Phylum Annelida
(segmented worms, bristle worms)

15,000 species
large successful phylum in water & on land
include earthworms, sand worms, bristle worms, clam worms, fan worms, leeches
worldwide distribution:
  marine, brackish, freshwater and terrestrial

Body Form
elongated wormlike body
  <1mm to 3 meters
hollow tube-within-a-tube design
one of the most successful animal designs
  → room for development of complex organs with muscle layers
  → allows for circulation of body fluids
  → provides hydrostatic skeleton

Body Wall
epidermis a single layer of cells (columnar epithelium)
epidermis secretes a thin flexible protective cuticle
most annelids have setae → small chitinous bristles secreted by epidermis
  repeated on each segment (ie. "bristle worms")
  used as anchors while burrowing
  to prevent capture
  some used for swimming
  or as protection or camouflage
beneath epidermis is two layers of muscle tissue
  thin layer of circular muscle
  thick layer of longitudinal muscle (obliquely striated)
  enhances use of hydrostatic skeleton
  allows for peristaltic movement for digging through sediment
body cavity a true coelom
lined with **peritoneum** (squamous epithelium) lines inside of body wall & outside of digestive tract also layers of muscle along digestive tract peritoneum also form **mesenteries** that hold blood vessels and the **septa**e between segments

**Movement**

coelem is filled with fluid (except leeches) which serves as **hydrostatic skeleton** annelids have 3 general types of movements:

1. **burrowing:**
   - waves of **peristaltic contractions** sweep down body
   - 1st animal elongates \(\rightarrow\) contraction of circular muscle
   - 2nd animal sortens \(\rightarrow\) contraction of longitudinal muscle
   - **setae** anchor hind end of body while front end pushes forward

2. **crawling:**
   - polychaetes use parapodia alternately to move

3. **swimming:**
   - mainly polychaetes and leeches undulating body movements parapodia help in polychaetes

**Feeding & Digestion**

complete digestive tract "tube within a tube" design muscle layers allow modification of tract into various structures:

- muscular **pharynx**- to take in food, often with eversible **pharynx** with **jaws**
- **crop** – food storage
- **gizzard** – food grinding
- **intestine** – digestion and absorption of nutrients
- **anus** – elimination of undigested wastes

**Respiration**

through body wall in most species body wall is richly supplied with capillaries to absorb and transport oxygen some marine forms respire through **parapodia** a few species have gills

**Circulation**

body cavity is filled with coelomic fluid which helps move food and wastes around most annelids also have a **closed circulatory system** that more efficiently carries nutrients and wastes several pairs of “pumping hearts” keep blood flowing **dorsal** and **ventral vessels** connected by capillary network

- dorsal vessel sends blood anteriorly
- ventral vessel sends blood posteriorly

**blood:**

- most with dissolved **blood pigments** to carry oxygen:
  - hemoglobin (Fe) red - most annelids
  - hemerythrin (Fe) red
  - chlorocruorin (Fe) green
  
  (only 4 blood pigments known in animal kingdom & annelids have 3 of them)

- blood also contains amoeboid cells which engulf foreign particles (like our WBC's)

annelids therefore have a double transport system for foods, gasses, wastes

- fluid filled coelom
- circulatory system with heart & vessels
  - \(\rightarrow\) foods, wastes and respiratory gasses are carried both in blood and in coelomic fluid

**Nervous System**

have both CNS and PNS

- CNS: a pair of dorsal cerebral ganglia above the pharynx and **ventral nerve cord** with paired fused ganglia in each segment

- PNS: **nerves** branch off fused ganglia to supply body wall and body organs
Senses:

- simple single celled photoreceptors or clusters of cells **ocelli** (= eyespots)
- a few polychaete **eyes** have cornea, lens, retina
  - can form images
- **statocysts** in some for balance
- **nuchal organ** → ciliated pit in head area
  - also found in some molluscs and a few other invertebrates
  - may function in chemoreception
- **tentacles & palps** → well developed sense of touch
- other simple chemoreceptors
- free nerve endings → tactile??

