

# Arthropods

Lec 14  
fish310

# Phylum Arthropoda

Subphylum Uniramia

Subphylum Trilobitomorpha

Class Trilobita—the trilobites

Subphylum Chelicerata

Class Merostomata—horseshoe crabs

Class Arachnida—spiders, mites, ticks,  
scorpions

Class Pycnogonida (= Pantopoda)—sea  
spiders

Subphylum Mandibulata

Class Myriapoda

Order Chilopoda—centipedes

Order Diplopoda—millipedes

Class Insecta (= Hexapoda)

Subclass Apterygota—the wingless insects

Subclass Pterygota—the winged insects

Class Crustacea

Subclass Malacostraca

Order Isopoda—pillbugs, woodlice

Order Amphipoda—sand fleas

Order Euphausiacea—euphausiids  
(krill)

Order Stomatopoda—stomatopods

Order Decapoda—crabs, lobsters,  
shrimp, hermit crabs

Subclass Branchiopoda—brine (fairy)  
shrimp, clam shrimp, water fleas

Subclass Ostracoda—the ostracods

Subclass Copepoda—the copepods

Subclass Pentastomida

Subclass Cirripedia—the barnacles

# Phylum Arthropoda

## But first...

Subphylum Trilobitomorpha

Class Trilobita—the trilobites

Subphylum Chelicerata

- nutrition

Class Merostomata—horseshoe crabs

Class Arachnida—spiders, mites,

scorpions

Class Pycnogonida (= Pantopoda)—sea

spiders

- reproduction

- development

Subphylum Mandibulata

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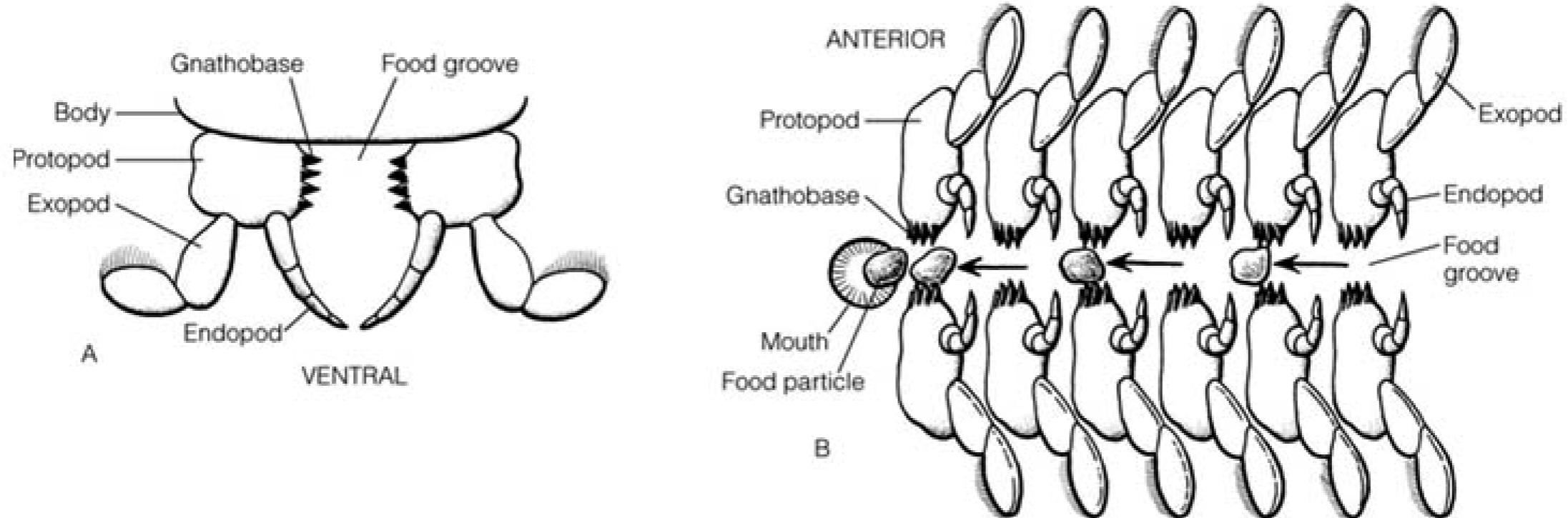
Subclass Copepoda—the copepods

Subclass Pentastomida

Subclass Cirripedia—the barnacles

# Nutrition

# Ancestral feeding

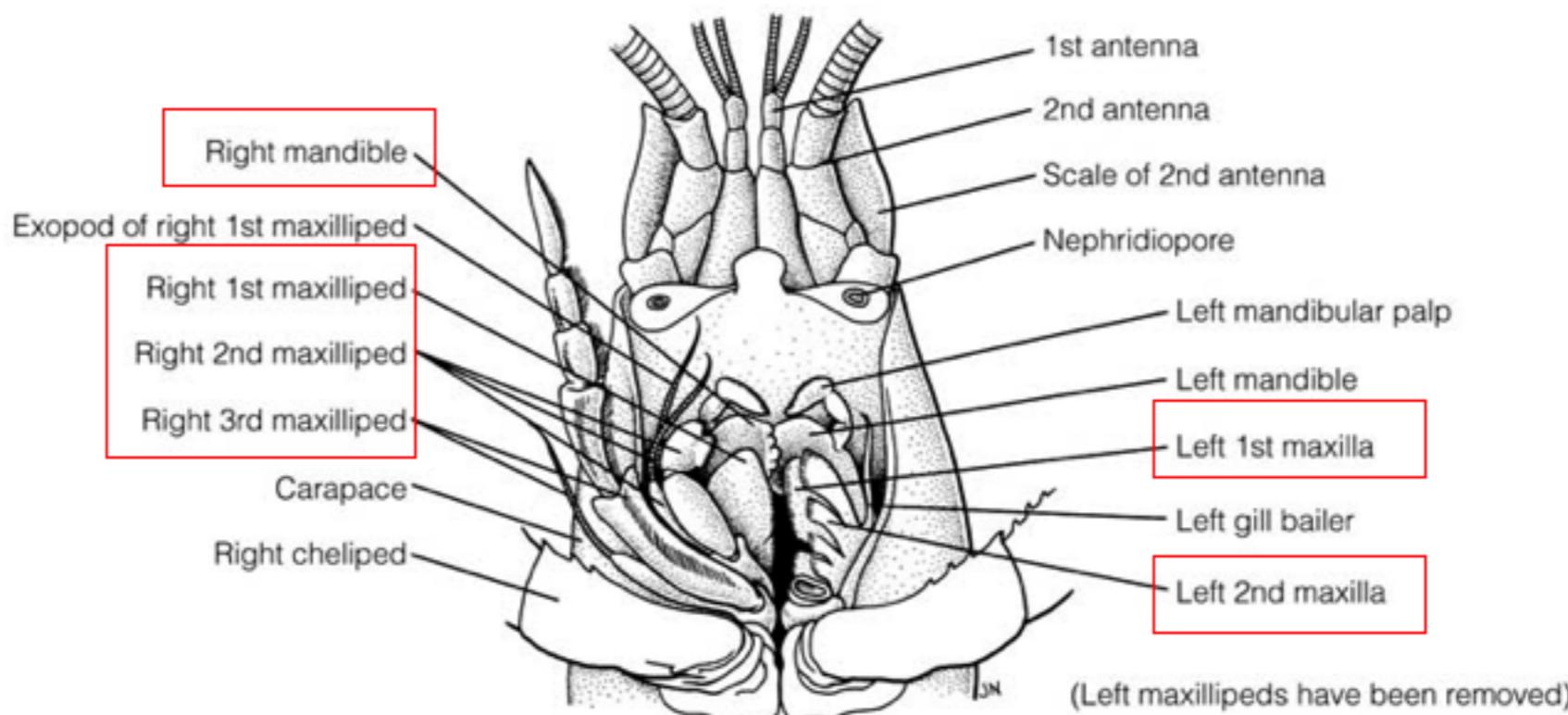


**Figure 19-4: Feeding mechanism of the ancestral crustacean.**  
**A, Cross section through a trunk segment showing a typical pair of mixopods. The exopod is a phyllopod, the endopod is a stenopod, and the protopod has a medial gnathobase. B, Ventral view of the anterior trunk, showing the food groove and feeding mechanism.**

# Feeding

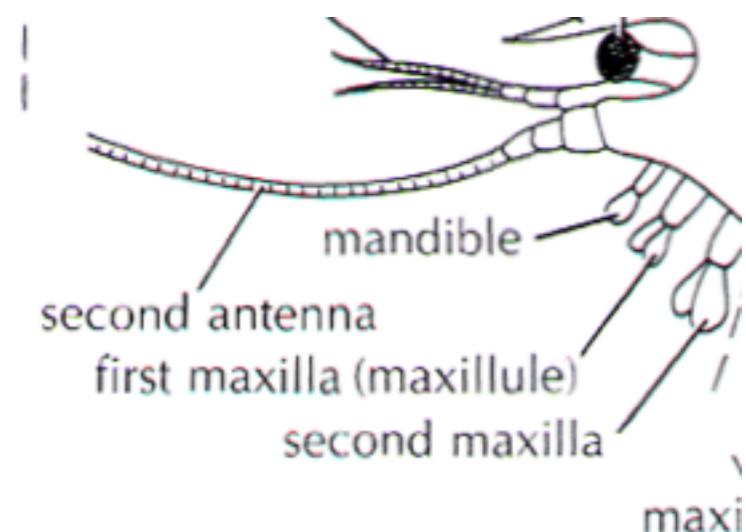
Six pairs of appendages are associated with the decapod mouth

- Mandibles flank
- Two pairs of maxillae and three pairs of maxillipeds attach posterior to mouth, extending anteriorly



# Feeding

- Most are predators and scavengers
- Food is grasped by chelipads and passed to third maxillipeds.
- Mandibles hold food, pieces torn away by maxillae and maxillipeds and transferred to mouth



# Feeding

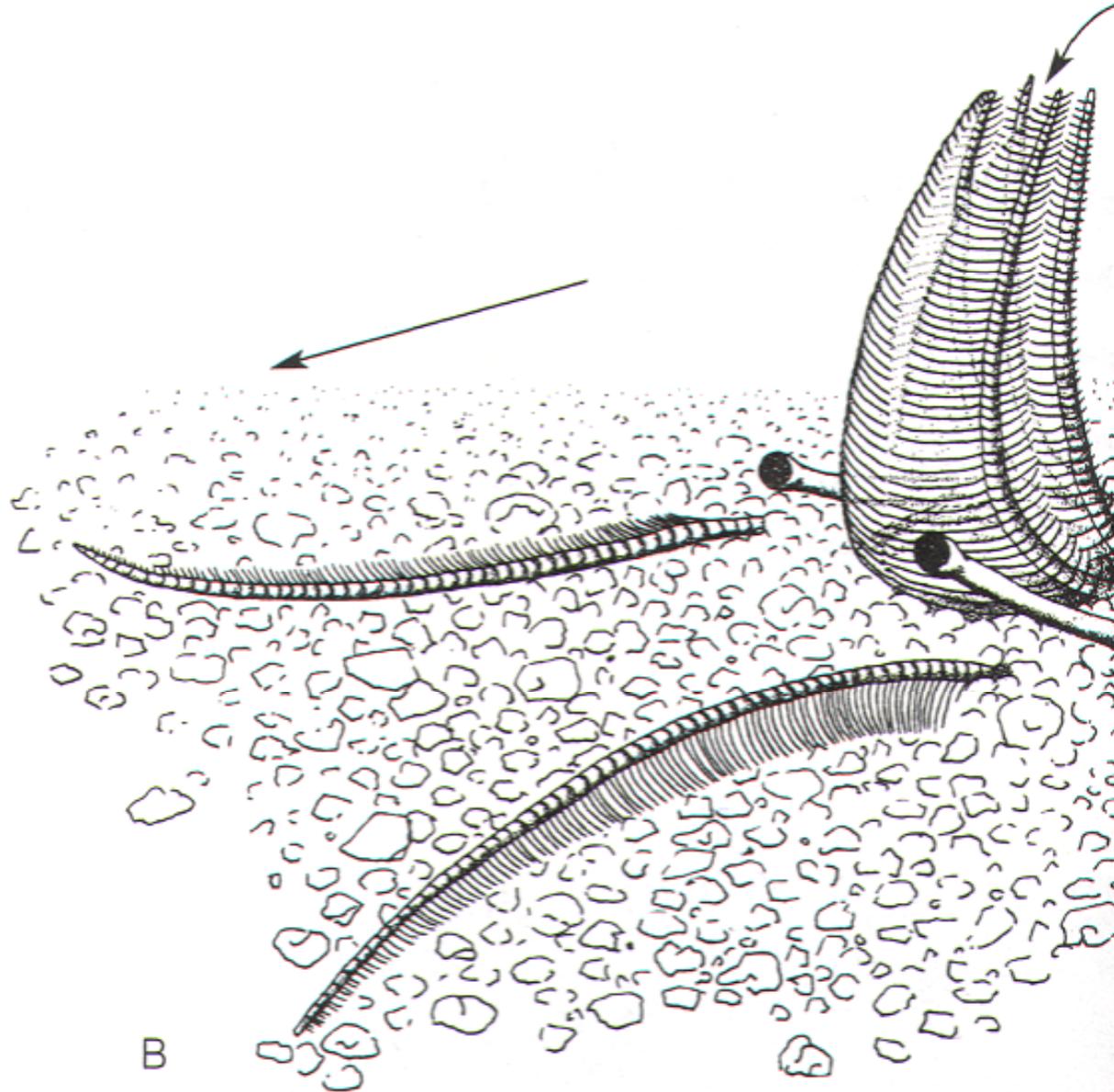
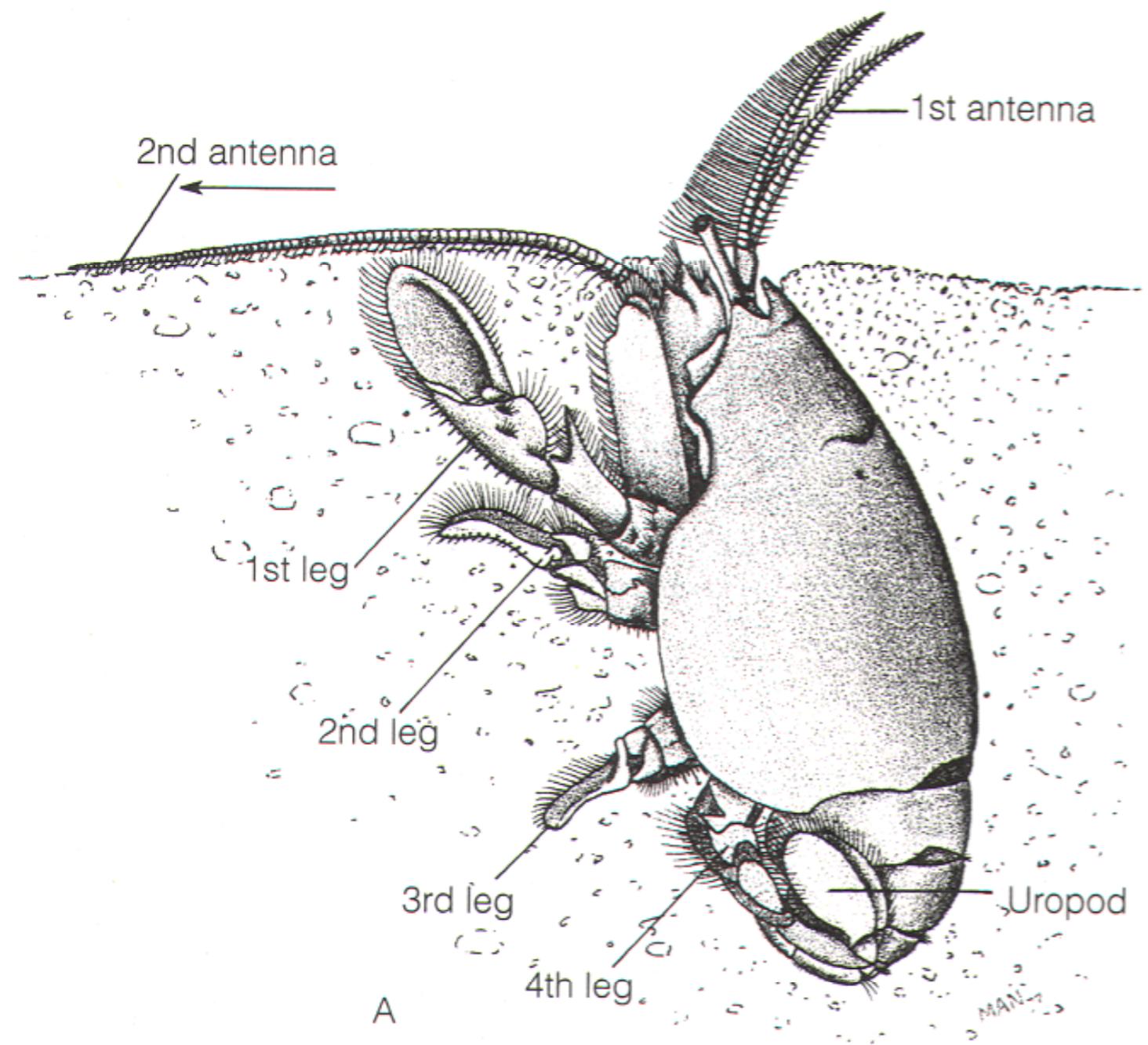
- Chelipads are adapted to feeding habits and food preferences of each species
  - Spoon shaped fingers - scrape algae from rocks or feed on detritus from sand and mud
  - Dimorphic chelipads -
    - Crusher claw has blunt, molar like teeth
    - Cutter claw- ??



