Chapter 12: Aquatic Mandibulates

Phylum Arthropoda

Subphylum: Crustacea (Latin *crusta* = shell) ~67,000 spp.

crustaceans together with insects comprise > 80% of all spp

Class: Malacostraca
- **Order: Decapoda**
- **Order: Euphausiacea**
- **Order: Amphipoda**
- **Order: Isopoda**

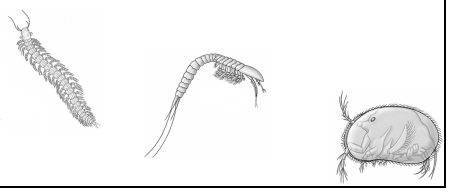
Class: Maxillopoda
- **Subclass: Copepoda** →most abundant: *Calanus*
- **Subclass: Cirripedia**

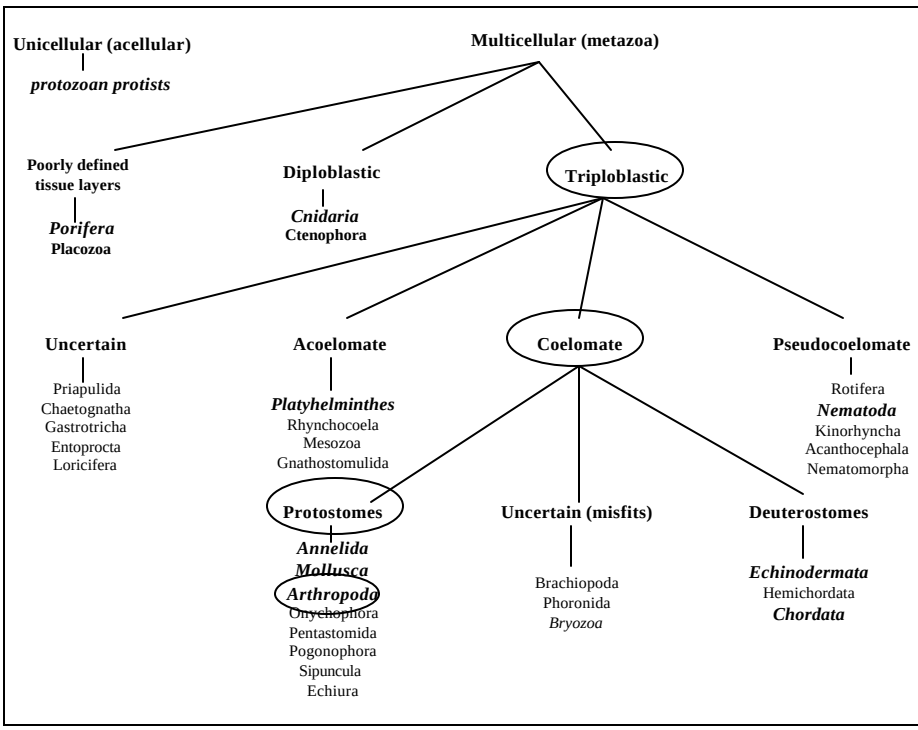
Class: Branchiopoda

Class Remipedia

Class: Cephalocarida

Class Ostracoda





General Characteristics

1) 3 tagmatas
   a) head & thorax = ***cephalothorax*** & trunk
   b) thorax
   c) abdomen
2) head:
   a) ***2 pairs of antennae***
   b) ***1 pair of mandibles***
   c) ***2 pairs of maxillae***
3) thorax & abdomen:
   a) one pair of appendages on each of the additional segments
   b) some segments may lack appendages
   c) gills typically associated with appendages
4) all appendages ***biramous*** (two main branches) except first antennae
5) ***compound*** or ***dorsal median naupliar eye***
6) mostly marine with few freshwater species

Class: Malacostraca

~20,000 species & most diverse

a) head
   5 fused somites
b) thorax
   8 fused somites
c) abdomen
   6 somites
d) anterior end non-segmented rostrum
e) tail
   1) last abdominal somite = posterior **telson**
   2) lateral uropods
f) carapace; dorsal covering most of the body or just cephalothorax

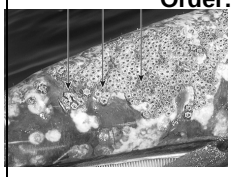
Class: Malacostraca

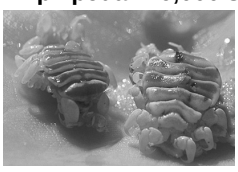
Order: Decapoda 10,000 spp

Order: Euphausiacea (krill) 85 spp

Order: Stomatopoda 350 spp

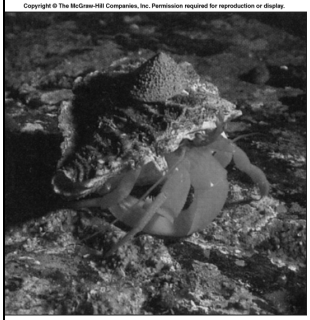
Order: Amphipoda 6,000 spp.





