

Chapter 19: 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*

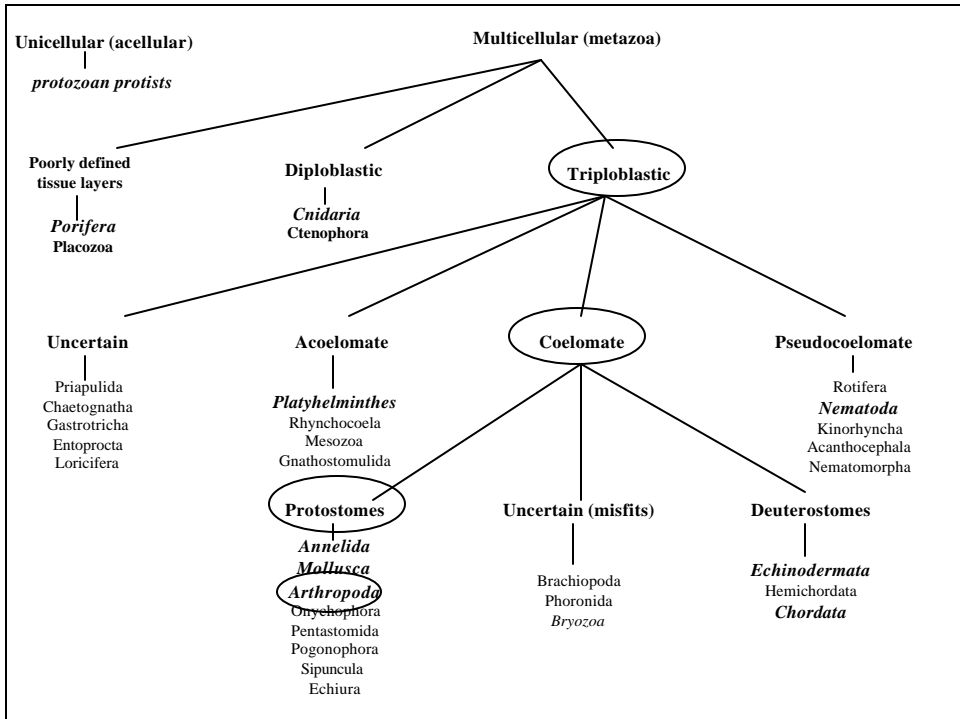
Subclass: Cirripedia

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

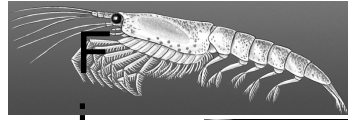
~20,000 species & most diverse

- 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

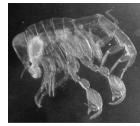
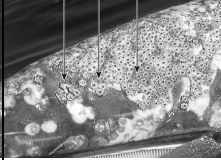
Order: Euphausiacea (krill) 85 spp



Order: Stomatopoda 350 spp



Order: Amphipoda 6,000 spp.



Order: Isopoda 10,000 spp.