# Fiddler feeding

- Brachyurans that feed on organic detritus
- One or two small chelipads that scoop
- Water washes material through filters on second and first maxilliped.
- Mineral particles are pelleted and deposited





**FIGURE 19-29** Decapoda, Anomura: *Emerita talpoida*, the mole crab, in the superfamily Hippoidea. This is a common crab on surf-swept beaches along the east coast of the United States. A, Lateral view of the animal buried in the sand. B, Surface view of the buried animal. The first antennae form an inhalant siphon to ventilate the gills. The curved arrow indicates the ventilating current. The straight arrow indicates the direction of the receding wave.

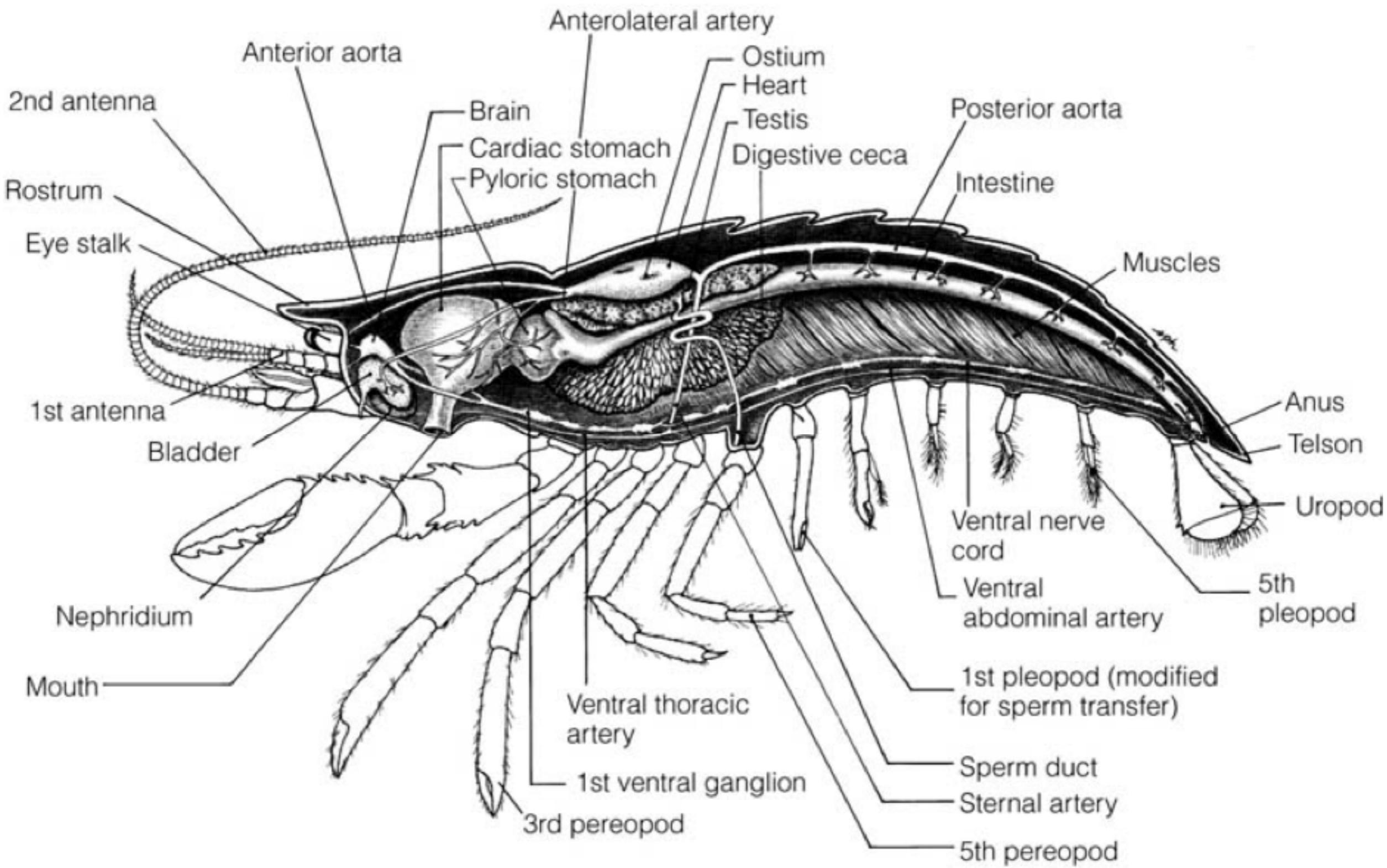
# Mole crab

- Uses uropod and fourth leg to dig
- Antennae and eyestalks extended above the sand
- Feeds on receding wave

