Phylum Rotifera
(Rotifers, Wheel Animals)

2200 living species
very few fossils have been found – since few hard parts

a group of microscopic animals discovered when microscopes were first being developed

1st described in 1696 by Rev John Harris as “an animal like a large maggot which could contract itself into a spherical figure and then stretch itself out again; the end of its tail appeared with a forceps like that of an earwig.”

von Leewenhoek himself describe a few species in the early 1700’s

"wheel bearers" = characteristic ciliated crown = corona; resembles rotating wheels

of all invertebrates, the rotifers are most characteristic of freshwater habitats

most species are common in freshwaters

some (<5%) are found in other habitats:

- marine or brackish waters
- a few are terrestrial, in moist soils & damp mosses & lichens

most aquatic forms are benthic or interstitial fauna

some are planktonic

some are epizoic or parasitic

a few are sessile, living inside tubes or gelatinous secretions

a few rotifers are colonial

most rotifers are 0.1-0.5 mm; but some up to 3 mm long

some even smaller than some protozoa

most are transparent, a few are brightly colored

great diversity in shape within the phylum

→ somewhat correlated with their mode of life:

floaters → globular and sac-like
creepers & swimmers → elongated and wormlike
sessile → vaselike

some species are cosmopolitan with a worldwide distribution

others with very restricted ranges

Body Form

body consists of: head, trunk, and foot

head
ciliated corona (or crown)
gives impression of spinning wheel
often with sensory bristles or papillae
used both for feeding
draws a vortex of water into mouth for feeding
mouth is inside corona
corona can also be used for locomotion

trunk
the trunk forms the major part of the body
encloses most of the internal organs
often elongated or sac-like
often has sensory antennae
often with false segmentation visible

in some: cuticle is very thick, caselike, fibrous layer

= lorica

foot
narrow, often tapered, with 1 to 4 toes
often arranged in plates or rings
often teloscopically retractile (external segmentation)

foot is an attachment organ

toes contain cement glands (=pedal glands)
pedal glands secrete adhesive material
used by both sessile and creeping forms

foot reduced in pelagic forms

many species secrete a wide variety of protective tubes in which they live:

gelatinous
constructed of small pieces of debris

sometimes colored yellow, green or brown
**eutely** as in nematodes

**Body Wall**

syncytial epidermis (= hypodermis)

secretes thin flexible **cuticle**

- in some species some or all of the cuticle is thickened into a rigid casing (= **lorica**)
- bands of muscles below epidermis
  - some circular; some longitudinal

body cavity a fluid filled **pseudocoelom**

amoeboid cells circulate in fluid

**Movement**

- some swim using coronal cilia which pull the animal through the water when unattached
- some with creeping or leechlike movement
- some sessile and remain attached to the substrate

**Feeding & Digestion**

most rotifers are omnivores

- eating anything small enough to fit in their mouths
- many are carnivores: feed on protozoa and small animals
- some are cannibalistic
- others feed on dead organic matter
- most feed by sweeping particles into mouth with corona
  - can filter 100,000 x’s its own volume/hr
  - rotifers are sometimes used in fish tanks to clear up water clouded by organic particles
- some are predatory and seek out their prey; probably by touch or chemical stimuli

- complete digestive tract
  - inside mouth food is directed to a uniquely modified **pharynx** called a **mastax** that is constantly working back and forth
  - lots of variation in size & shape
  - operated by bands of muscles
  - contains hard chitinous jaws (=**trophi**) that suck in and grind up food

the pharynx leads to the esophagus which opens into the stomach

- both digestion and absorption occurs in the stomach
- short intestine leads from stomach to anus in foot

some species of rotifers have symbiotic zoochlorellae within the cells of the stomach wall

**Respiration**

rotifers have no specific organs for respiration

- their small size allows them to exchange respiratory gasses by diffusion across their body wall

rotifers have a relatively high metabolic rate compared to other aquatic invertebrates

- generally have high O$_2$ requirements
- others are capable of withstanding anaerobic or near anaerobic conditions for extended periods
  - eg some live in anoxic mud or in sewage treatment plant filters

**Excretion**

pair of protonephridial tubes with **flame cells**

- tubes empty into **bladder**, then to **cloaca**

**Nervous System**

bilobed brain dorsal to mastax

- sends pairs of nerves to sense organs and viscera
- senses:
  - **eye spots** (up to 5)
  - **sensory bristles** especiall around the corona (touch)
  - **sensory pits** lined with cilia in head region
  - **papillae**
    - usaul 2 pairs of short dorsal **antennae**

**Life Cycle**

rotifers are notable in that they have a much faster metabolism than many other cold blooded invertebrates

- they can grow and reproduce very quickly
they can grow from an egg to a reproducing adult in 18 hrs.
rotifers can have up to 40 generations/yr
in some species, females undergo

**cyclomorphosis**
=a cyclical change in form of offspring throughout the year

rotifer species are also noted for variations in size and appearance in different habitats
many rotifers are quite tolerant to drying or desiccation (=**anhydrobiosis**)
under harsh conditions some can cease metabolism and dehydrate
some rotifer eggs can also withstand drying
can survive for years (up to 9) and then be rehydrated and active within a few hours
some can form true **cysts** that are even more resistant to extreme cold and heat

**Reproduction**

asexual reproduction does not play a major role in this phylum as it does in most other animal phyla

rotifers even have poor ability to regenerate parts

**sexual reproduction** predominates

rotifers are **dioecious**
however, females predominate in most populations
in some species males are unknown
males, when present, are minute, degenerate and/or short-lived
commonly only ~1/3rd as long as females
in some species males are only found for a few weeks each year
in others males are degenerate (no digestive tract)
males are ready for mating within an hour after hatching

rotifers have internal fertilization
the male uses sensory receptors on its corona to find a female

the male attaches its penis to the coronal region of the female and transfers sperm into her body cavity
the male dies soon afterwards

in some species the males are unknown
→ females can reproduce by parthenogenesis

recent research has shown that the DNA of these rotifers is loaded with genes from bacteria, fungi and plants
this apparently provides adequate mutations to shuffle genes as an alternative to sexual reproduction

in some species, females can produce different kinds of eggs:
**amictic eggs:**
diploid eggs produced by parthenogenesis
produced during most of the year

**mictic eggs:**
haploid eggs
capable of being fertilized by male sperm
produced only at certain times of the year

if a female with mictic eggs is not impregnated she immediately lays the eggs and they hatch as males

**resting (winter) eggs:**
heavy and thick shelled
overwinter on sediment
extremely resistant to drying and extreme temperatures

in some rotifers, the eggs are retained in the female until they hatch (ovoviviparous)
→ rotifers bear live young

**Ecology**
rotifers are an important part of aquatic foodchains particularly planktonic food chains
→ reproduce quickly into large populations
important as food for larger zooplankton and fish in aquatic ecosystems
rotifers affect the species composition of algae in ecosystems through their choice in grazing
they also compete for the same food sources of microcrustaceans common in the same habitats
also many species contribute to the decomposition of organic matter in the soil

**Evolutionary Relationships**

while rotifers are typically considered with the pseudocoelomate phyla, new molecular evidence indicates that they are more closely related to coelomates than pseudocoelomates