Order: Decapoda



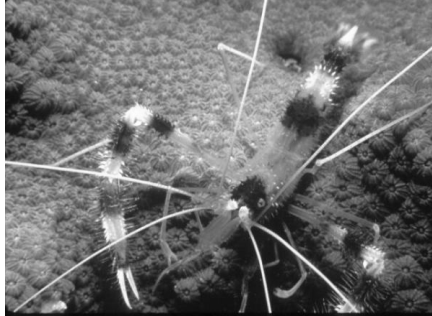
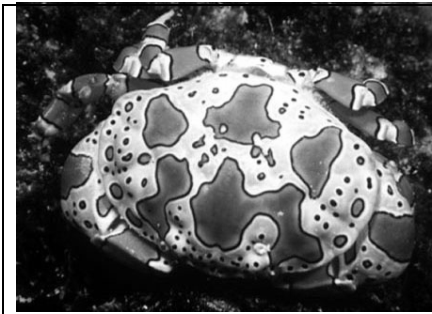
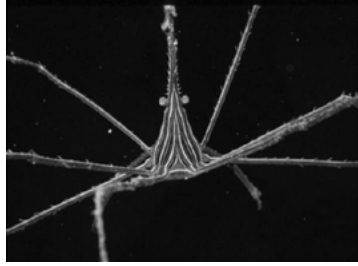
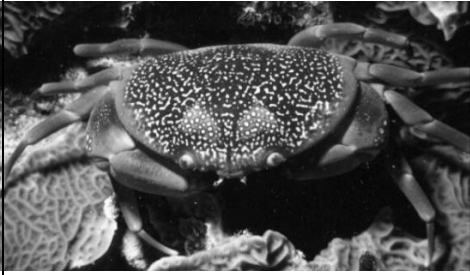
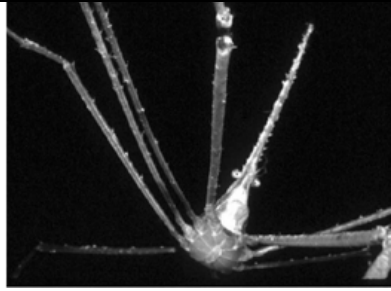
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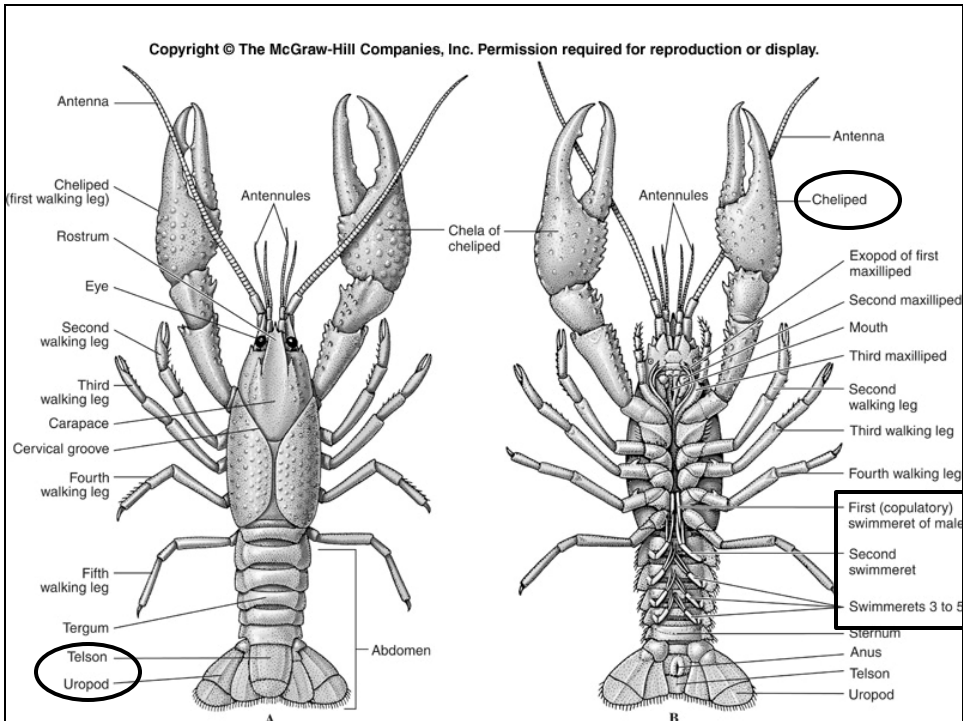
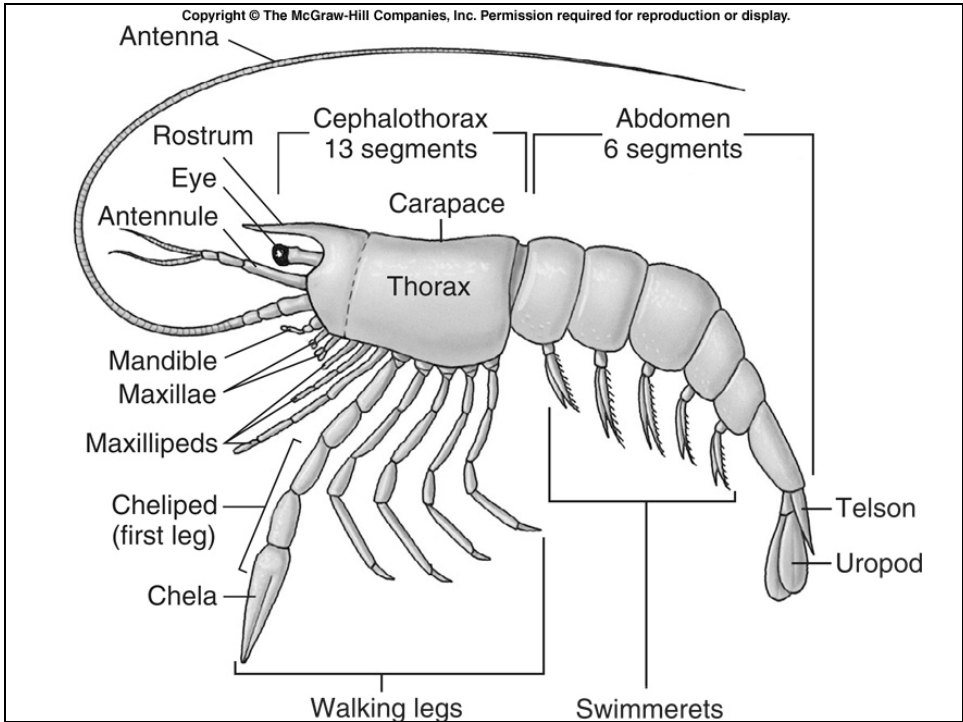
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B