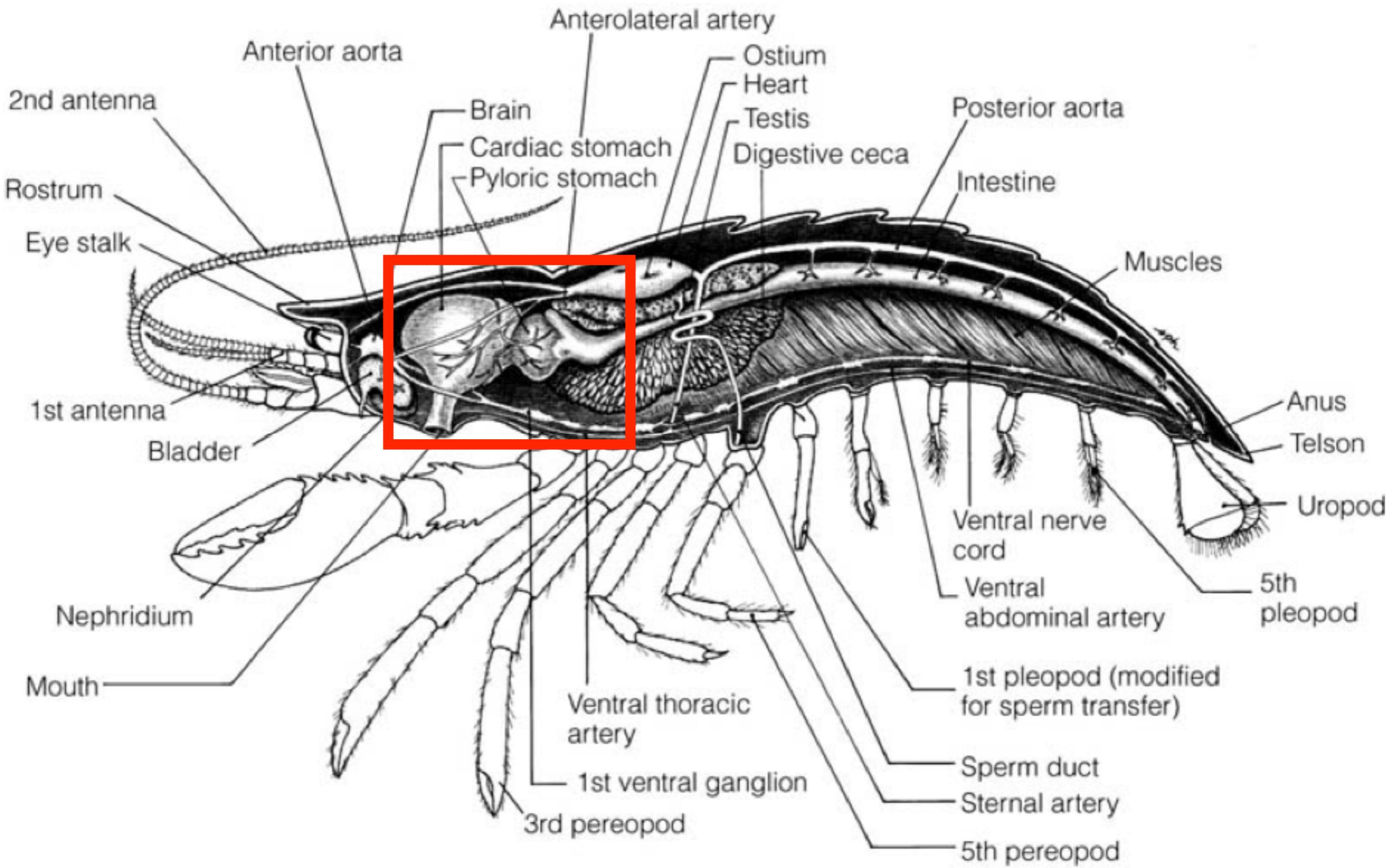


# Digestion

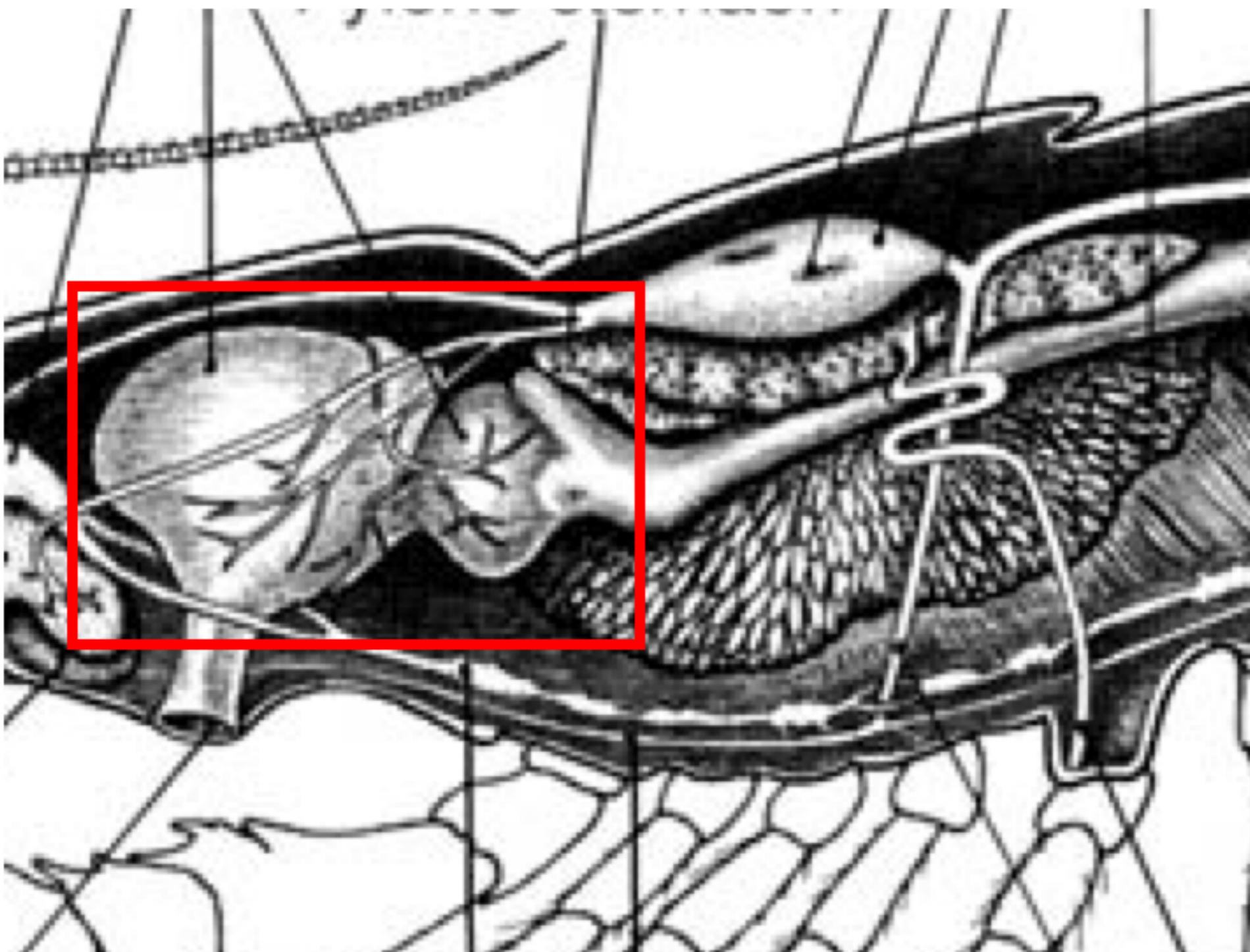
# Digestion



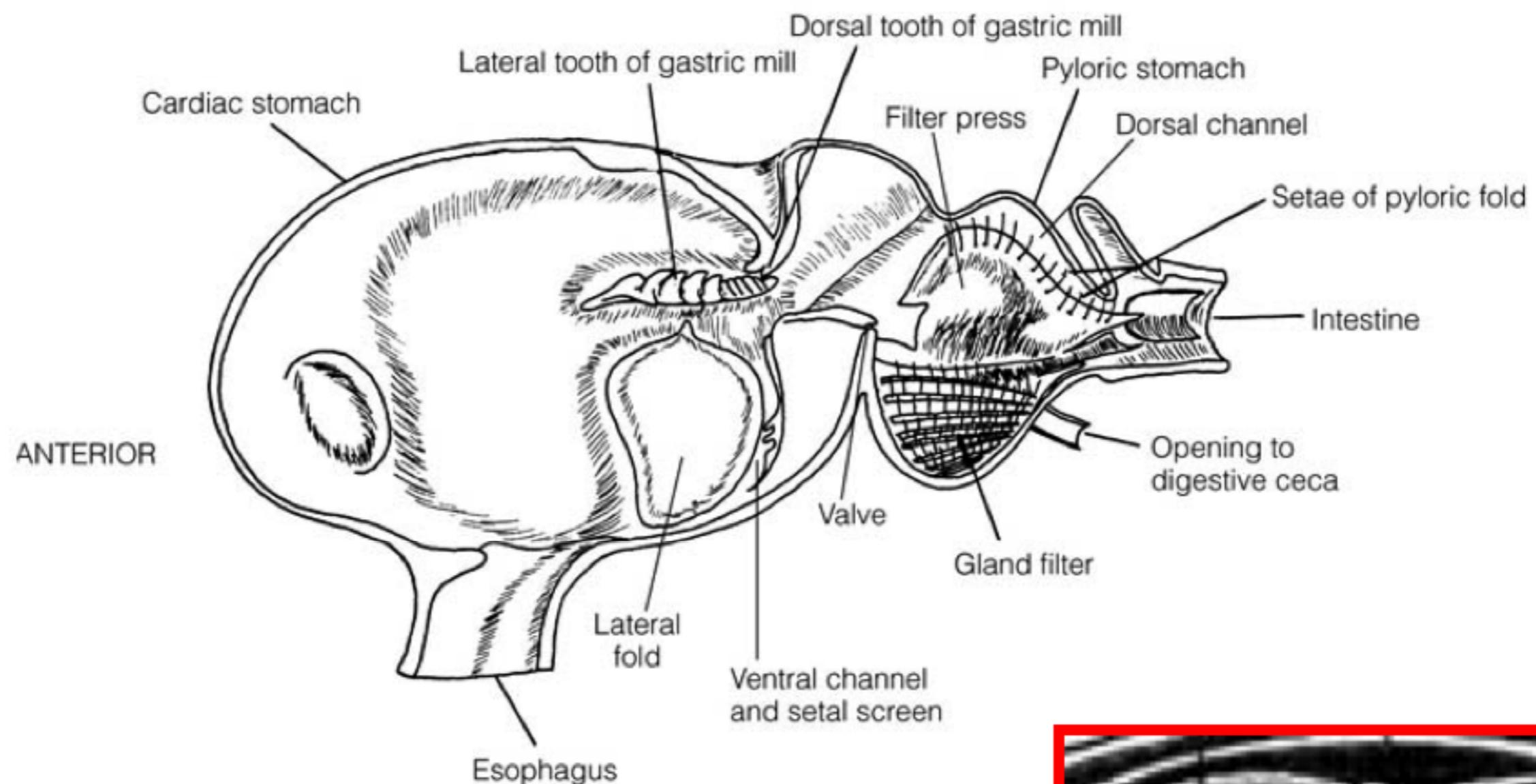
# Digestion



# Digestion

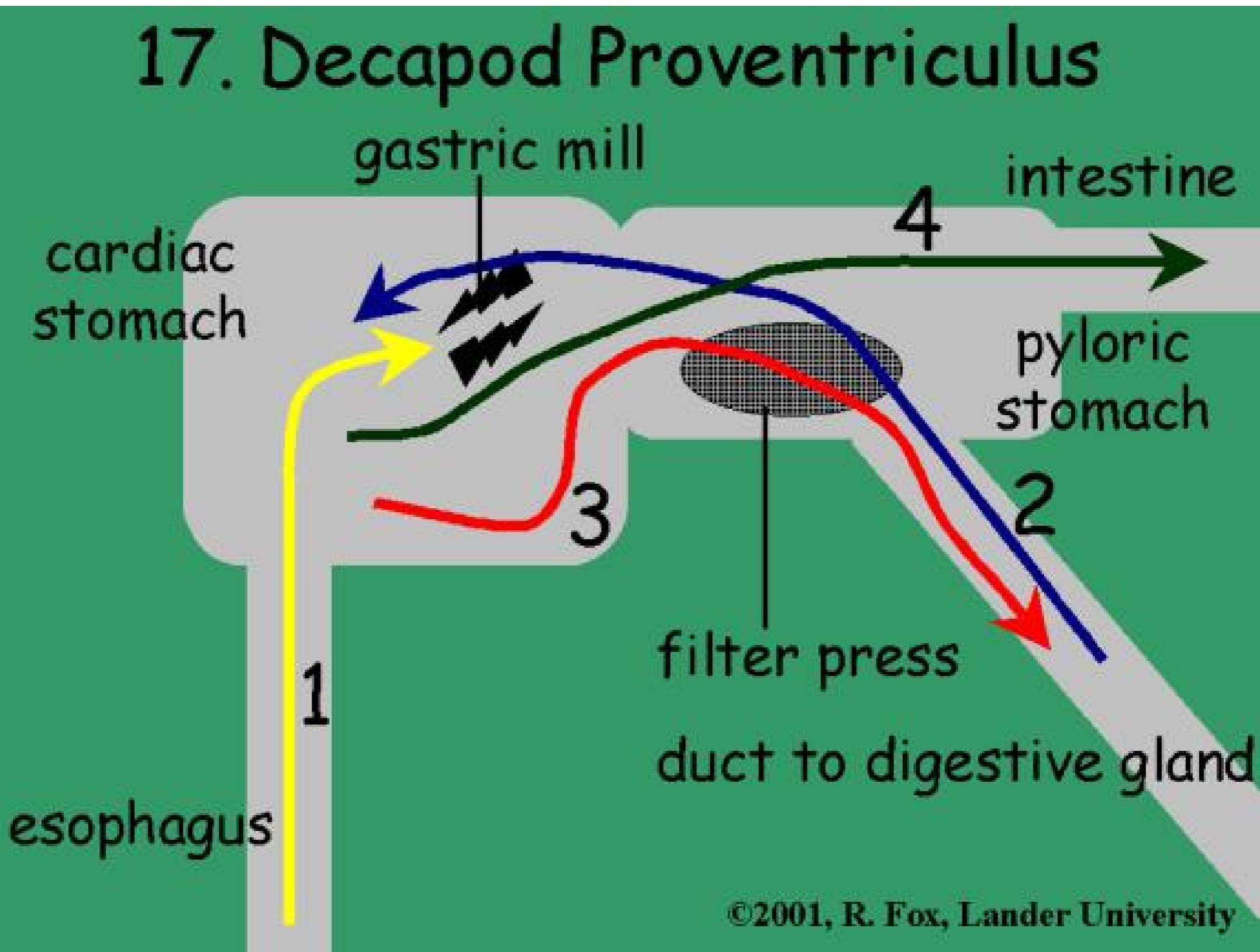


# Digestion



# Digestion

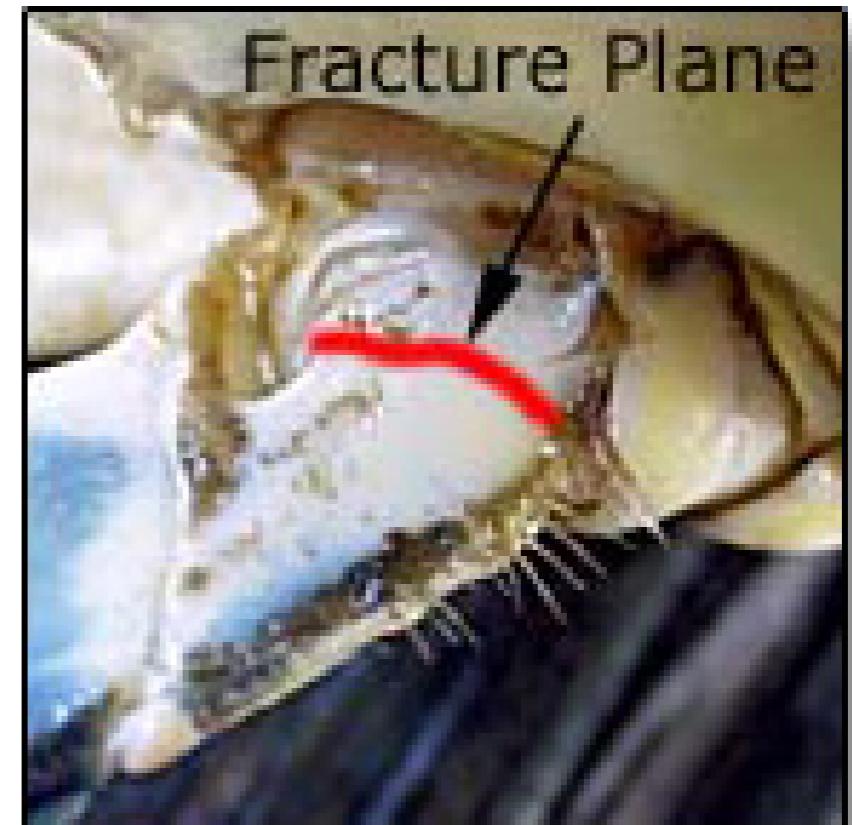
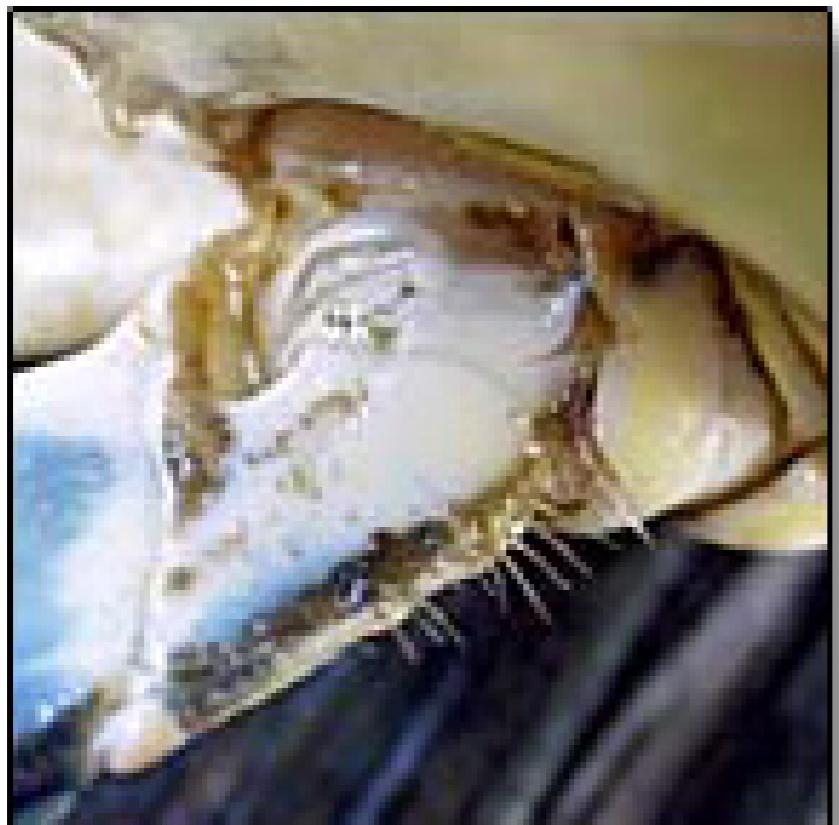
## 17. Decapod Proventriculus