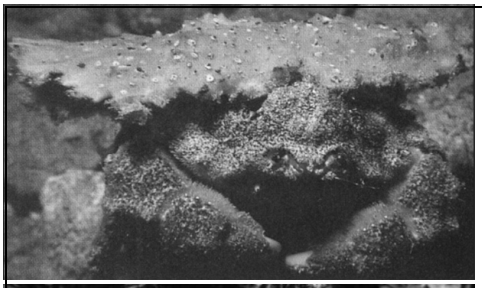
Order: Isopoda 10,000 spp.

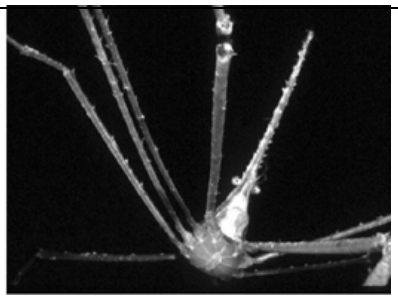
Order: Decapoda

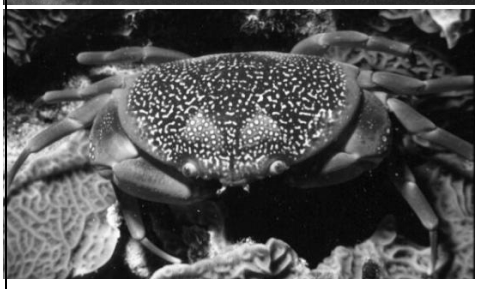


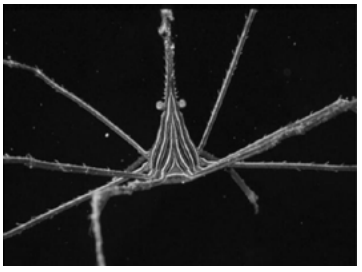
B

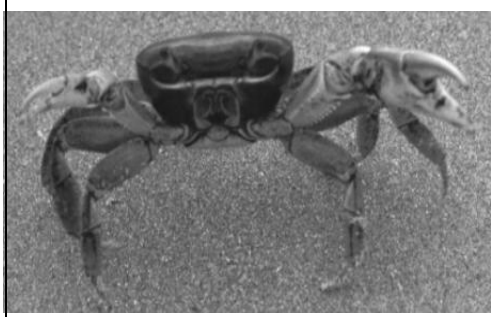
C