C





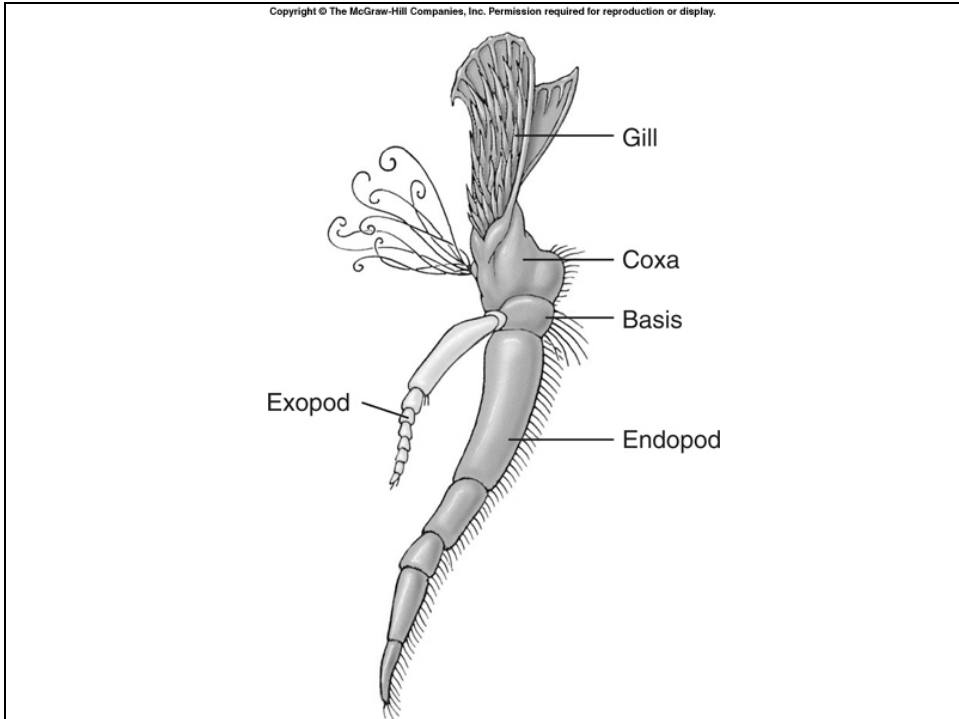
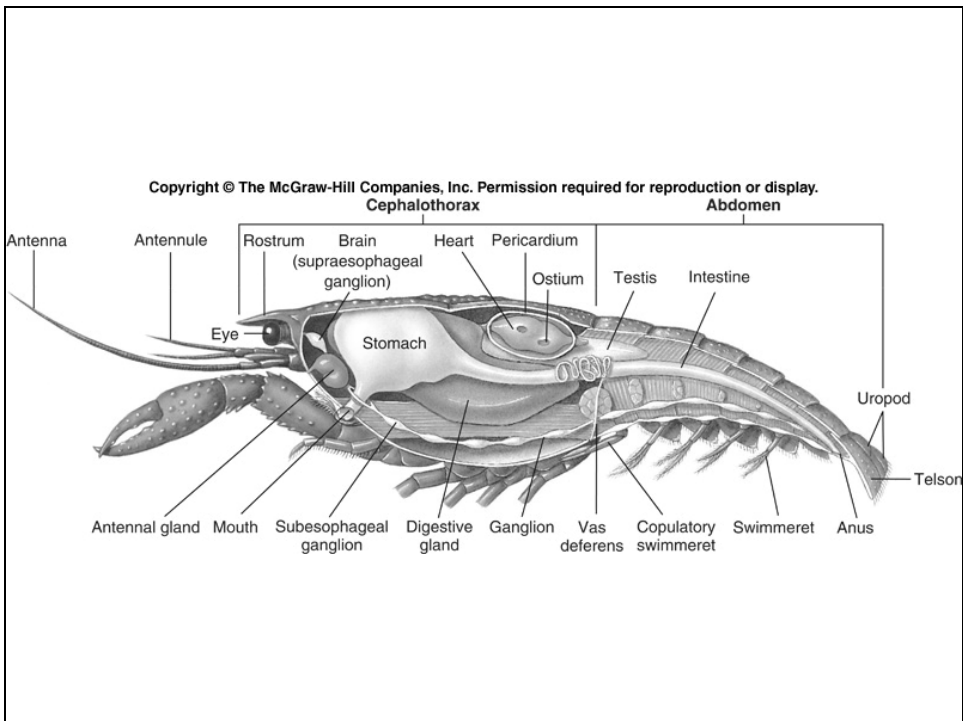