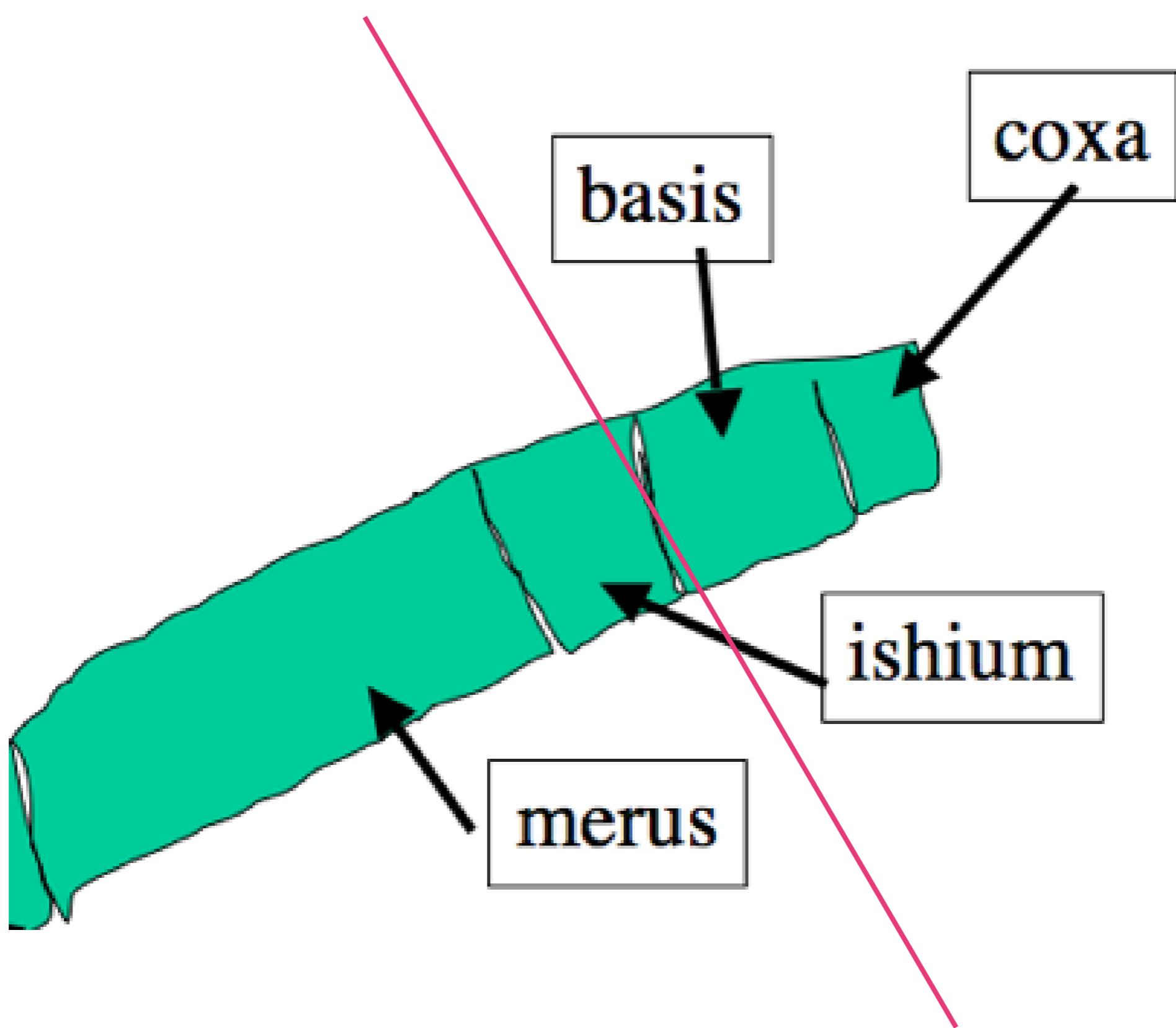


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# Autotomy

- **Controlled response to trauma**
  - Pre-formed breakage plane
  - Typically only on appendages likely to be lost
- **predator grabbing limb**
- **limb damaged – stop blood loss**
- **temp or chemical stress**
- **starvation**





# Autotomy

- leverage against the coxa used
  - Several muscles involved in coordinated effort
- little pressure to break-
  - *Carcinus* 125-385 grams pressure to break against coxa
  - 3.5-5 kg pulling in straight line



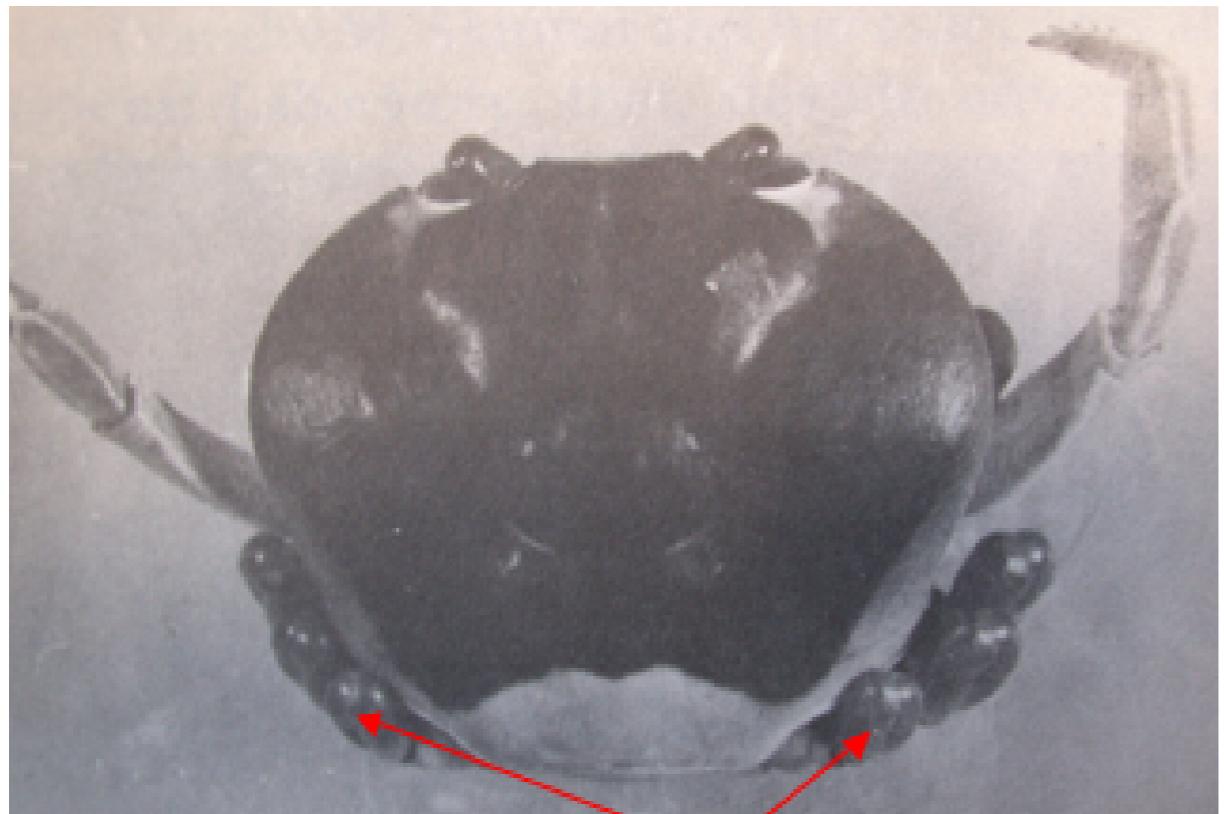
Before



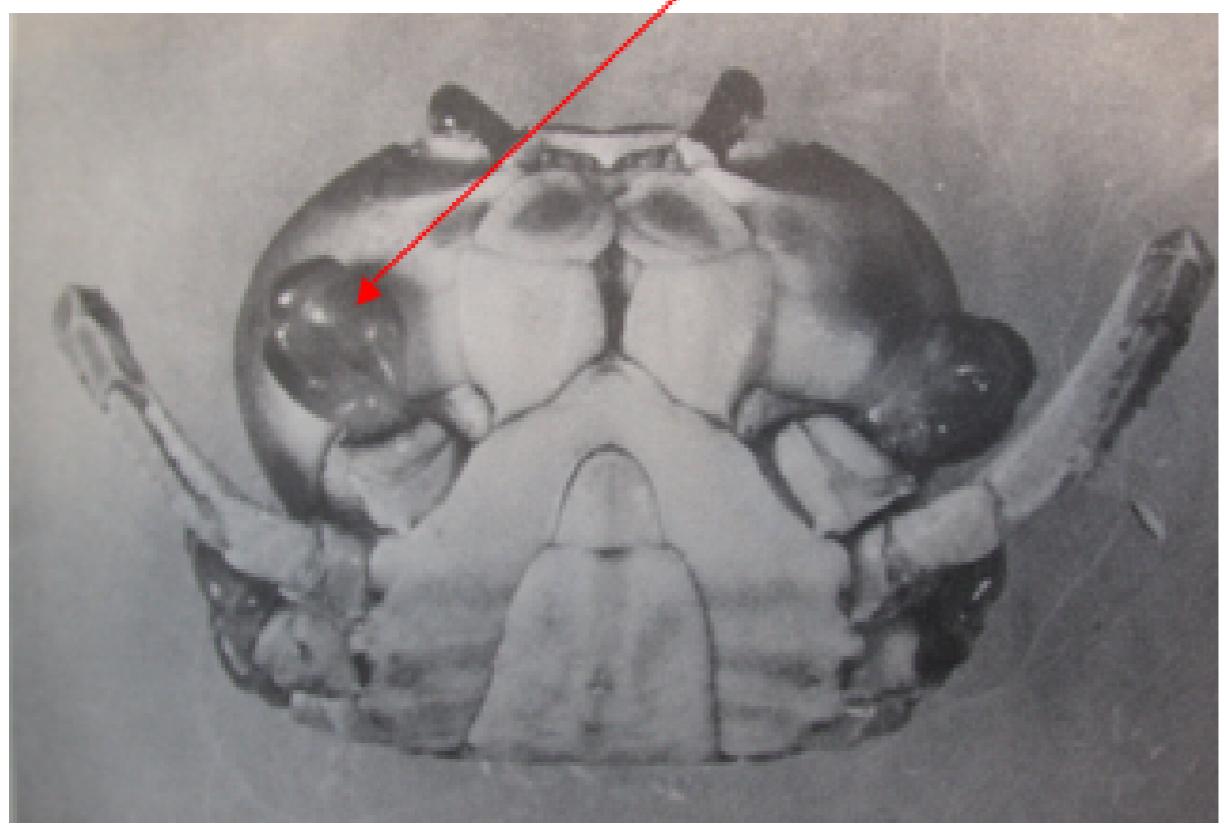
After

*Petrolisthes  
eriomerus*

G. Jensen



Limb buds



Bliss

# Reproduction

# Pheromones

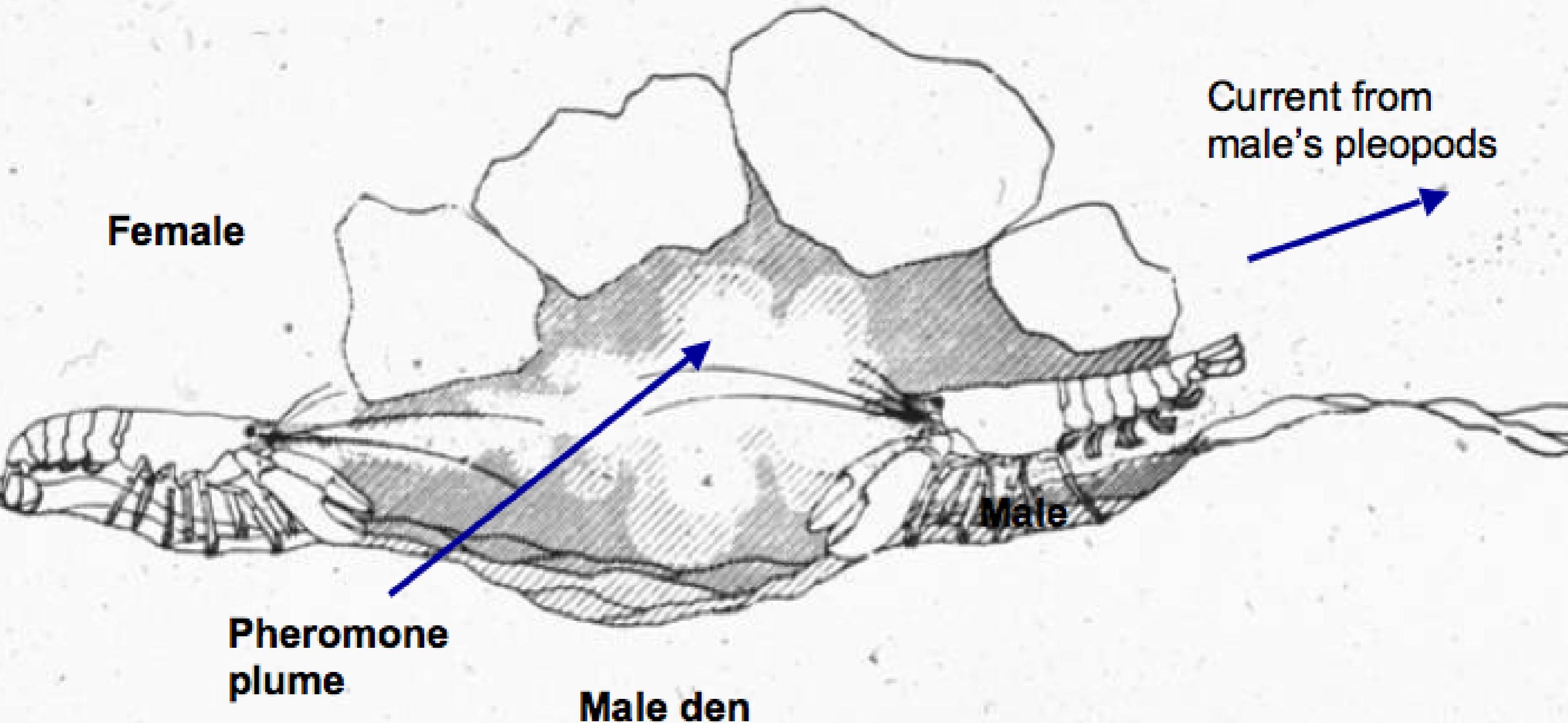
- **Strict definition: “Chemical produced by an organism that influences the behavior of another”**
- **Most crustacea mate when female is soft-shelled**
  - **Males usually attracted by sex pheromone**