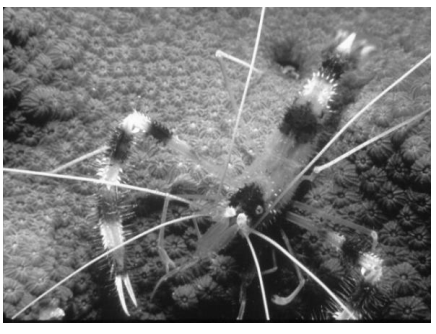


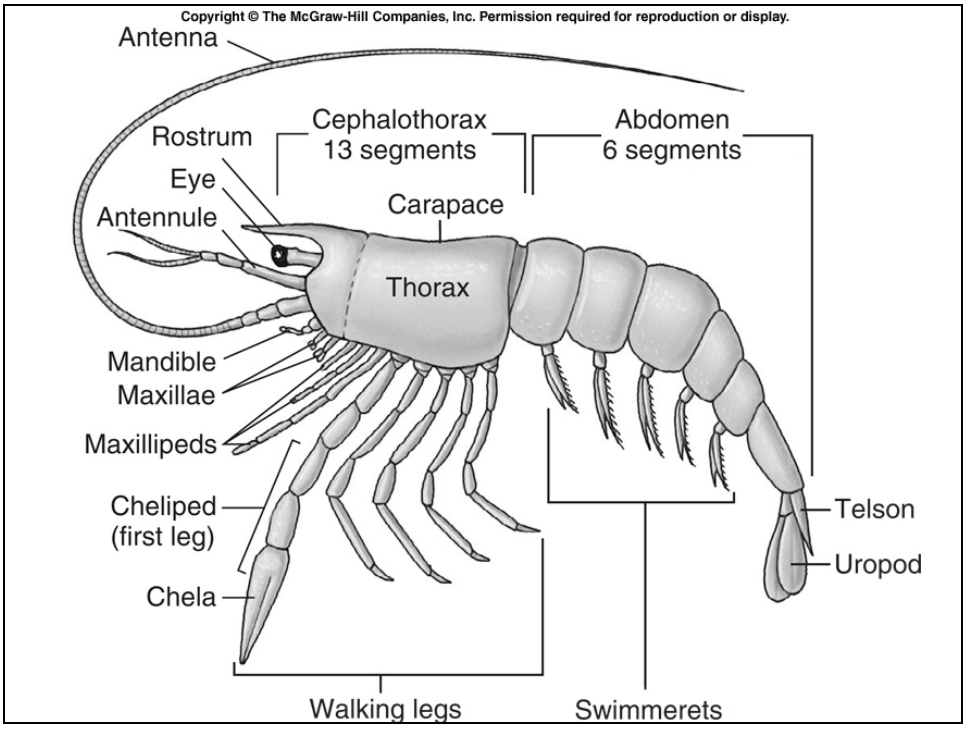


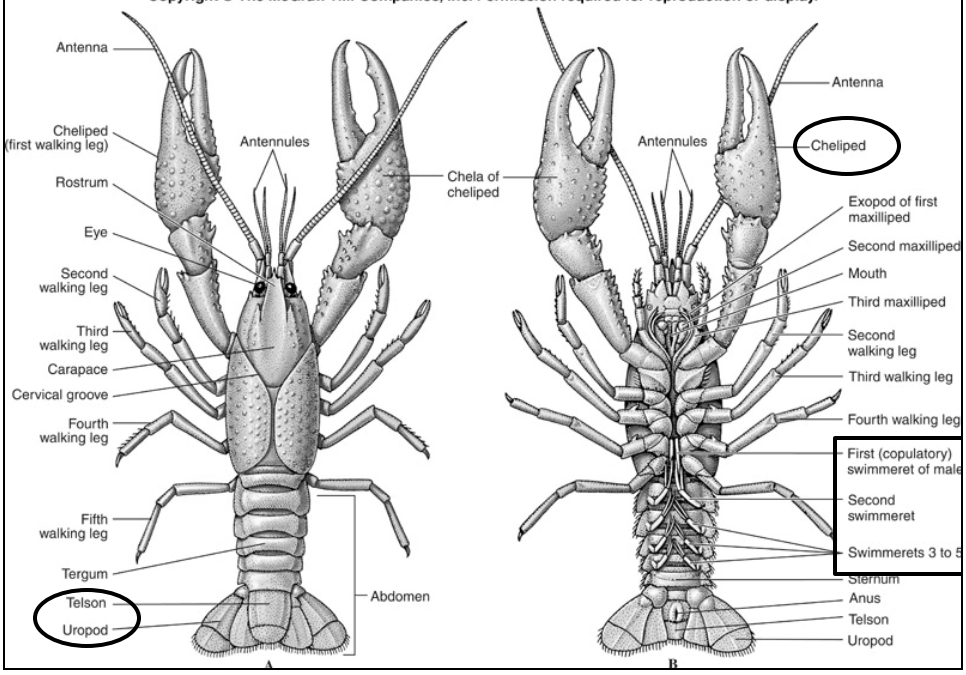












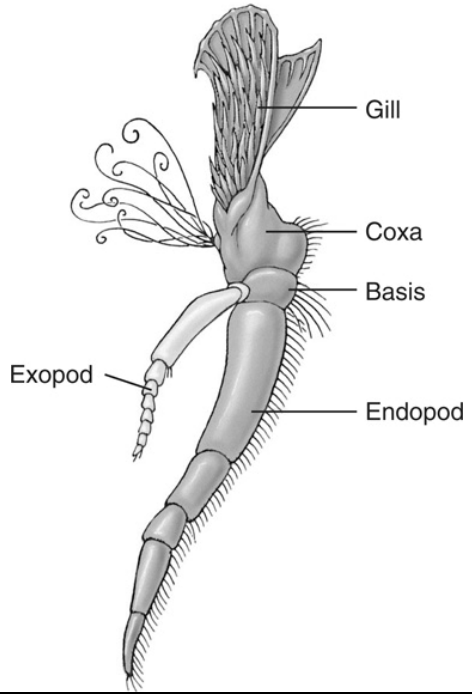
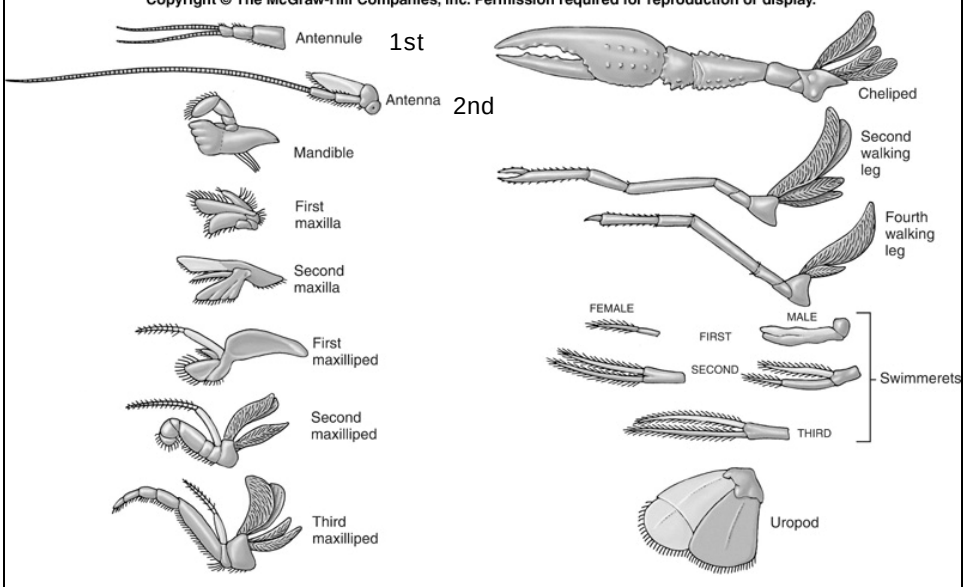
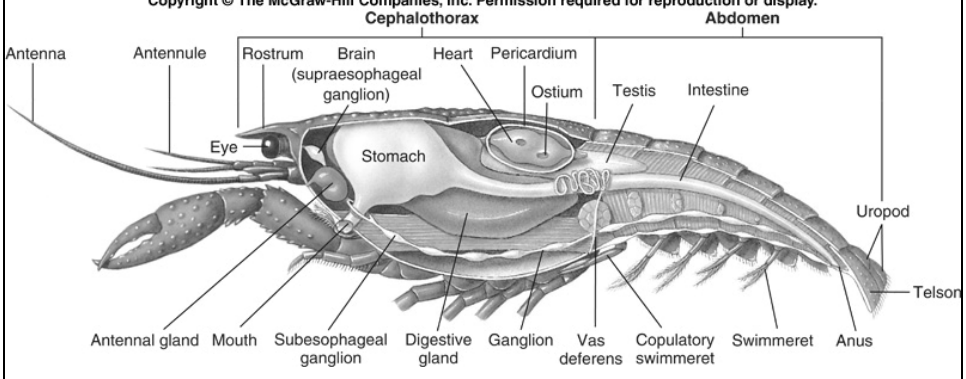