Endocrine System

- neurosecretory cells in brain and ganglia
- secrete **hormones** that regulate:
  - reproduction
  - secondary sex characteristics
  - regeneration

Excretion

- one pair of **nephridia** (=metanephridia) in each segment similar to that in molluscs
  - (a few polychaetes have protonephridia or both)
- **nephric tubule**:
  - **nephrostome** = funnel like opening into previous segment
  - **coiled ciliated tubule** surrounded by capillaries
  - **bladder** like structure
  - **nephridipore** = opening to outside
- function:
  - wastes from coelom are drawn in
  - salts and organic wastes from blood are discharged into duct
  - useful stuff is selectively reabsorbed
  - in earthworms and leeches chloagogue cells collect NH4 or urea and deposit in blood or take directly to nephrostome
  - some nitrogen wastes are also excreted through body wall
  - excretory organs also help in salt and water balance

Reproduction and Development

Annelids have both asexual and sexual reproduction quite variable within the phylum

Asexual

- most can bud to some degree
- other spontaneously fragment

Sexual

- monoecious or dioecious
- most annelids are hermaphrodites
- larva, if present = **trochophore**

Classification of Annelida

Class: **Polychaeta** (Bristle Worms)
- mostly marine

Class: **Clitellata** (Earthworms & Leeches)
- subclass: **Oligochaeta** (Earthworms)
  - mainly terrestrial and freshwater
  - head absent
  - fewer setae, no parapodia
- subclass: **Branchiobdellida**
  - commensal on crayfish
  - no setae
  - posterior sucker only
- subclass: **Hirudinea** (Leeches)
  - terrestrial, freshwater or marine
  - no parapodia or setae
  - fixed # of segments with “false segments” (=annuli)
  - anterior and posterior suckers

Class: **Echiura** (Spoon Worms)
- shallow marine burrowing forms
once considered a separate phylum

Class: Polychaeta
(Sand Worms)
means “many setae”; also called bristle worms
10,000 species; 2/3rds of all Annelid species
sand worms, bristle worms, fan worms, clam worms, etc
largest, most diverse and most primitive class of Annelids
all are aquatic; mostly marine; worldwide distribution
a few found in freshwater
most 2-4” long (5-10 cm); some up to 10’ (3 M)
often brightly colored
deposit feeders, filter feeders, predators, scavengers,
live in crevasses, old shells, burrows or construct tubes
some have elaborate filtering structures
eg feather duster worms
a few are pelagic → part of the plankton

important in marine food chains

Body Plan
distinct head with mouth and sense organs & wormlike body or trunk with repeating segments body segments with flaplike parapodia

Head
have distinct head

head has retractable pharynx with chitinous jaws used to capture prey

lots of different kinds of sense organs
1. chemoreceptors (nuchal glands) on palps and tentacles
2. touch receptors also on tentacles for locating food and shelter
3. eyes (simple eyes = ocelli; and more complex eyes)
some can focus an image = esp predators
very similar to cephalopod and vertebrate eyes

Body or Trunk
on each segment are a pair of flaplike parapodia, each with many bristles (=setae)

both parapodia and setae are moved by internal muscle bands

these parapodia have a variety of functions and create many bizarre shapes:
→ crawling or digging in the sediment; use parapodia as as legs
→ swimming, use parapodia as paddles
→ as gills for respiration
→ used as anchors while burrowing or to prevent capture
→ to create feeding currents inside tubes
→ converted into feathery appendages to filter water
→ as protection or camouflage
→ in some, parapodia modified into fans and mucous bags for feeding or to create water currents

most polychaetes are active swimmers, crawlers or burrowers in the sediment

Feeding & Digestion
1. predators

the most active polychaetes are predators
eg. clam worm or sand worm (Nereis)
up to 10“ long
Animals: Phylum Annelida; Ziser Lecture Notes, 2015.10

live in mucus tubes in or near low tide; but can also swim
males - iridescent bluish-greenish color
females - light green with yellow, orange-red mottling
most active at night
move out onto sand to search for food
use their jaws to capture small animals
jaws open as pharynx is everted
jaws close as pharynx is retracted

eg. Blood Worms (Glycera)
red worms, all marine, several species
found in shallow waters
poor swimmers but good burrowers
carnivores
on their proboscis are 4 hollow jaws that can inject poison
into prey
eat other worms and organisms in the sediment
painful to humans
harvested extensively in NE US for bait

eg. Scale Worms
very abundant
flattened and covered with scales formed by the modified parapodia

eg. Chaetopterus (parchment worm)
secretes parchment like tube
creates a continuous current through its tube to feed
tubeworm must maintain a flow of water to get oxygen
and get rid of wastes
uses modified parapodia as paddles
can emit strong bioluminescent flashes
burrows often shared by commensal crab