# Pheromones (evidence)

- *Portunus*- urine from premolt female attracted males
- No response if:
  - Female not sexually mature
  - Excretory pore of female blocked
  - Female was of different species
  - Water was from premolt male tank



# Pheromones



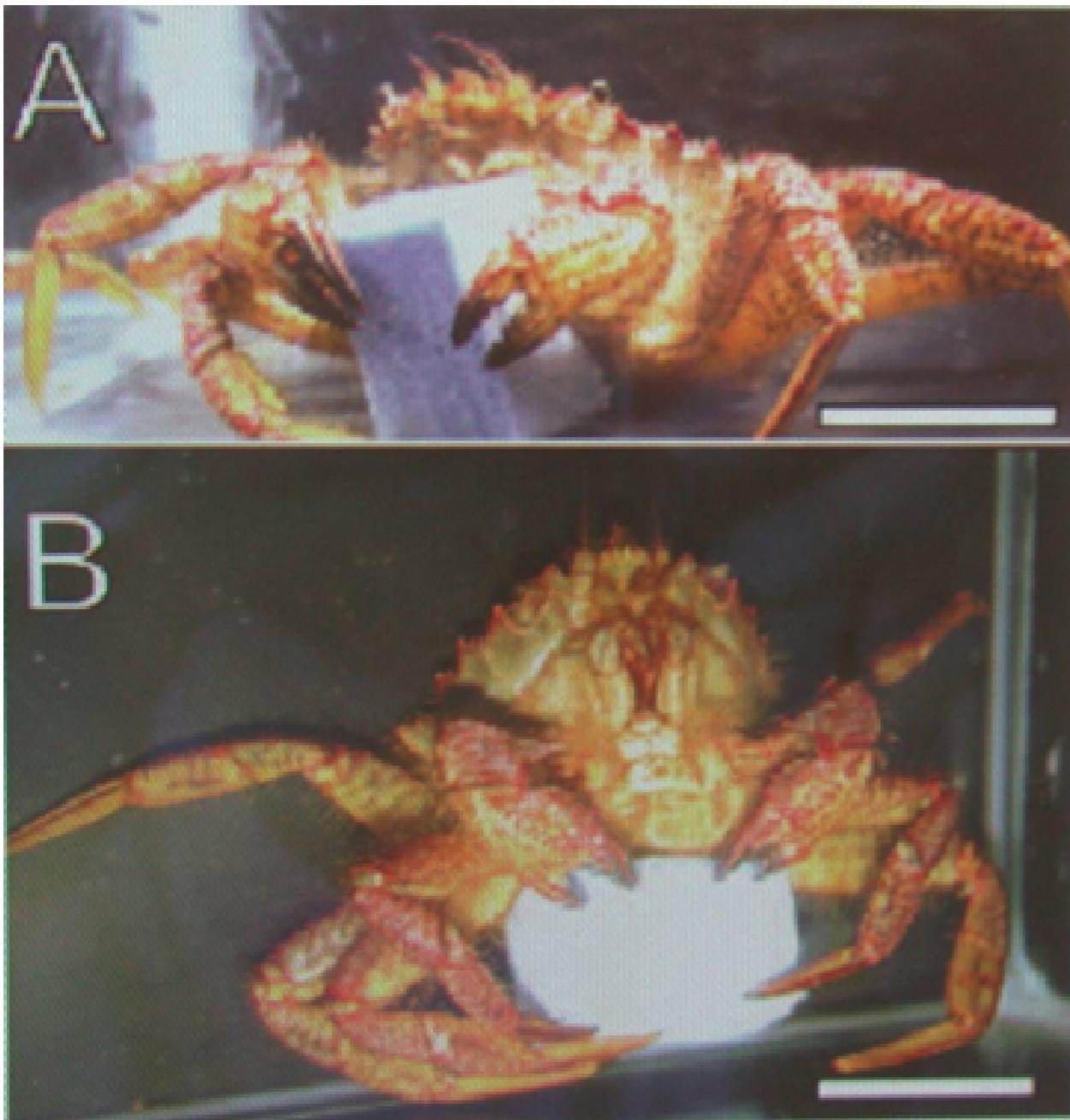
# Pheromones



Breithaupt & Eger

# Pheromones

Kamio et al 2002

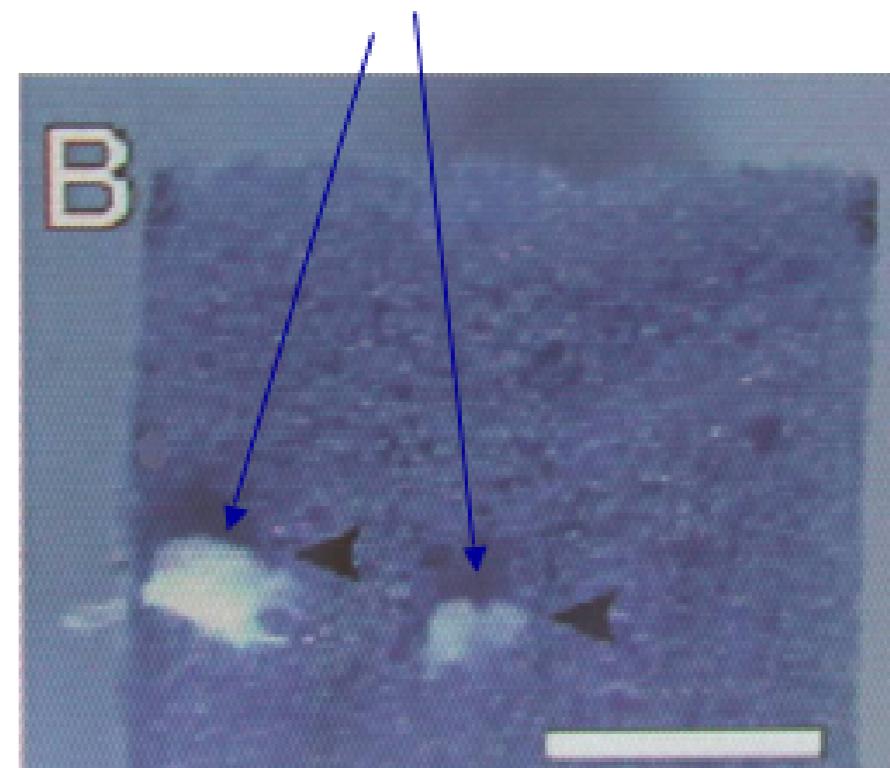


## *Telmessus*

**Copulation pheromone**

**Source unknown; not  
antennal gland**

**Sperm plugs on foam**



A local species that has been shown to have a copulation pheromone that females release for 21 days after molting. Shows a poor male mating with a sponge block that was soaked in water from a female's tank.

# Mate Attraction

- Aquatic species use olfactory (pheromonal) and tactile cues

Terrestrial?

# Mate Attraction

- Aquatic species use olfactory (pheromonal) and tactile cues
- Terrestrial use visual and auditory cues
  - Semi-terrestrial fiddler crabs (*Uca* spp.) have elaborate courtship behavior
  - Also produce sounds by rapping propodus of cheliped against the substrate or by rapidly flexing walking legs

# Mate Attraction





# Decapod development

- With the exception of penaeid shrimps, all decapods brood their eggs on their pleopods
- Development times vary from several weeks to a year or more: larger eggs take longer to hatch
  - Biggest eggs hatch into large, lecithotrophic larvae—reproduction is year round in these species
  - Hatch for most shallow-water decapods is timed with the spring and summer plankton blooms.
    - Why?

Larval release often tied to tidal cycles (lunar cycles)- maximize transport from nearshore areas

Shaking of egg mass elicited by pheromone from eggs

Brachyura- all eggs usually hatched at same time (minutes to hours)

Anomura- some release over long period (weeks - month)



# LOCOMOTION

| penaeid                | caridea                | Brachyura              | clawed<br>lobster      | crayfish               |                              |
|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------------|
| nauplius               | nauplius               | nauplius               | nauplius               | nauplius               | antennae<br>and<br>mandibles |
| protozoea              | protozoea              | protozoea              | protozoea              | protozoea              | exopods on<br>maxillipeds    |
| zoea                   | zoea                   | zoea                   | zoea                   | zoea                   | exopods on<br>legs           |
| mysis                  | mysis                  |                        | mysis                  | mysis                  | pleopods                     |
| megalops               | megalops               | megalops               | megalops               | megalops               |                              |
| 1st instar<br>juvenile |                              |
| 2nd instar<br>etc.     |                              |

N P Z M M ..

N P Z M M ..

Never Play w/a Zebra Mussel's Mantle



# Classification

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Subclass Copepoda—the copepods

Subclass Pentastomida

Subclass Cirripedia—the barnacles

# Subclass Branchiopoda

- Primarily Freshwater
- Coxa is modified to form flattened paddle
  - gas exchange / locomotion
- *branchio* - *poda*

Region of attachment to carapace

Adductor muscle

Mandible

Growth ring

Compound eye

Antenna

Carapace

Furca

(a)