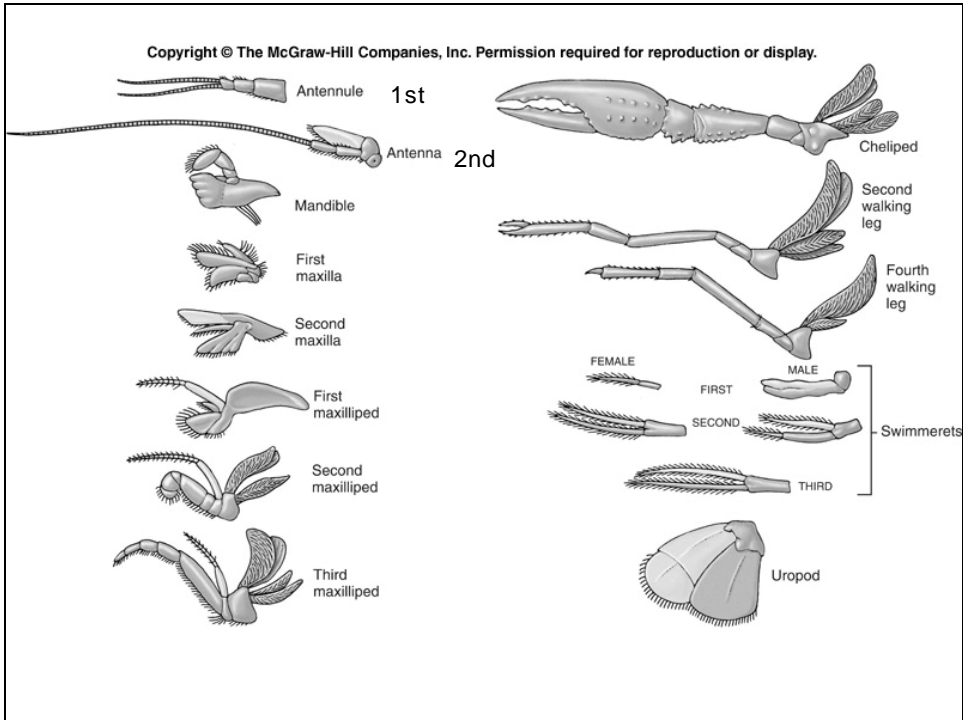
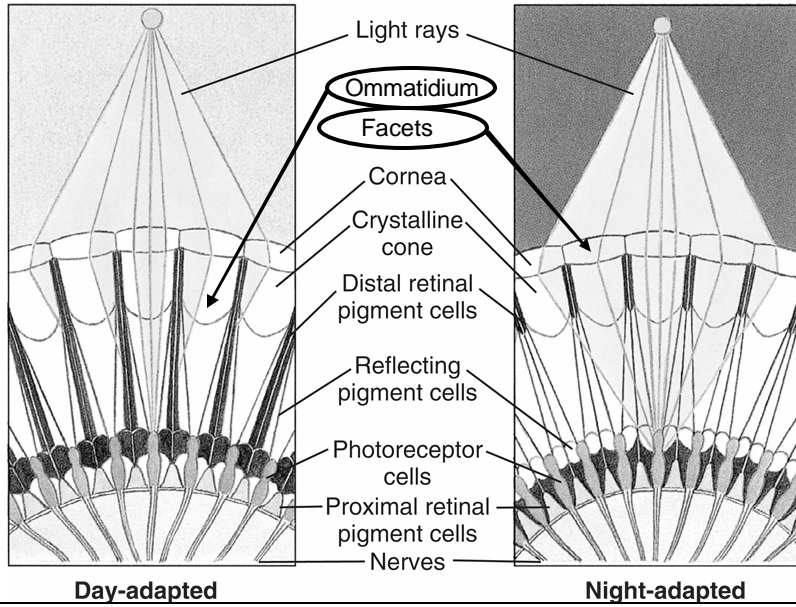


