyzoan, cycloneulia, and cephalorhyncha?
- However, at least one cladistic analysis did not include the priapulids in ecdyzoan clade (Eernisse et al 1992). It has been suggested that a priapulid ancestor with an armored cuticle may have given rise to arthropods (Conway Morris 2000).

Concerning the Cephalorhyncha Phyla

- This group shares characteristics with rotifers and acanthocephalans, and with echiura and sipunculid taxa, and with nematodes. Therefore molecular sequence data has been particularly valuable in this mystery. No clear way to support one hypothesis over the others without this kind of approach.