TABLE 19.1

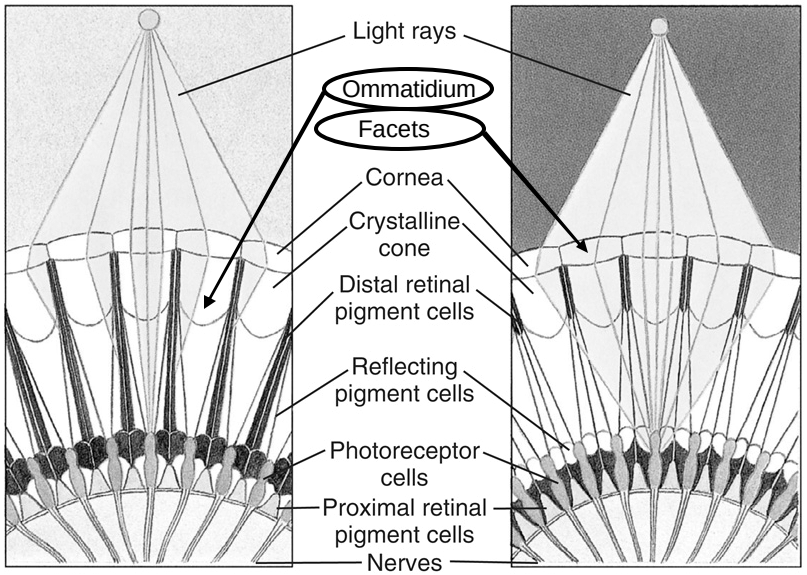
Crayfish Appendages

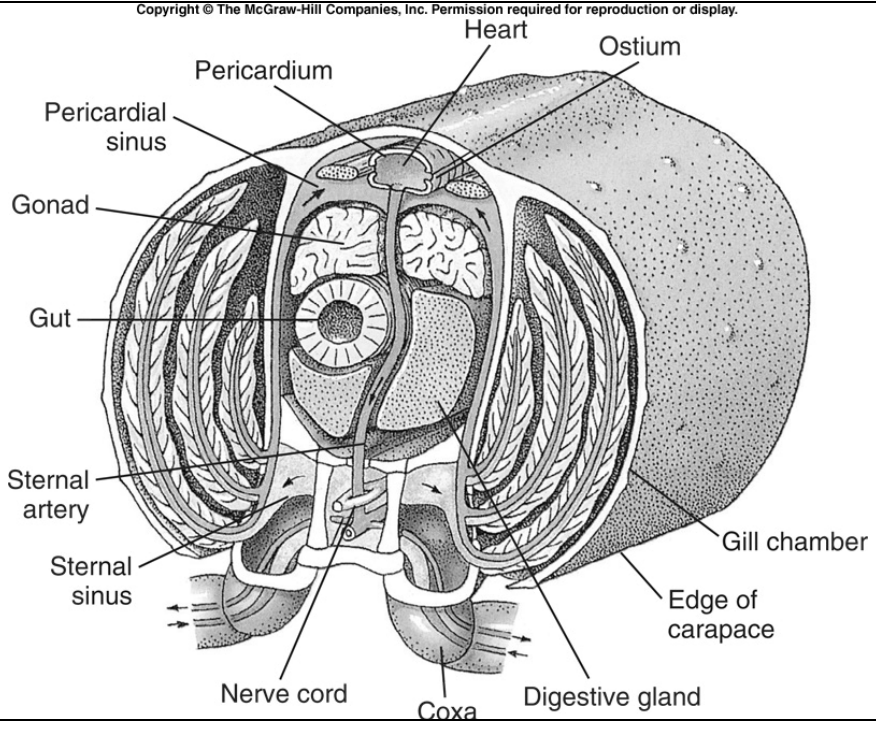
Appendage	Protopod	Endopod	Exopod	Function
First antenna (antennule)	3 segments, statocyst in base	Many-jointed feeler	Many-jointed feeler	Touch, taste, equilibrium
Second antenna (antenna)	2 segments, excretory pore in base	Long, many-jointed feeler	Thin, pointed blade	Touch, taste
Mandible	2 segments, heavy jaw and base of palp	2 distal segments of palp	Absent	Crushing food
First maxilla (maxillule)	2 segments with 2 thin endites	Small unjointed lamella	Absent	Food handling
Second maxilla (maxilla)	2 segments, with 2 endites and 1 scaphognathite (epipod)	1 small pointed segment	Part of scaphognathite (bailer)	Drawing currents of water into gills
First maxilliped	2 medial plates and epipod	2 small segments	1 basal segment, plus many-jointed filament	Touch, taste, food handling
Second maxilliped	2 segments plus gill (epipod)	5 short segments	2 slender segments	Touch, taste, food handling
Third maxilliped	2 segments plus gill (epipod)	5 larger segments	2 slender segments	Touch, taste, food handling
First walking leg (cheliped)	2 segments plus gill (epipod)	5 segments with heavy pincer (chela)	Absent	Offense and defense