## FOUR ORDERS

DIFFER IN BODY FORM

First trunk limb

Digestive diverticulum

Heart

Carapace

Eggs in brood chamber

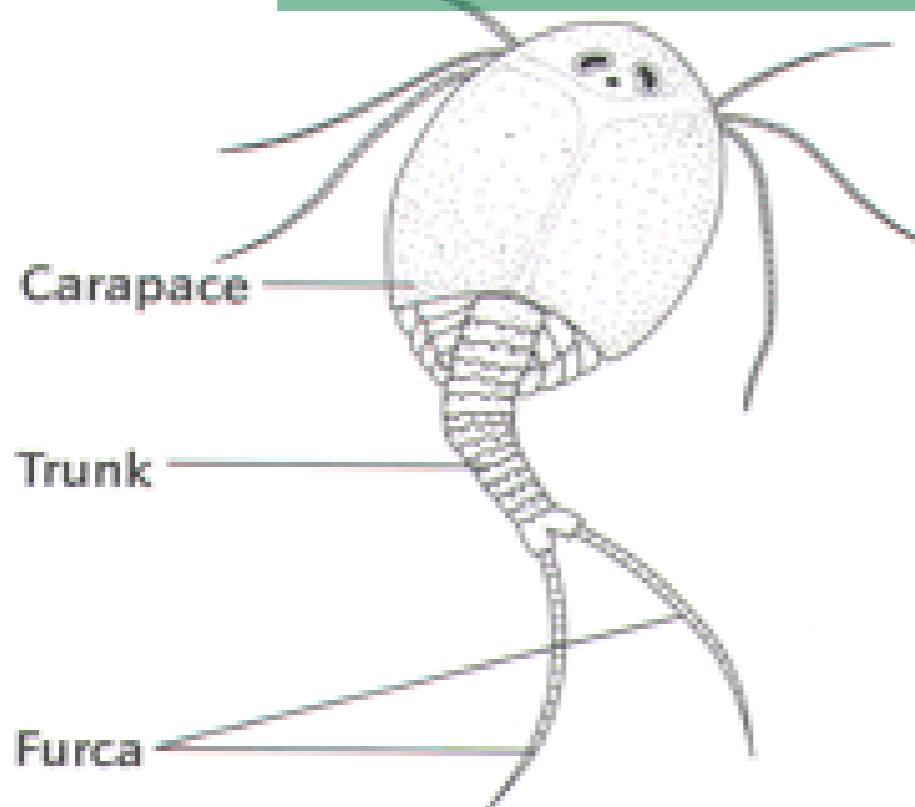
Compound eye

Antenna

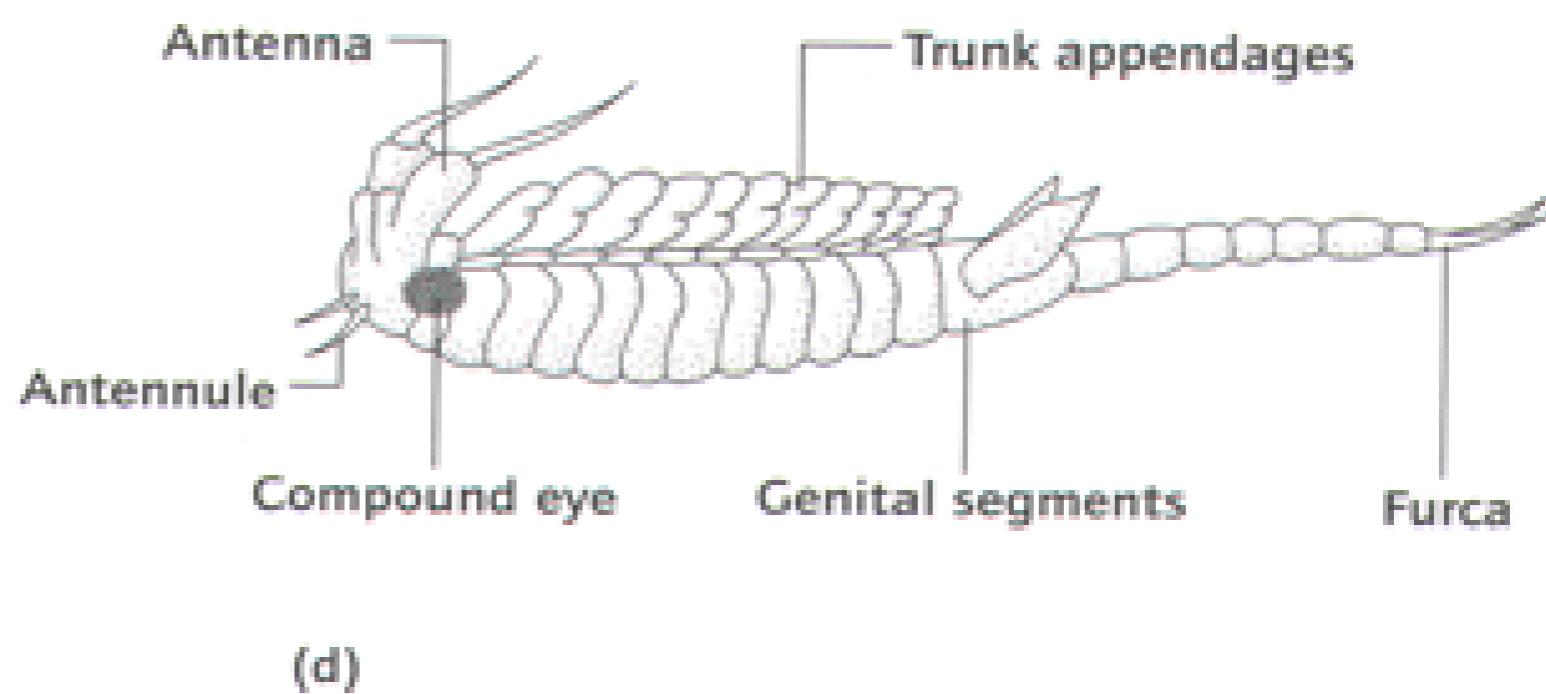
Antennule

Trunk appendages

Furca

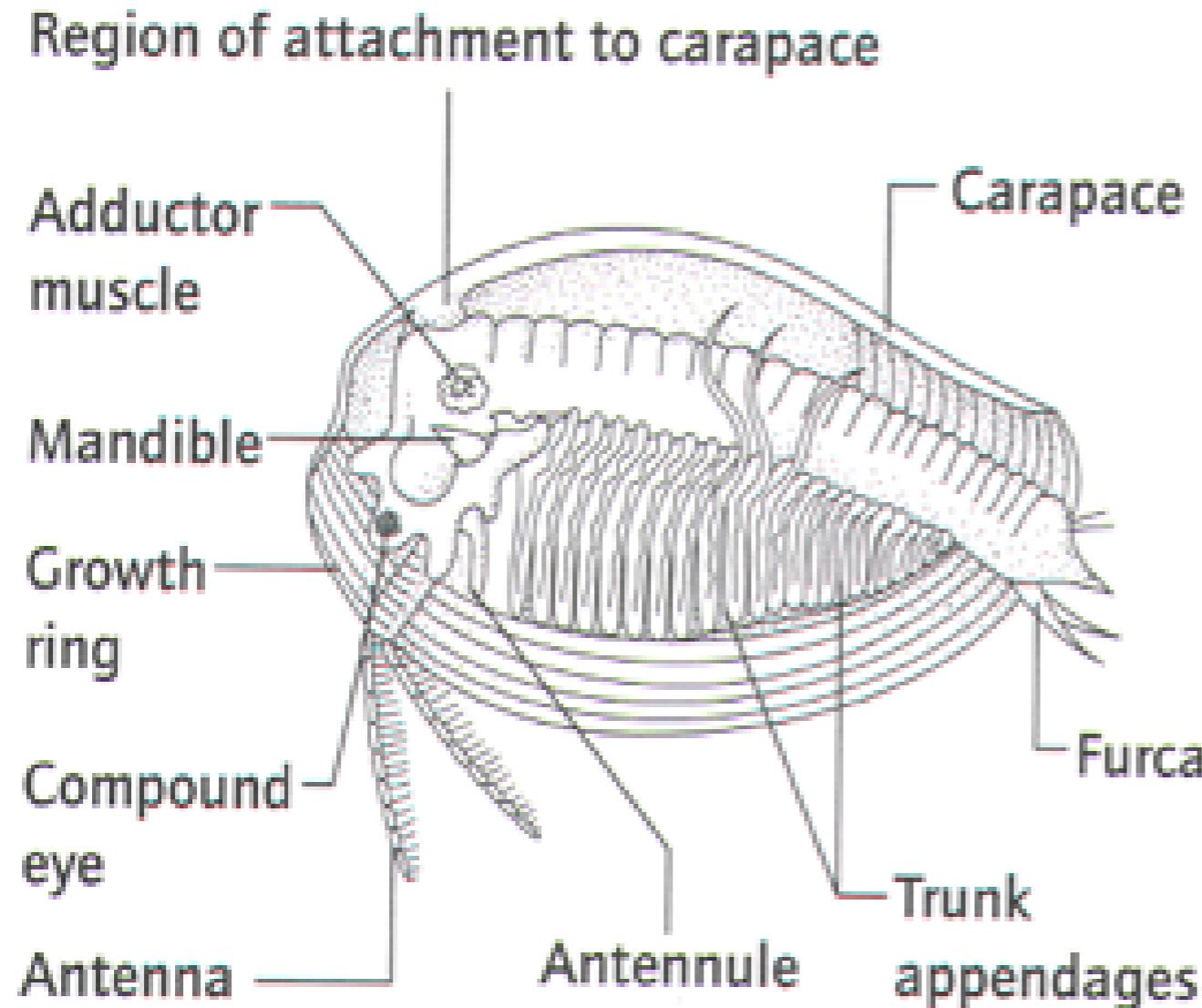


(c)



# Branchiopoda

## Conchostraca, lateral view with shell removed

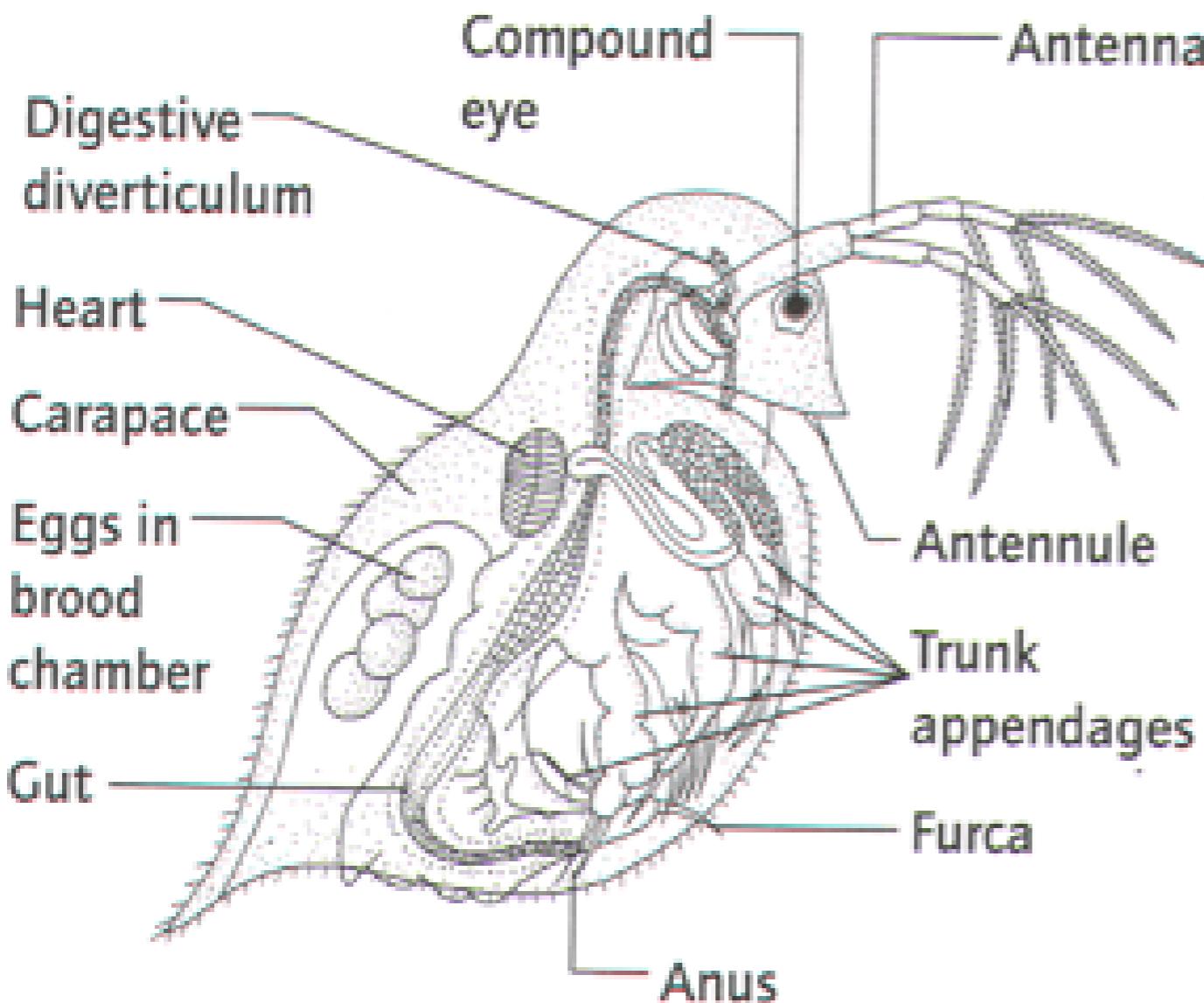


- Clam Shrimps
- Short, circular bodies
- Locomotory antennae
- Claw-like furca
- Dorsal brood chamber
- Laterally compressed carapace
- 30+ trunk segments
- Carapace encloses head
- Carapace not molted
- Grows by addition of concentric rings like....

# Branchiopoda

## *Daphnia*

### Cladocera



- Water Fleas
- Short, circular bodies
- Locomotory antennae
- Claw-like furca
- Dorsal brood chamber
- Laterally compressed carapace
- Carapace never encloses head
- In some reduced to small dorsal brood chamber
- Not more than six pairs of trunk limbs