3. detritus feeders
other polychaetes eat organic detritus in or on the sediment

Respiration
usually through parapodia
some have paired gills on some segments
eg. Tangleworms (Cirratulus grandis)
on east and west coasts of US
yellow to green; 5-6” long
front with great mass of long red hairlike filaments used as gills
some have no special organ and exchange across body surface

most are small; some up to 19 cm
carnivores
many are commensals with other marine inverts

2. filter feeders
many polychaetes burrow or live in tubes rather than crawling around on the sediment
many sedentary polychaetes are filter feeders
eg. Fanworms, tubeworms, featherduster worms
secrete many kinds of tubes:
firm calcareous tubes
bits of shell cemented together
some burrow
most have long feathery tentacles that they extend to filter feed
resemble colorful tentacles that they extend to filter feed
cilia on tentacles move collected particles toward mouth
tentacles can be quickly retracted when threatened
often develop specialized food gathering structures for filter feeding
leads to tagmosis → fusion and reduction of metamerism

Excretion
protonephridia and in some metanephridia or both
1 pair per segment
opens into coelomic compartments
tubule absorbs any useful materials and concentrates wastes as fluid passes to nephriopore

Senses:
eyes: simple eyespots to complex organs
esp in free moving (errant) polychaetes
in one group can form image: cornea, lens, retina

nuchal organs: ciliated sensory pits

chemoreceptors used in food gathering

statocysts in burrowers and tube building forms

Reproduction & Development
simple reproductive system
have no permanent gonads
→ gonads appear as temporary swelling of peritoneum at certain seasons.

Gametes are shed either
→ through genital ducts
→ or through nephridiopore
→ or through rupture in body wall

Some polychaetes live most of the year as sexually immature individuals = atokes.

After living 1 or 2 years as benthic organisms they become sexually mature and swollen with gametes = epitokes.

Head shrinks, body enlarges, gonads develop and produce egg or sperm.

Sometimes only part of the body makes the transformation, breaks off and the rest of the worm lives to repeat next season.

Eg. palolo worm:
- Males and females gather by the millions in one spot.
- At night determined by phases of the moon.
- Female releases pheromone.
- Pheromone excites male to circle about female.
- Swarms of epitokes appear at start of moon's last quarter in October or November.

Sea is literally thick with epitokes just before sun rises, epitokes burst to release gametes.

Anterior portion of worm returns to burrows = synchronous mating.

→ Ensure most eggs are fertilized.
→ Predator saturation.

Predators have a field day; but too many prey so some are always left to reproduce.

Atokes safely in their burrows to repeat next year.

A Samoan holiday to feast on epitokes.

Ecological Roles of Polychaetes

Eg. detritus food chains.

Eg. prominent in marine food webs.

Eg. Beard Worms (pogonophorans)

Once thought to be a separate phylum, now known to be an unusual kind of polychaete.

Discovered in 1900; today 150 known species.

All are marine; most live in bottom ooze of deep ocean.

In many the forepart bears long tentacles giving it a bearded appearance.

Thin, transparent, segmented trunk has several pairs of setae and is enclosed in a chitinous tube.

The trunk ends in a small segmented opisthosoma.

The best known of the group of beardworms are the giant tubeworms found around deep sea hydrothermal vents.

Some up to 6' long.

With a bright red plume that extends from the tube.

Giant tubeworms are part of an entire ecosystem not based on photosynthesis.

They are the only non-parasitic animals without a digestive tract.

No mouth, digestive tract or anus.

They get most of their nutrients from symbiotic bacteria living in a large sac (=trophosome) within the trunk of the worm.

The worms are bright red due to hemoglobin in their blood.

The worm absorbs the hydrogen sulfide and oxygen in the waters near the vents.

These bind to the hemoglobin in the worms blood and are delivered to the symbiotic bacteria in the trunk of the worm.

The bacteria harvest energy from H2S and convert inorganic elements into sugars for the worm.

CO2 + H2S + O2 + H2O → H2SO4 + sugars.

Giant tubeworms reproduce by releasing sperm and eggs into the water.

The larvae will drift through the deep water until they locate a hydrothermal vent.

They will then settle to a rocky perch.

The young tubeworms do have a mouth and gut and feed.