TABLE 19.1

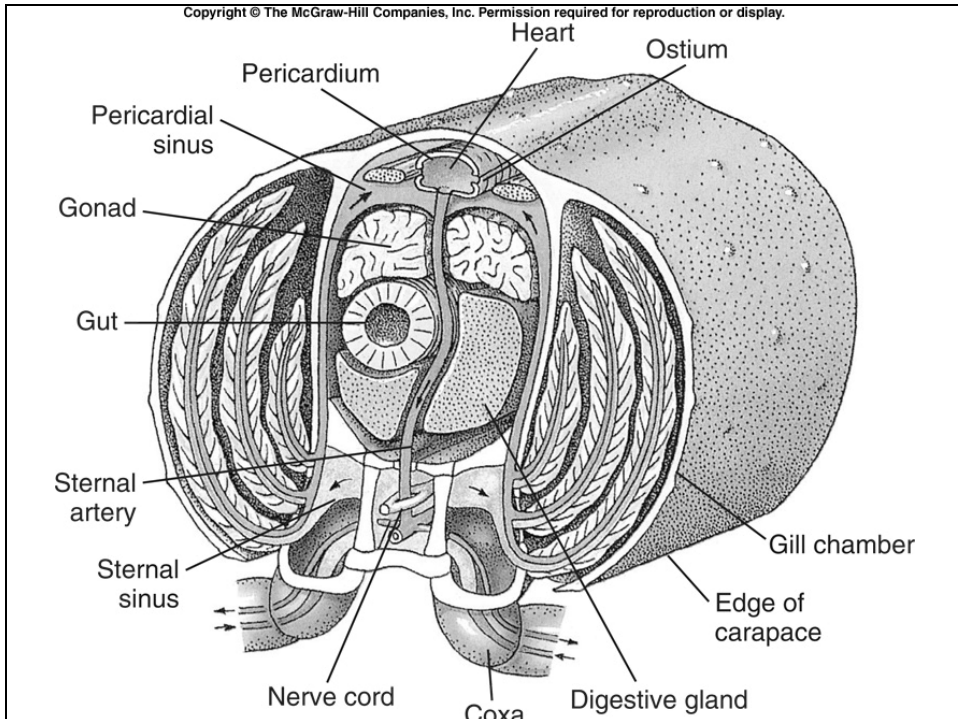
Crayfish Appendages				
Appendage	Protopod	Endopod	Exopod	Function
First antenna (antennule)	3 segments, statocyst in base	Many-jointed feeler	Many-jointed feeler	Touch, taste, equilibrium
Second antenna (antenna)	2 segments, excretory pore in base	Long, many-jointed feeler	Thin, pointed blade	Touch, 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