Second walking leg	2 segments plus gill (epipod)	5 segments plus small pincer	Absent	Walking and prehension
Third walking leg	2 segments plus gill (epipod); genital pore in female	5 segments plus small pincer	Absent	Walking and prehension
Fourth walking leg	2 segments plus gill (epipod)	5 segments, no pincer	Absent	Walking
Fifth walking leg	2 segments; genital pore in male; no gill	5 segments, no pincer	Absent	Walking
First swimmeret	In female reduced or absent; in male fused with endopod to form tube			In male, transferring sperm to female
Second swimmeret				
Male	Structure modified for transfer of sperm to female	Structure modified for transfer of sperm to female		
Female	2 segments	Jointed filament	Jointed filament	Creating water currents; carrying eggs and young
Third, fourth, and fifth swimmerets	2 short segments	Jointed filament	Jointed filament	Creating water currents; in female carrying eggs and young
Uropod	1 short, broad segment	Flat, oval plate	Flat, oval plate; divided into 2 parts with hinge	Swimming; egg protection in female



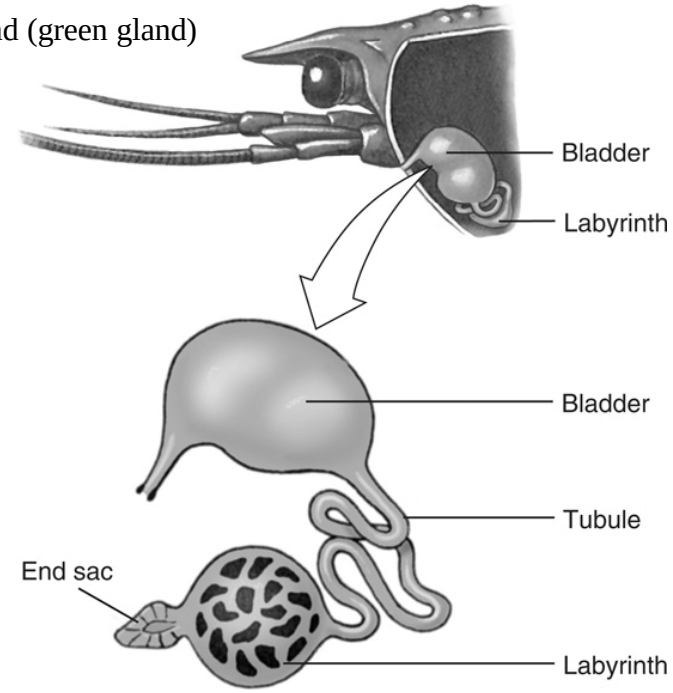


Compound Eye

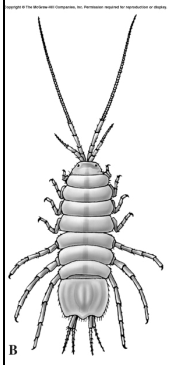


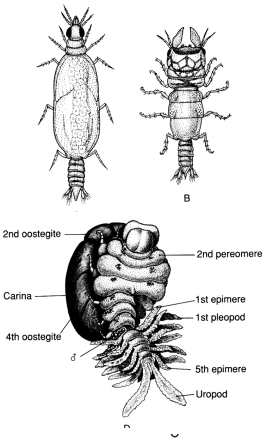


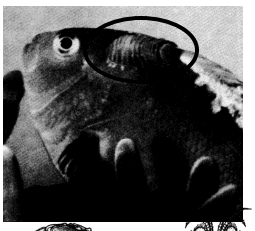
Antennal Gland (green gland)