As the worm matures the mouth and gut degenerate and the area once holding the digestive systems becomes a bacteria-filled sac.

Tube worms seem to have few predators.

Although sometimes crab and shrimp will feed on the worm’s red plume.

Eg. Bone eating worms (Oseadax).
major decomposers of deep sea whale carcasses

2001 found red fuzz on whale carcasses in deep ocean
1000’s of polychaetes with red plumes up to 6 cm long
new genus and species of polychaete
seem to be unique to “whale fall”
worms have no functional mouth or gut
have symbiotic bacteria that digested oil in bones
→ they degrade hydrocarbons
the bacteria live in rootlike structures of worm that extend in and throughout the bone
worm provides oxygen via blood vessels extending into the roots

Economic Impacts of Polychaetes
eg. human food (samoan)
eg. insecticides
  eg. Padan – a powerful insecticide produced from a polychaete worm
eg. anticancer drugs
  eg. dolastatins from sea hare (Dolabella auricularia) has potential anticancer properties

Class Clitellata
new genetic analysis indicates that what used to be 3 separate “classes” of segmented worms should more correctly be subclasses of a “new” class: Clitellata
the clitellum is part of the reproductive system of these worms
it is near the head
the clitellum is a thick, glandular, non-segmented region in these worms that secretes mucous to hold cross-fertilizing worms together while mating
and it produces a sac in which eggs are placed

Subclass Oligochaeta (Earthworms)
means “few setae”
over 3000 species
relatives of sand worms but:
no distinct head
no parapodia
and very few setae
most with 4 prs of short setae/segment
often present in high densities:
rich soil 1 ton of common earthworms/acre
very small aquatic worms (tubificids) up to 40,000/M² in rich muds
earthworms are extremely important in the texture and fertility of the soil
Aristotle referred to them as “the intestines of the earth”
Darwin wondered whether there was any other animal that has played so important part in the history of the world as earthworms
"Earthworms are miniature topsoil factories, they make soil. ALL other (terrestrial) living things eventually pass through an earthworm on the way to becoming soil. And it is likely that nearly every atom in your body (with very few exceptions) has been in an earthworm's stomach before it was part of you."

most oligochaetes are less than a few inches long
some tropical earthworms get up to 3 M long
eg. giant Gippsland earthworm
   native to Australia;
   average 3’ long and 1” diameter, can reach 9’ long
   dark purple head and blue-grey body
   live in deep burrow systems in clay soils along stream banks
   take 5 years to reach sexual maturity
   breed in warmer months; lay cocoons in their burrows
   12” worm hatches in a year
   a protected species – being killed from tilling the land as area converts land from grazing to farming

eg. giant Palouse earthworm
   in Idaho
   thought extinct but recently rediscovered
   up to 3 ft long, lives in burrows 15’ deep
   spits at predators

one unusual group lives on glaciers
eg. ice worms
   small worms <1” long
   only found on surface of glaciers at temperatures below freezing
   they die at temperatures of 40º F (5ºC) or more
   can appear by the 100’s
   eat algae and pollen

and a few oligochaetes are marine or brackish

Body Wall
protective layer of collagenous cuticle secreted by epidermis

surface of the body is kept moist by
   pores allowing coelomic fluid to leak out and lubricate outer surface of animal
   also has numerous mucous glands

Feeding & Digestion
most oligochaetes are scavengers or detritus feeders

mostly terrestrial → burrow in the soil
most conspicuous ‘worms’ on land
(roundworms are much more abundant but microscopic)
many species are common in freshwaters

eg. Aquatic “earthworms”
   smaller, benthic, longer setae, more active
   better developed sense organs
   some have gills
   generally eat algae and detritus
   some with great powers of asexual budding

eg. tubifex
   red worms to 10 cm long
   live on bottoms of lakes, ponds and polluted streams
   live in very low oxygen concentrations
   have large amounts of hemoglobin
   keep their heads in tubes while waving bright red tails
   in heavily polluted areas banks appear bright red at low water
   absorb dissolved nutrients (DOM) across skin

feed on decaying organic matter in the soil
eat as they burrow then let digestive system extract nutrients

mouth beneath prostomium
inside the mouth is a powerful pharynx
   in some aquatic species the pharynx can be everted as in sand worms to suck food in the digestive tract may include:

esophagus
   has calciferous glands that maintain calcium balance by secreting excess calcium from blood into the digestive tract
   (lots of calcium in soil; lots gets absorbed, excess is secreted)