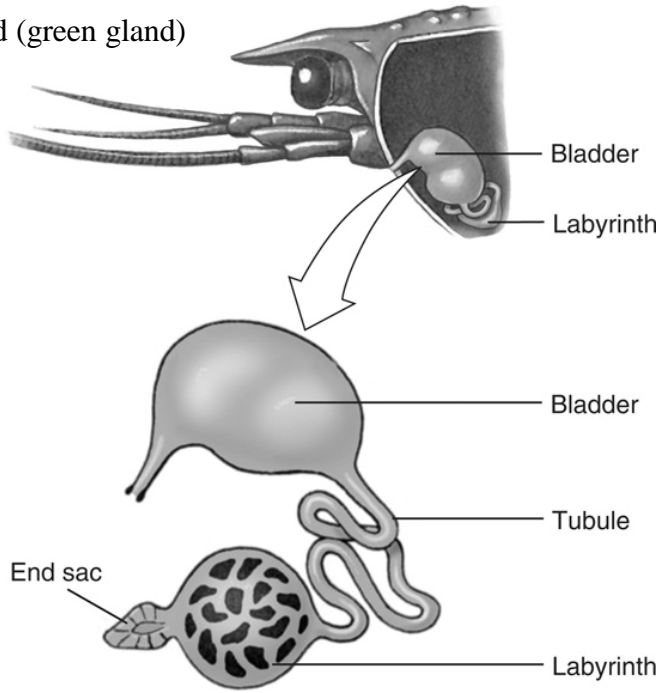
Compound Eye



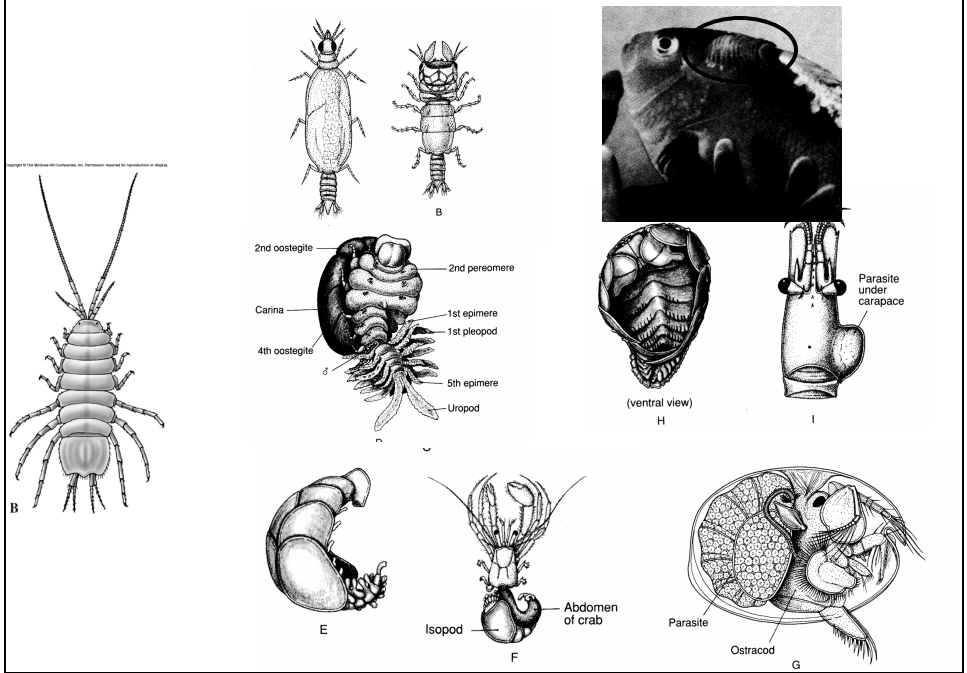
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Antennal Gland (green gland)



Parasitic Isopods

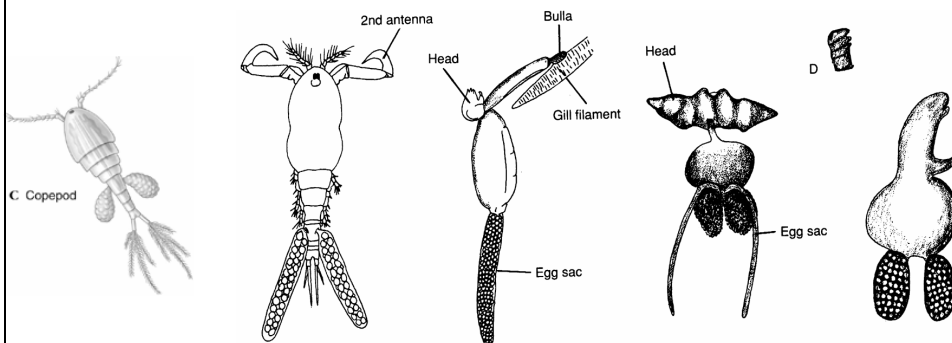


Class Maxillopoda

Subclass: Copepoda

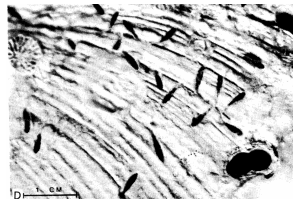
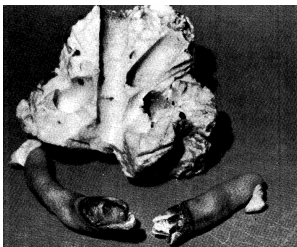
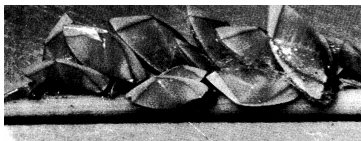
- 1) anterior, appendage-bearing portion of the body
 - a) antennules often longer than other appendages
 - b) lack a carapace & retain simple, median, nauplius eye in the adult
 - c) 1 pair of uniramous maxillipeds
 - d) 4 pairs flattened, biramous, thoracic swimming appendages
- 2) major joint separates 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