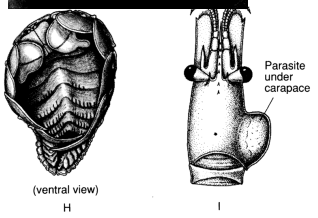


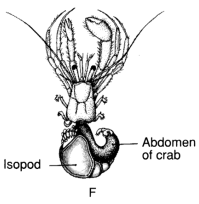
Parasitic Isopods

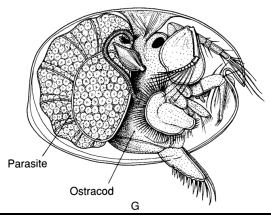










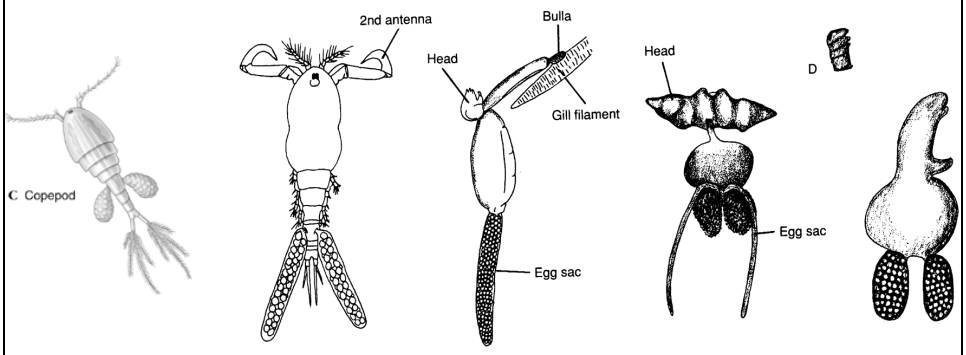


Class Maxillopoda

Subclass: Copepoda

1) anterior, appendage-bearing portion of the body
   a) antennules often longer than other appendages
   b) lack a carapace & retain simple, median, nauplius eye in the adult
   c) 1 pair of uniramous maxillipeds
   d) 4 pairs flattened, biramous, thoracic swimming appendages
2) major joint separates anterior from posterior portion
3) ecology
   a) free-living dominant consumer
      marine plankton: *Calanus:* most abundant biomass in zooplankton
      freshwater plankton: *Cyclops* & *Diaptomus*
   b) free-living intermediate hosts
      human parasitic tapeworms & nematodes
   c) parasitic forms highly modified & reduced, often unrecognizable
4) development
   a) indirect development
   b) unusual metamorphoses in some highly modified parasites

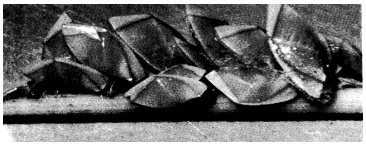
Parasitic Copepods

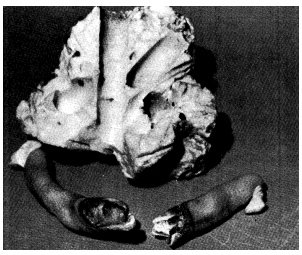


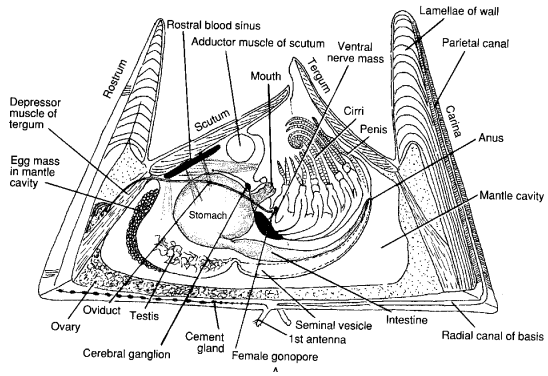
Subclass: Cirripedia

1) Order Thoracica:→***barnacles*** 3 Orders: → burrowing or parasitic
2) sessile
3) attach directly (acorn barnacles) or by a stalk (goose barnacles)
4) carapace surrounds the body and secretes a set of ***calcareous plates***
5) general structure
   a) reduced head
   b) ***no abdomen***
   c) ***thoracic legs are long with hair-like setae***
      many-jointed ***cirri*** with setae extend from plates to feed on small particles
6) ecology
   a) filter feeders
   b) problems of desiccation during low tides: plates close
7) reproduction & development
   a) hermaphroditic
   b) metamorphosis during development
      1) ***nauplii***
      2) ***cyprid*** larvae with a bivalve carapace & compound eyes
         attach to the substrate by their first antennae and adhesive glands
         secrete calcareous plates, lose eyes & change swimming appendages to filtering cirri
   c) ***parasitic*** forms: ***kentrogon stage*** injects cells into host hemocoel