crop – for food storage

Gizzard – for grinding up food into smaller pieces
   thick and muscular
**intestine** for chemical digestion and absorption of nutrients

in some the first part of intestine is used for **digestion**

secretes digestive enzymes

most of intestine is used for **absorption**

on dorsal surface is infolding = **typhlosole**

increases surface area for absorption

on outside surface of intestine are yellowish **chloragogue cells**

→ equivalent to our liver: synthesizes glycogen and fats

→ they also travel through coelom to repair wounds

→ function in excretion: convert amino acids to urea & ammonia

**Respiration**

no respiratory organs or parapodia like polychaetes

breath through skin, no lungs or gills

extensive system of **capillaries** in epidermis

**Excretion**

paired **nephridia** in each body segment

in aquatic forms nephridia release ammonia

in terrestrial forms nephridia release urea (conserves water)

in fw and terrestrial oligochaetes nephridia not only eliminate wastes but also eliminate excess water (osmoregulation)

also, terrestrial worms have **calciferous glands**

worms eat soil; soil has lots of calcium

high levels of calcium in blood

calciferous glands remove excess calcium from blood and deposit it in the intestine for removal

**Sense Organs**

rather than concentrated in head they are distributed all over body

numerous sensory cells (chemo- and mechano-receptors) on skin

chemoreceptors esp on prostomium

many free nerve endings → probably tactile

**Earthworm Reproduction**

earthworms are **hermaphrodites**

cross fertilize each other

copulation involves a **double exchange** of sperm cells

mucous secreted from **clitellum** holds pair together with genital pores aligned

can last 2-3 hours

sperm is deposited in seminal receptacle

after copulation worms return to burrows

fertilization and egg laying occur a few days later

each worm secretes a sheath of mucous around **clitellum**

clitellum then secretes nourishment for egg

then envelopes mucous and food in tough chitin-like cocoon

the worm then backs out of the cocoon

as cocoon slips over the genital openings it receives an egg, then sperm

fertilization occurs in the cocoon

cocoon is deposited in soil

in 2-3 weeks a new worm emerges
Ecological Effects of Earthworms

1. Detritus food chain

**eg. Night Crawler**
- burrow within the upper 30 cm of moist soil rich in organic matter
- in soft soil earthworms move by peristaltic contractions
- setae prevent back sliding
- this type of movement only works because segments are separated by septa

mainly active at night
- on warm damp nights, forage for leaves and organic debris
- up to 54,000 earthworms /acre
  - turn over 18 tons of soil per year
- prefer moist soil but if too much water they will move to surface
  - sometimes in great numbers
  - used to think they “rained” down from the sky

important in keeping soil fertile since they are constantly turning over earth and mixing organic matter into it
- if all material ever moved through earthworm gut was piled on surface of earth it would rise 30 miles above sea level (5x’s height of Mt Everest)

2. Food for birds and other animals

Human & Economic Impacts of Earthworms

1. Food for Humans
   - in some parts of Asia, Africa and Latin America people regularly eat worms
   - usually because there is not much other food available
   - a few restaurants in the US offer them as novel food fare

2. earthworms improve the productivity of farm soil
   - sometimes doubling or tripling crop yields

3. Fishing bait
   - worms are commonly used for freshwater fishing
   - nightcrawlers, redworms

4. Vermicomposting
   - using worms to recycle compost

Subclass Hirudinea
(Leeches)

500 sp
- mainly freshwater
- a few marine and terrestrial
- most 2-6 cm long; some to 20 cm
- often brightly colored
- many are carnivores; some are parasites

body is dorsoventrally flattened
- anterior and posterior suckers
- fixed number of true segments
  - usual 32 plus prostomium & pygidium
- each segment with 2-14 annuli (=false segments)

**Body Wall**
- coelom functions as a single large chamber
  - no septae between segments
- coelom is filled with connective tissue and muscle
- except for a system of spaces (=coelomic sinuses and channels) filled with coelomic fluid
  - acts as secondary circulatory system

**Movement**
- no parapodia (except 1 genus)
- no setae

- leeches have poor hydrostatic skeleton
- aquatic species use muscle layers to make undulating swimming movements
- can also use suckers to move like inchworms
- some terrestrial forms are able to “stand up” on hind sucker to search for prey