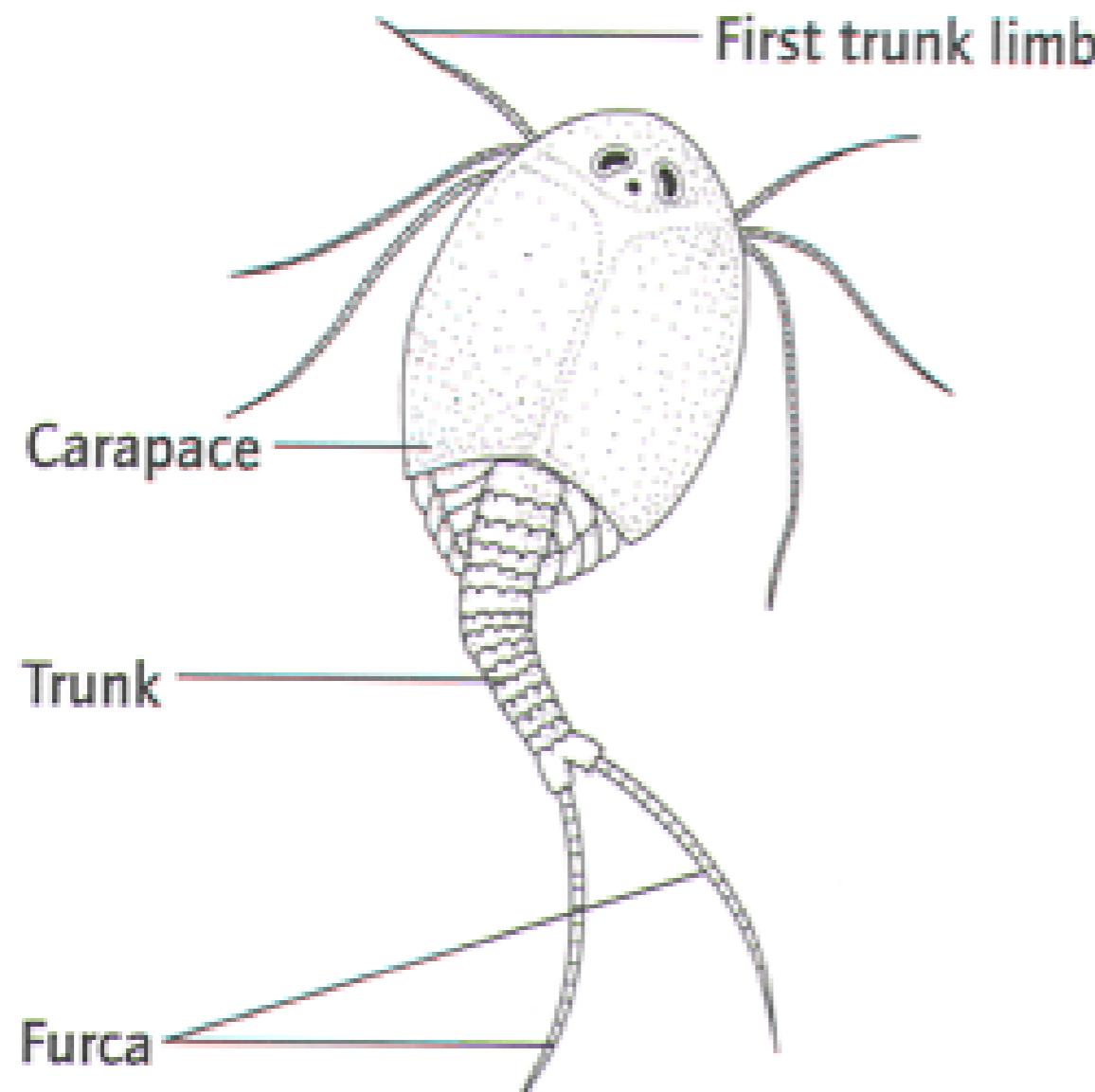
# Branchiopoda

*Daphnia*

## Cyclomorphosis

# Branchiopoda

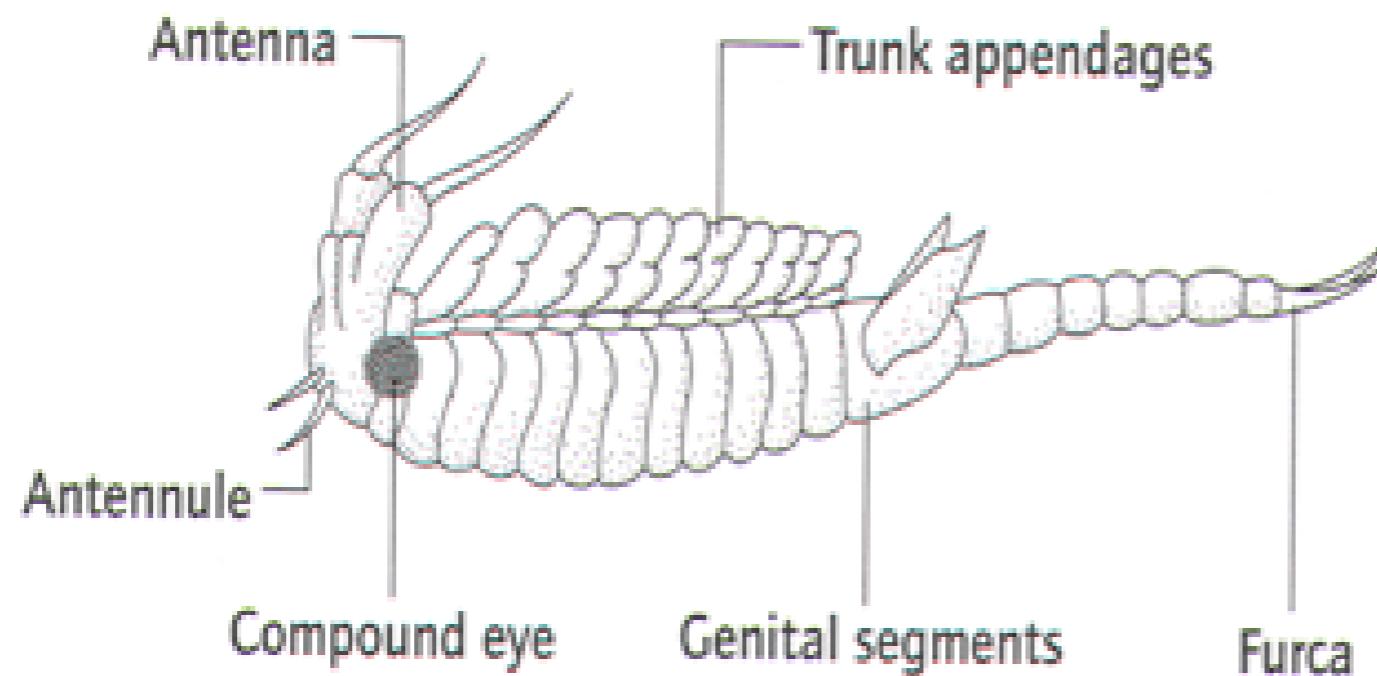
## Notostraca



- Tadpole Shrimps
- Carapace wide and dorsoventrally flat
- 2 long annulate furcal rami
- Trunk segments partially differentiated,
- one section could have 6 pairs of limbs
- Up to 70 pairs of trunk limbs
- 11th carry brood chamber
- Harsh environments
- Extreme resting forms

# Branchiopoda

## Anostraca



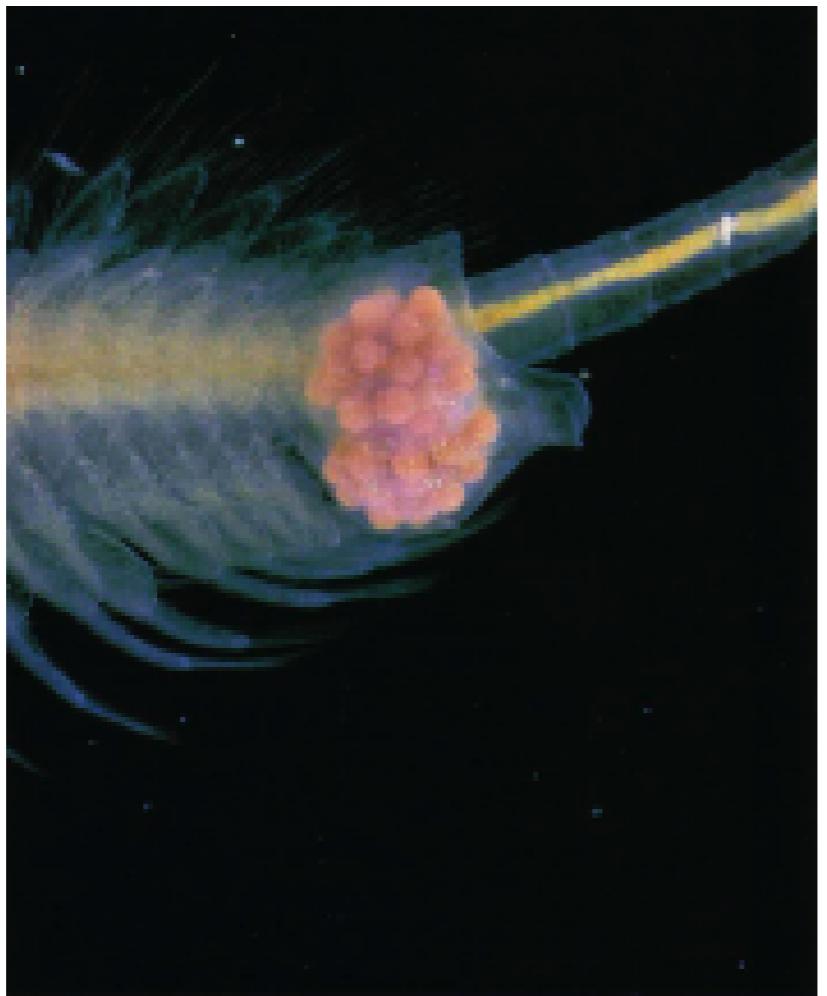
- Brine or Fairy Shrimps
- Lack carapace
- Brood chamber in body
- Harsh environments
- Extreme resting forms

Can withstand drying, freezing, fish - birds - mammals

# Sex and the Single Brine Shrimp

*Around the Mediterranean, female brine shrimp have been reproducing—without help from males—for millions of years*

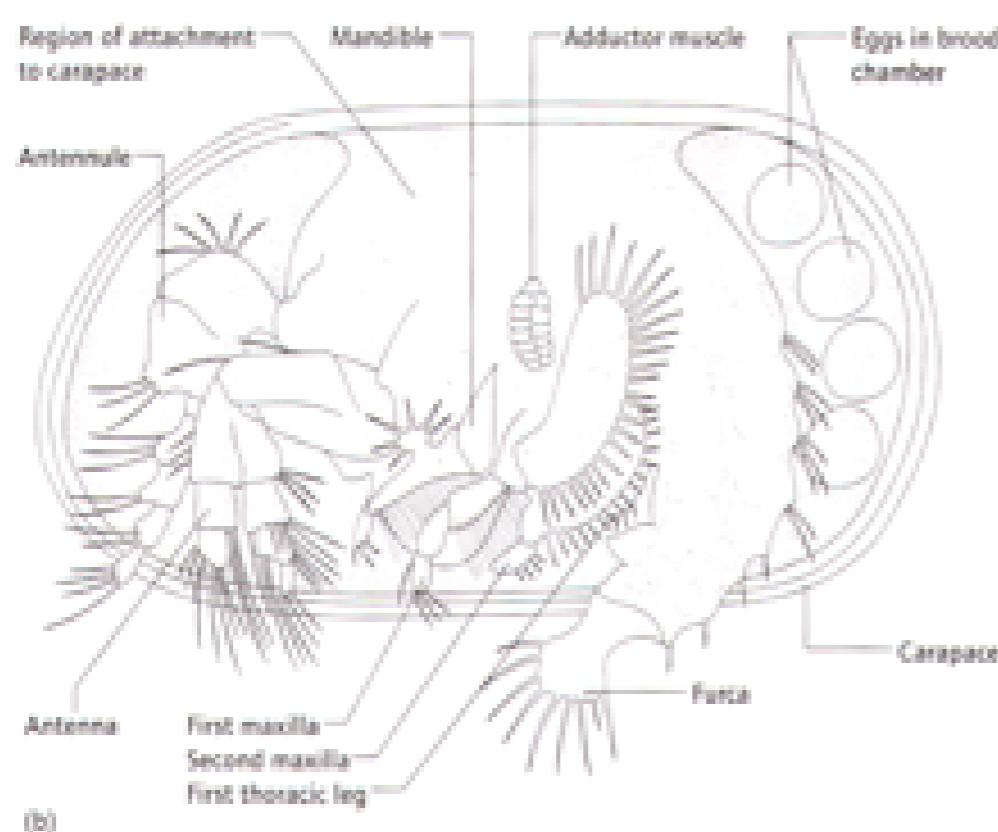
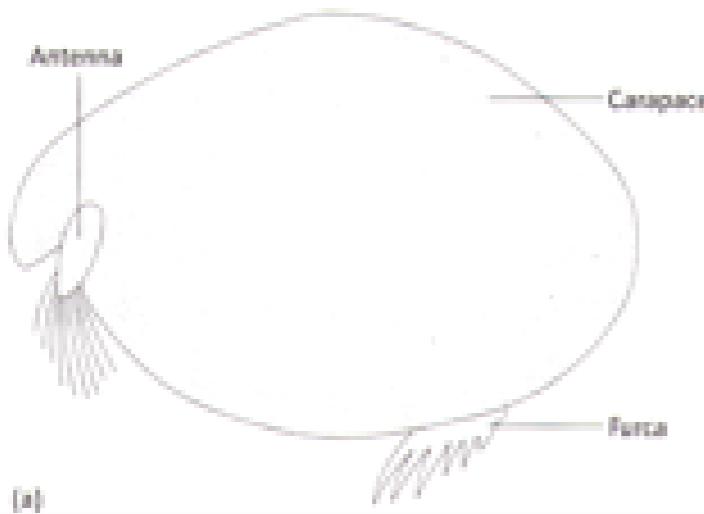
by Robert A. Browne



# Subclass Ostracoda

- Head and body are enclosed in a bivalved carapace, lacking concentric rings
- Trunk of body possesses no more than 2 pairs of limbs

# Subclass Ostracoda



- Short oval body
- Bivalved, often calcareous shell formed by carapace
- Molting does occur
- No segmentation evident



# Subclass Ostracoda

## Reproduction

- Some FW - parthenogenetic
- External genitalia and gonopores are ventral
- Zenker's organ
  - Peristaltic sperm pump
- Largest Sperm
  - Larger than organism?
- Male clasps female dorsally and posteriorly with 2nd antennae or 1st thoracopods

# Subclass Ostracoda

## Reproduction

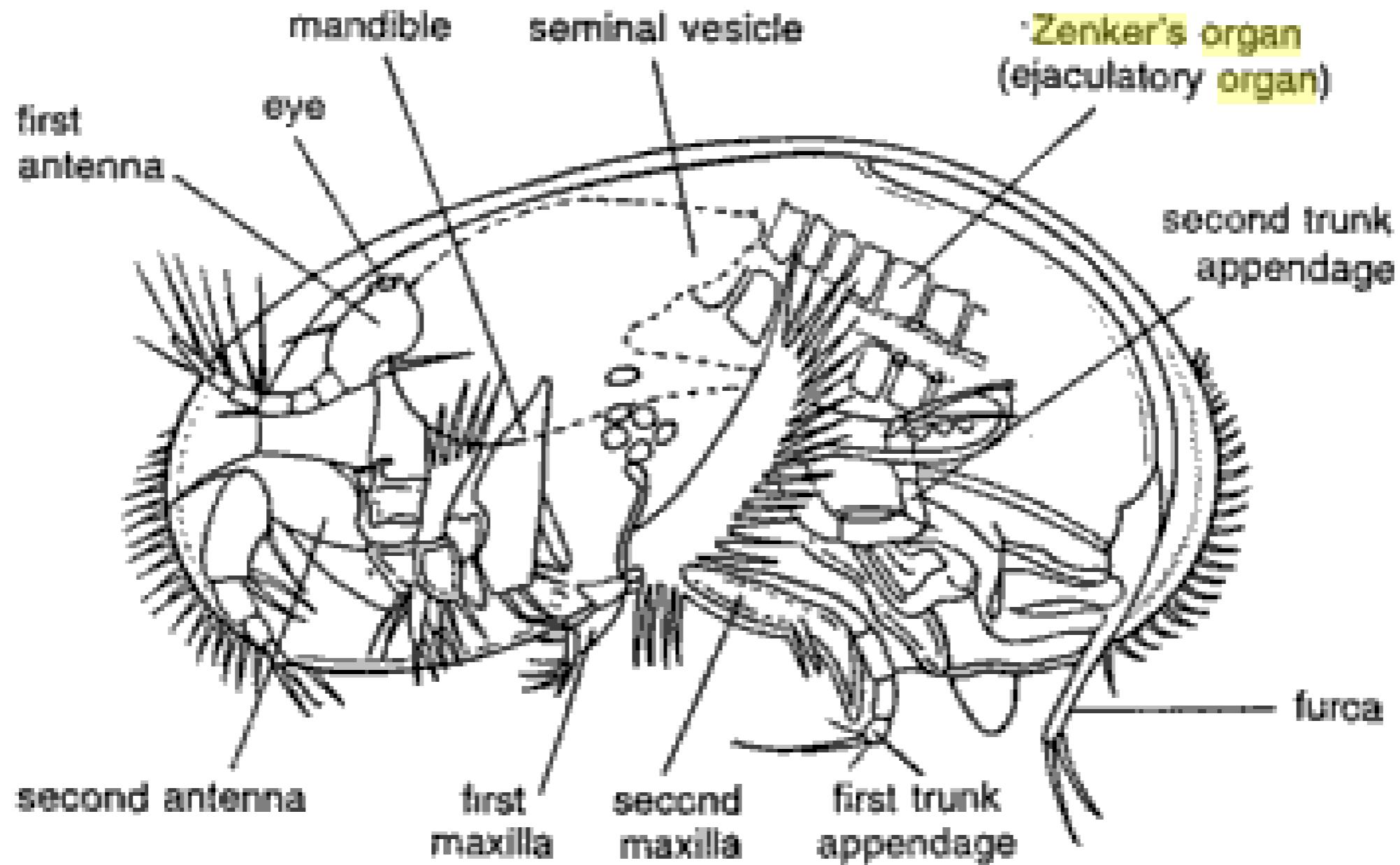


Fig. 34.5 *Candona sublurana*.