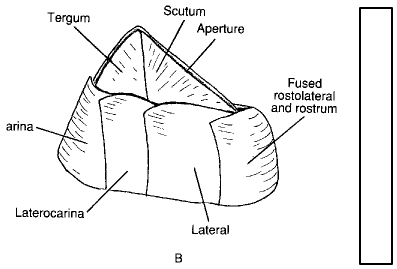




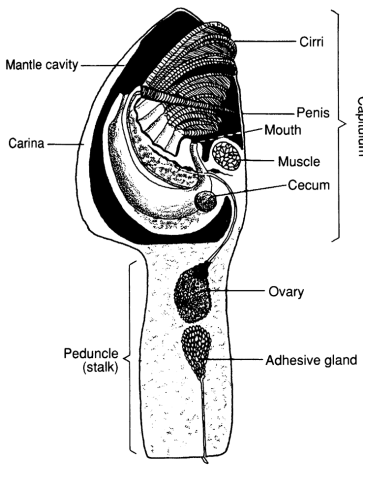




Rostral blood sinus
Adductor muscle of scutum
Ventral nerve mass
Lamellae of wall
Parietal canal
Rostrum
Mouth
Tergum
Depressor muscle of tergum
Scutum
Cirri
Penis
Carina
Anus
Egg mass in mantle cavity
Stomach
Mantle cavity
Oviduct
Testis
Ovary
Cement gland
Cerebral ganglion
Female gonopore
Seminal vesicle
1st antenna
Intestine
Radial canal of basis

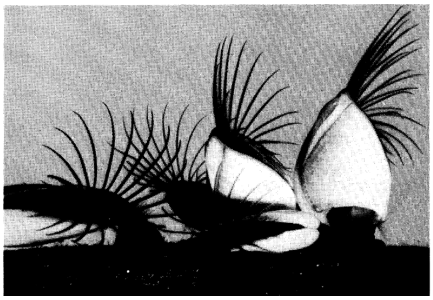
A

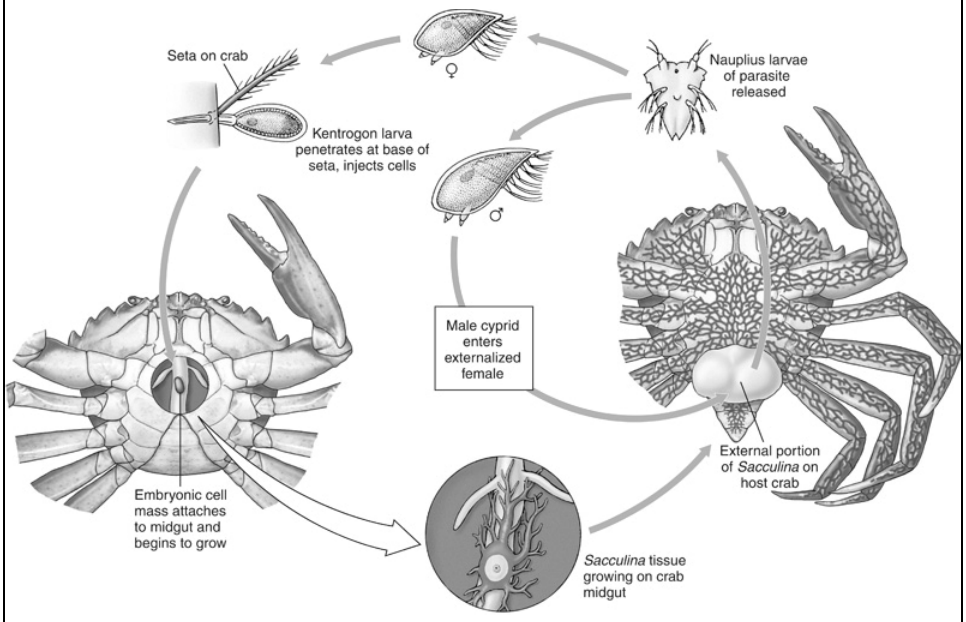

Tergum
Scutum
Aperture
Fused rostolateral and rostrum
arina
Laterocarina
Lateral

B


Cirri
Mantle cavity
Penis
Mouth
Carina
Muscle
Cecum
Capitulum
Ovary
Peduncle (stalk)
Adhesive gland