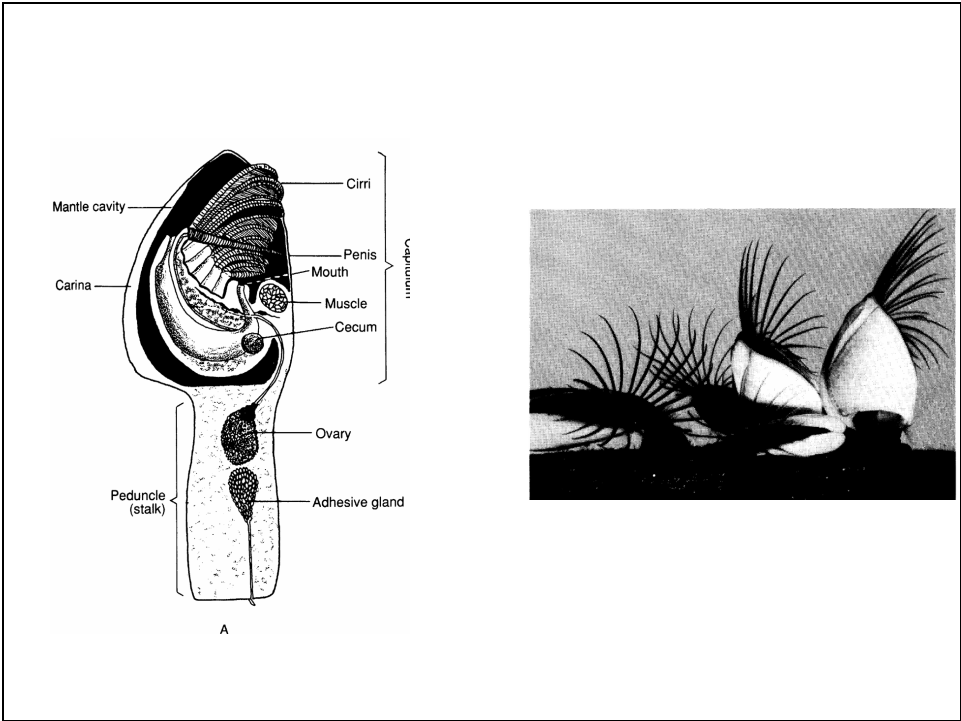
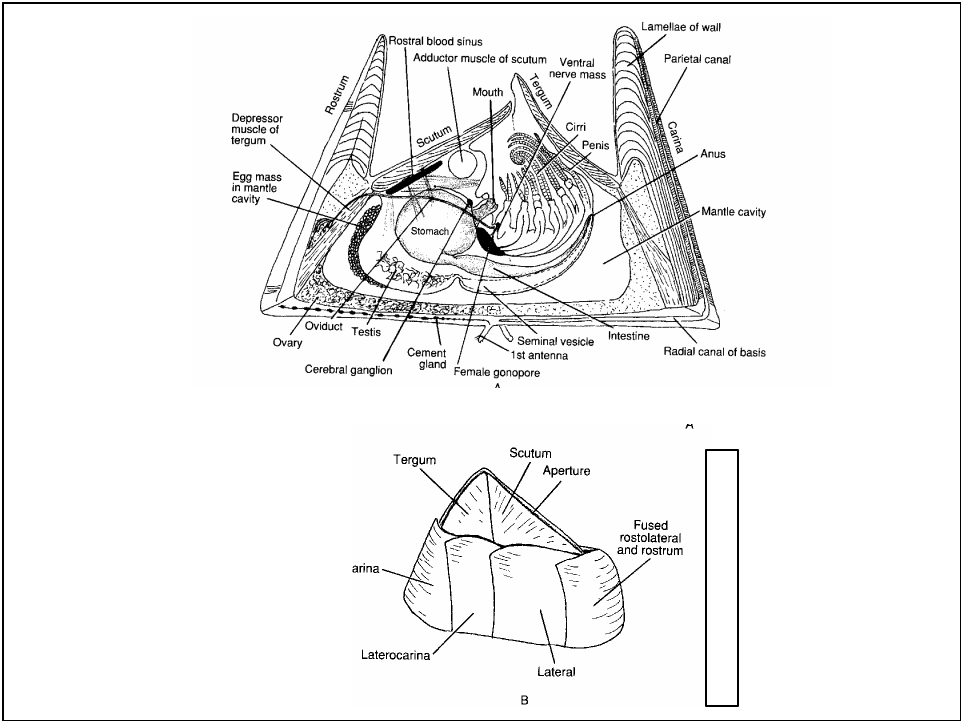
Parasitic Copepods