**Feeding & Digestion**
- most are predators of snails, worms and insect larvae
  - protrusable pharynx with 3 jaws armed with teeth
- some are scavengers
some are blood sucking parasites

**adaptations to parasitism** by leeches:
- attach to host with suckers
- pierce skin with sharp teeth on end of proboscis
- while cutting, secrete local anesthetic and histamine-like chemical that dilates blood vessels of host
- consume large blood meals
  - blood is sucked by muscular pharynx
- while being swallowed, blood mixes with hirudin (anticoagulant) to prevent clotting

very slow digestion
- gut secretes very few digestive enzymes
  - depend on **bacterial digestion**
- can live for almost a year on one meal
  - may take up to 200 days to digest one meal
  - can live for another 100 days afterwards

**Respiration**
- most exchange gasses through skin
- a few aquatic forms have **gills**

**Circulation**
- many species have no blood vessels
  - coelomic fluid does the work of blood in open haemocoel
  - may be hemoglobin in haemocoel fluid

**Nervous System**
- nervous system similar to other annelids
  - but leeches have two “brains”
  - one composed of paired cerebral ganglia around pharynx as in other annelids
  - the other in posterior of animal consists of 7 pairs of fused ganglia
- simple sense organs are much better developed in terrestrial species which tend to be blood suckers

**Reproduction**
- hermaphroditic
  - mating process similar to earthworms
  - cross fertilize during copulation

**Human Impacts of Leeches**

1. **medicinal uses**
   - in past centuries medicinal leech, *Hirudo*, was used to suck out “bad blood”
   - believed many bodily disorders were the result of bad blood or too much blood
   - were collected almost to extinction in Europe
   - now a protected species
   - introduced into US but rare in nature
   - today leeches used in medicine to speed healing of reattached fingers and limbs

2. commonly used in **biology labs**

3. leeches have become leading **research models** for understanding how the nervous system works

4. some chemicals used by the leech in obtaining and digesting blood are being studied for treating circulatory diseases

5. leeches have also affected history:
   - **eg. land leeches of India**
     - live in extremely large numbers in humid forests of India
Animals: Phylum Annelida; Ziser Lecture Notes, 2015.10

live in trees and shrubs and fall like “drops of dew” onto any humans passing underneath

their mass attack caused the retreat of a British regiment during the Sikh rebellion in India in mid 1857 (rebellion against East India Company)

class: Echiura
(Spoon Worms)

140 species

sausage shaped worms

1 cm to 50 cm

all marine

most live in shallow waters; a few deep water forms

many burrow in sand or mud

other live in rock and coral crevaces

a few live inside dead sand dollars, mollusc shells, or annelid tubes

they enter shells when young and get too large to leave

generally are deposit feeders

Body Form

cylindrical and somewhat sausage shaped

resemble sipunculans in size and general habits

body in two parts:

anterior flattened proboscis (=prostomium)

can be extended and retracted

posterior cylindrical trunk

Proboscis

has ciliated groove giving it a spoon-like appearance

proboscis is very mobile

swipes on mud to find organic debris

can extend up to 10 times its retracted length

eg. Bonellia is 7 cm (~3.5") long and can extend its proboscis 1.5 meters (4.5")

no tentacles

Trunk

trunk is gray, reddish brown, or rose

body has several sets of setae

hooked, anterior setae used for digging burrows

setae at posterior end for anchorage

→ circles of setae around posterior end for anchorage and burrow maintenance

Feeding and Digestion

most are deposit feeders

collect small particles of detritus

digestive system is extremely long and coiled

mouth is at base of prostomium

anus is at posterior end of trunk

Circulation

simple closed circulatory system

Excretion

excretion by nephridia

Nervous System

simple nervous system

circumenteric nerve ring

ventral nerve cord

Animals: Phylum Annelida; Ziser Lecture Notes, 2015.10
Reproduction & Development

dioecious
show sexual dimorphism;
males often much smaller
gametes shed into water
external fertilization
produces **trochophore** larva
metamorphosis to wormlike adult

some males are parasitic

- in some species (eg green spoon worm; *Bonellia viridis*) the first larvae to settle and metamorphose become females
- larvae that land on top of female become males
- the tiny male creeps up her body, into her mouth and migrates down to her uterus
- up to 20 males become parasitic in the females uterus giving her an instant supply of sperm without having to search and mate.

Human Impacts

in arctic spoon worms were once eaten by eskimos