A





Class Branchiopoda

flattened & leaf-like legs: chief respiratory organs

4 orders >10,000 species most freshwater

I. Order Anostraca: lack a carapace legs suspension feeding
fairy shrimp & brine shrimp gradual metamorphosis

II. Order Notostraca: carapace forms large dorsal shield legs suspension feeding
tadpole shrimp gradual metamorphosis

III. Order Conchostraca: bivalved carapace legs suspension feeding
clam shrimp gradual metamorphosis

IV. Order Cladocera: carapace encloses only body but not head
water fleas
mostly direct development

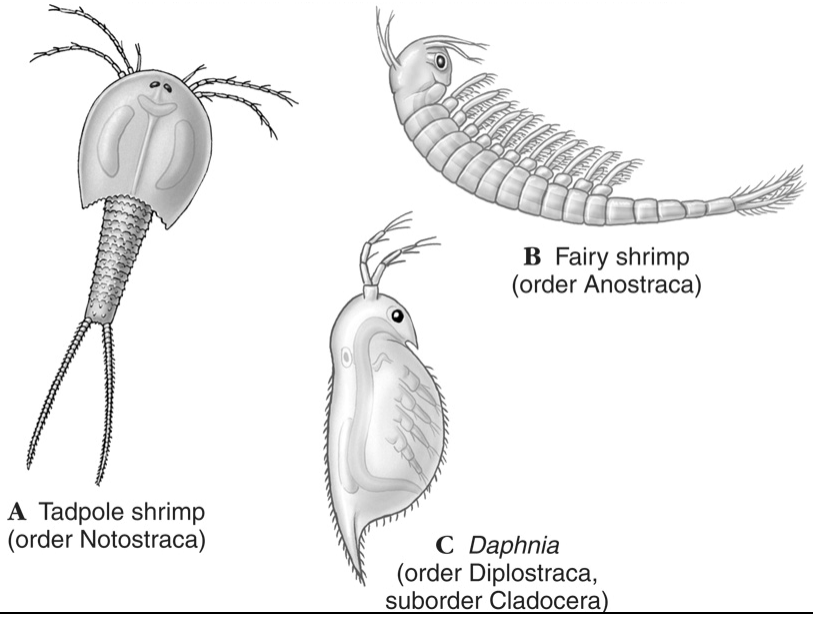
important part of freshwater zooplankton
legs function locomotion

parthenogenesis: reproduction without males

rapidly boost summer populations;
sexual reproduction with onset of unfavorable conditions

fertilized eggs highly resistant to cold → critical for winter survival

Branchiopods



A Tadpole shrimp
(order Notostraca)

B Fairy shrimp
(order Anostraca)

C *Daphnia*
(order Diplostraca,
suborder Cladocera)

Diversity of Reproduction

1) monoecious

barnacles but generally cross-fertilize

2) parthenogenesis (reproduction without males)

ostracods : males scarce

3) dioecious

brood eggs:

in brood chambers

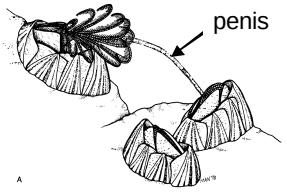
in brood sacs attached to abdomen

attached to abdominal appendages

4) direct development without larval form

crayfishes

Well-hung barnacle!



Crustacean Development

I. larva unlike the adult in form

A. nauplius

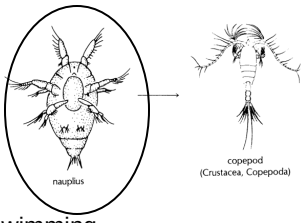
1) appendages/somites added → series of molts

a) uniramous first antennae

b) biramous second antennae → feeble swimming

c) mandibles

B. adult

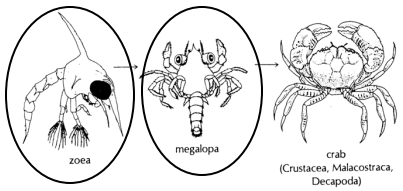


II. larva + juvenile stage → adult

A. nauplius → zoea

B. juvenile stage → megalopa

C. adult

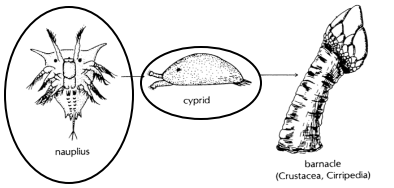


III. larva → 2nd distinct larva → adult

A. free-swimming nauplius

B. cyprid larva with bivalve carapace

C. sessile adult with plates



Artemia Larval Development


300µm
Pre-nauplius in E-1 stage

15 - 20 hours in seawater cyst shell breaks

1) prenauplius in E-1 stage
embryo hangs beneath cyst shell → umbrella stage

newly hatched prenauplius mouth & anus not fully developed: yolk sac for nutrients


Pre-nauplius in E-2 stage

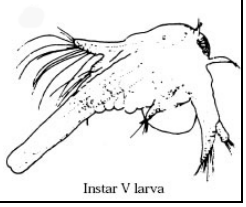
2) **pre-nauplius E-2 stage**

3) free-swimming nauplius → **Instar 1** nauplius
specially modified antennae for locomotion & later for food filtering


Freshly hatched Instar 1 nauplius

4) ~12 hours posthatch molts into second larval stage **(Instar II)**
filter feeding on microalgae, bacteria & detritus

5) nauplius can live on yolk & stored reserves for up to 5 days
or through the **Instar V stage**


Instar V larva

6) nauplius progresses through 15 molts → adult ~ 8 days.