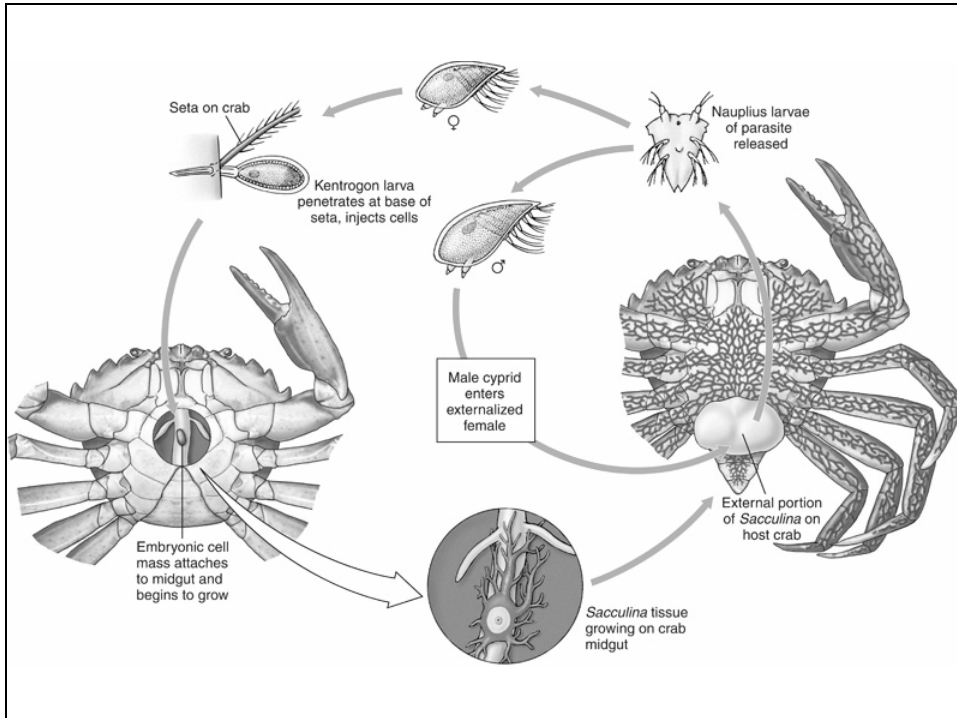


Subclass: Cirripedia

- 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







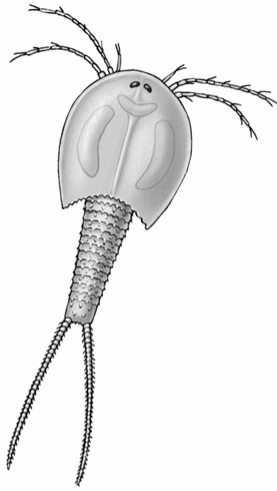
Class Branchiopoda

flattened & leaf-like legs: chief respiratory organs

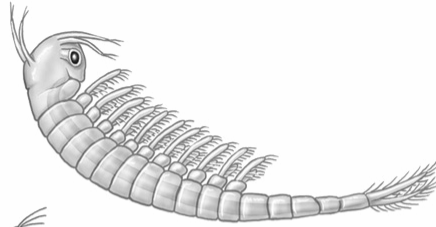
4 orders >10,000 species most freshwater

- 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:

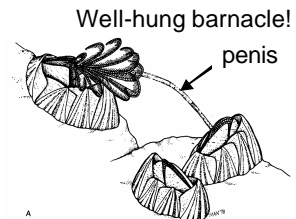
in brood chambers

in brood sacs attached to abdomen

attached to abdominal appendages

4) direct development without larval form

crayfishes



Crustacean Development

I. larva unlike the adult in form

A. nauplius

1) appendages/somites added → series of molts

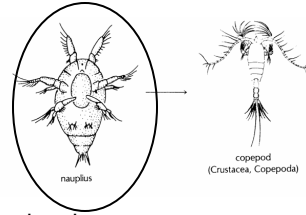
a) uniramous first antennae

b) biramous second antennae

c) mandibles

feeble swimming

B. adult

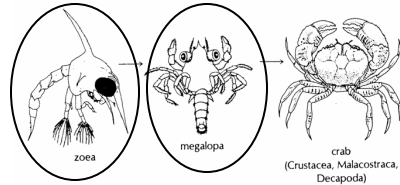


II. larva + juvenile stage → adult

A. nauplius → zoea

B. juvenile stage → megalopa

C. adult

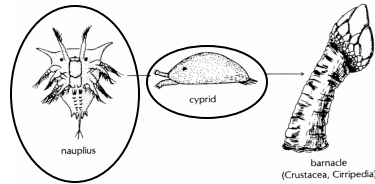


III. larva → 2nd distinct larva → adult

A. free-swimming nauplius

B. cyprid larva with bivalve carapace

C. sessile adult with plates



Artemia Larval Development

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

2) pre-nauplius E-2 stage

3) free-swimming nauplius → Instar 1 nauplius

specialized antennae for locomotion & later for food filtering

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

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



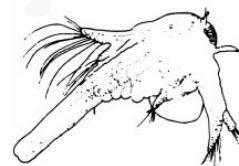
300µm
Pre-nauplius in E-1 stage



Pre-nauplius in E-2 stage



Freshly hatched Instar I nauplius



Instar V larva