# Subclass Ostracoda

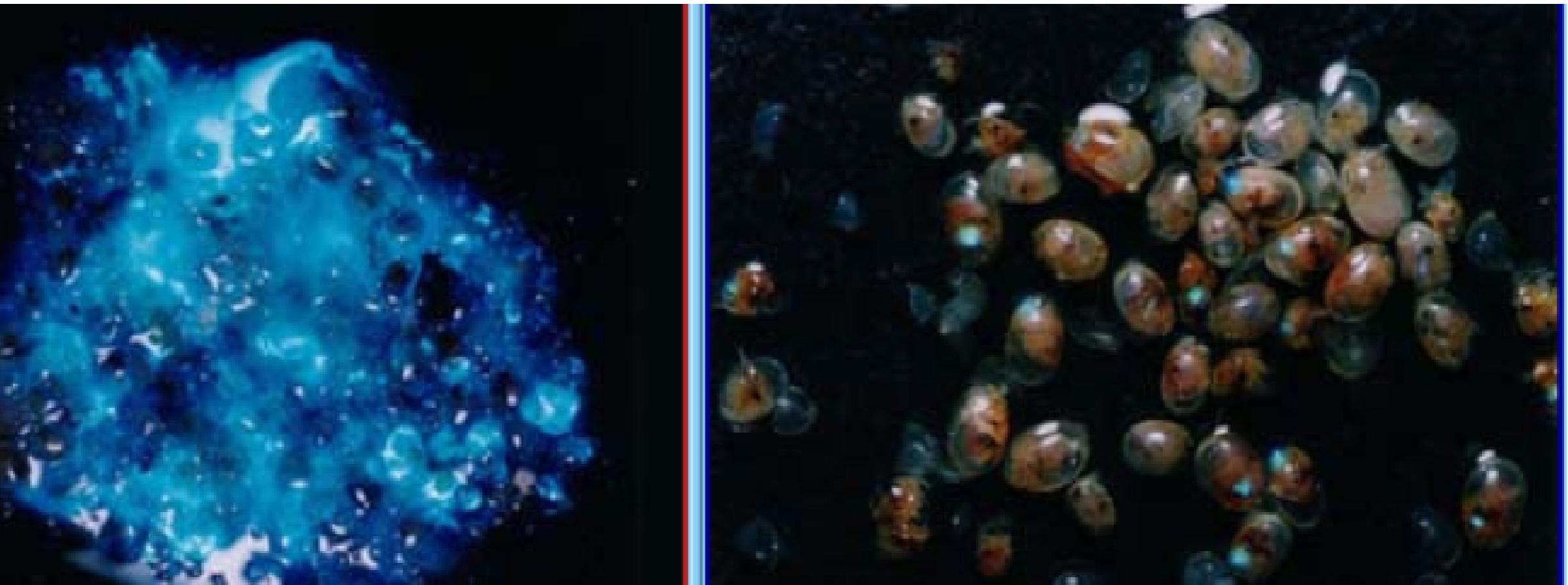
Deep-sea



*Gigantocypris mulleri*

# Subclass Ostracoda

Reproduction



# Subclass Ostracoda

## Giant sperm found in crustacean fossils

'Gargantuan gametes' are oldest on record and have visible nuclei.

Daniel Cressey

14 May 2014



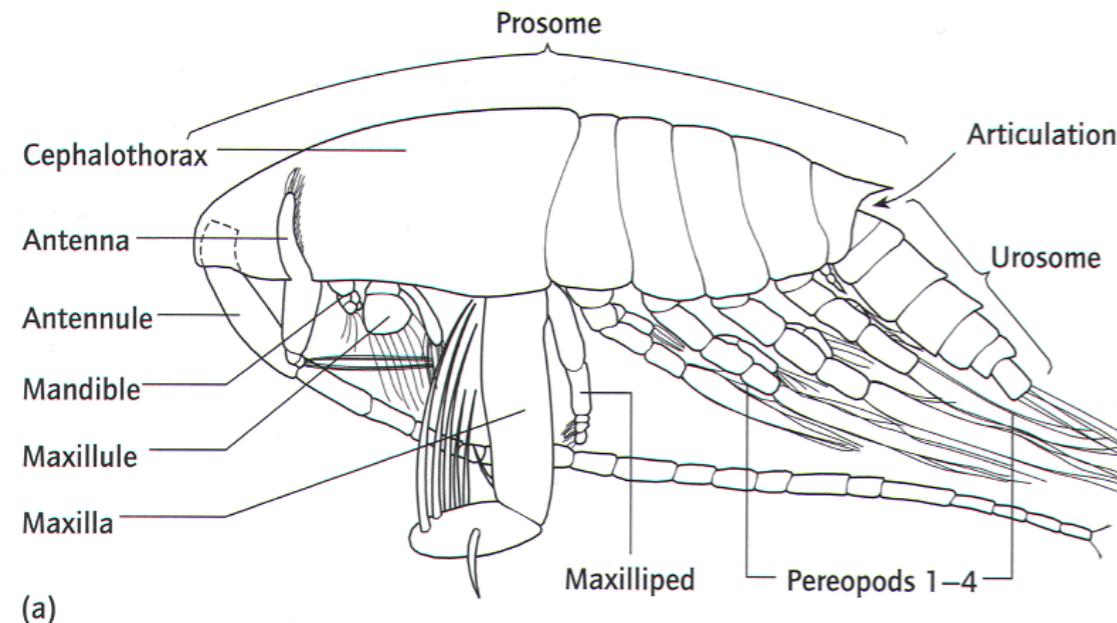
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# Subclass Copepoda

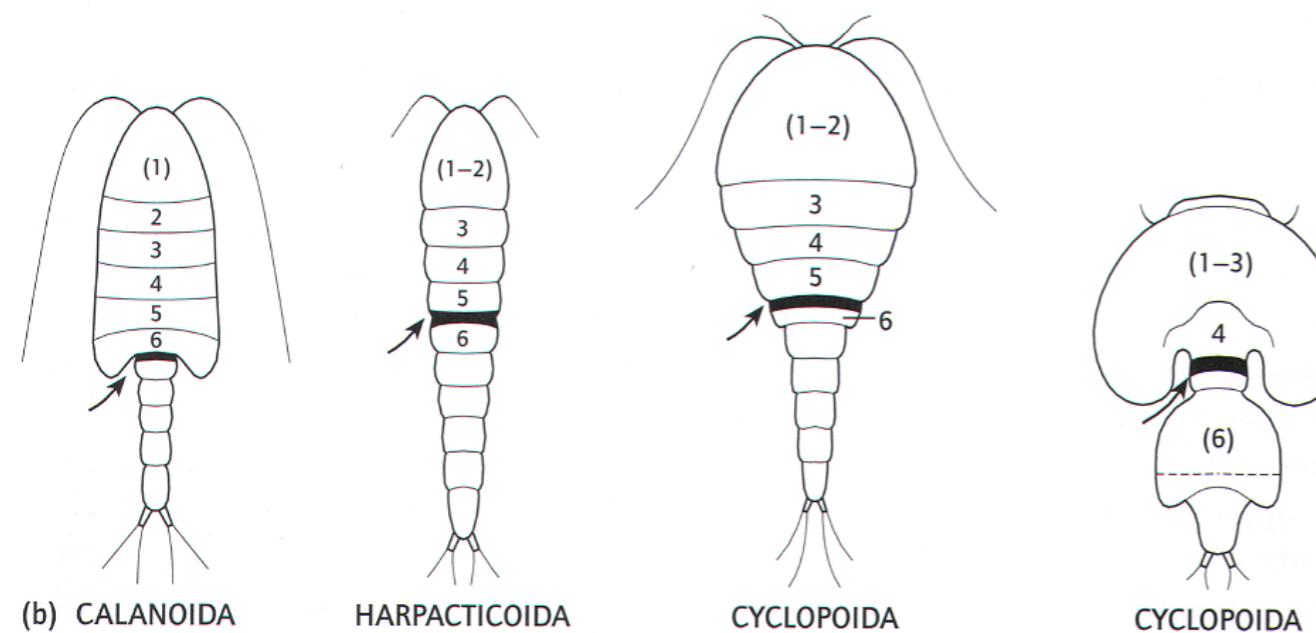
- Thorax with 6 segments, abdomen with 5 segments
- First segment of thorax fused to head
- Loss of all abdominal appendages
- Most species bear a single, “naupliar” eye

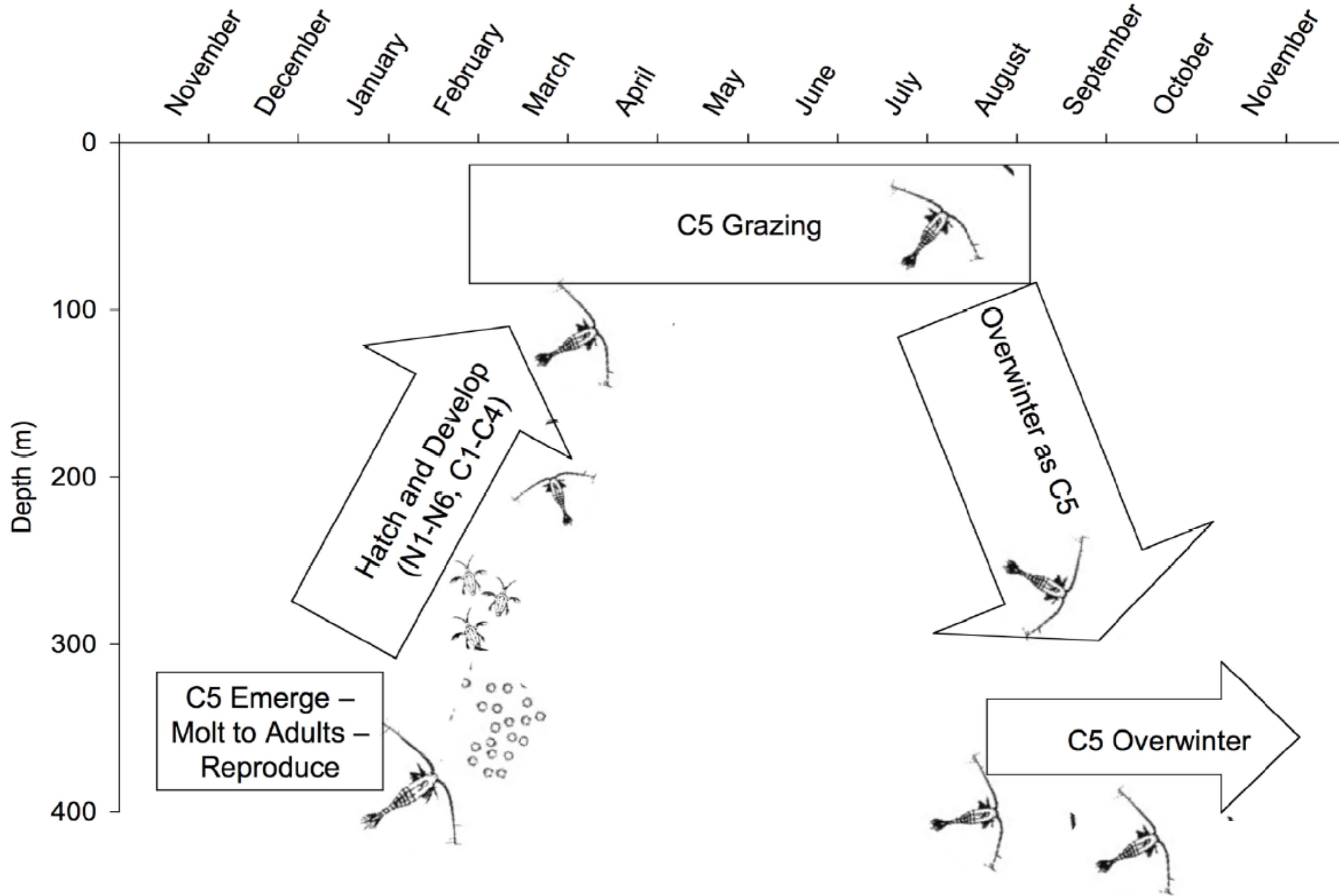
# Subclass Copepoda



(a)

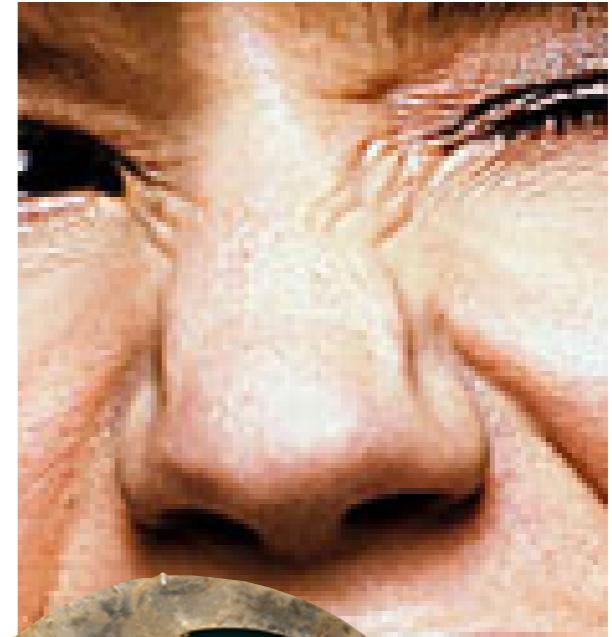
- Dominant member of plankton
- 25% parasitic
- Body parts
  - Head with well developed mouth parts and antenna
  - Segmented (6) thorax w/ limbs
- Dramatic diversity
  - Parasitic forms lose segmentation
- Lack carapace and compound eyes
- Eggs





# Subclass Pentastomida

- All are parasitic in the nasal passages of vertebrate hosts
- body bears only 2 pairs of appendages, with claws



# Subclass Pentastomida



An x-ray reveals tiny, cashew-shaped calcified cysts. From Despommier et al.

## Management and Therapy:

Pentastomiasis is only treated when it becomes a serious medical condition. In these cases, surgery is the most common treatment.

## Epidemiology:

Pentastomiasis is found mostly in tropical and subtropical areas. It's been reported relatively frequently in West Africa, where it infects the respiratory tracts of pythons and other reptiles. It has also been reported in certain parts of Europe. Infections have also been reported in the Americas (Drabek 1089).

## Public Health and Prevention Strategies:

Improved sanitation and food sterilization techniques will limit the spread of Pentastomiasis. Avoiding raw or undercooked foods and handling wild reptiles.

## Useful Web Links:

[A case study in Chicago, from Applied Radiology Online](#)

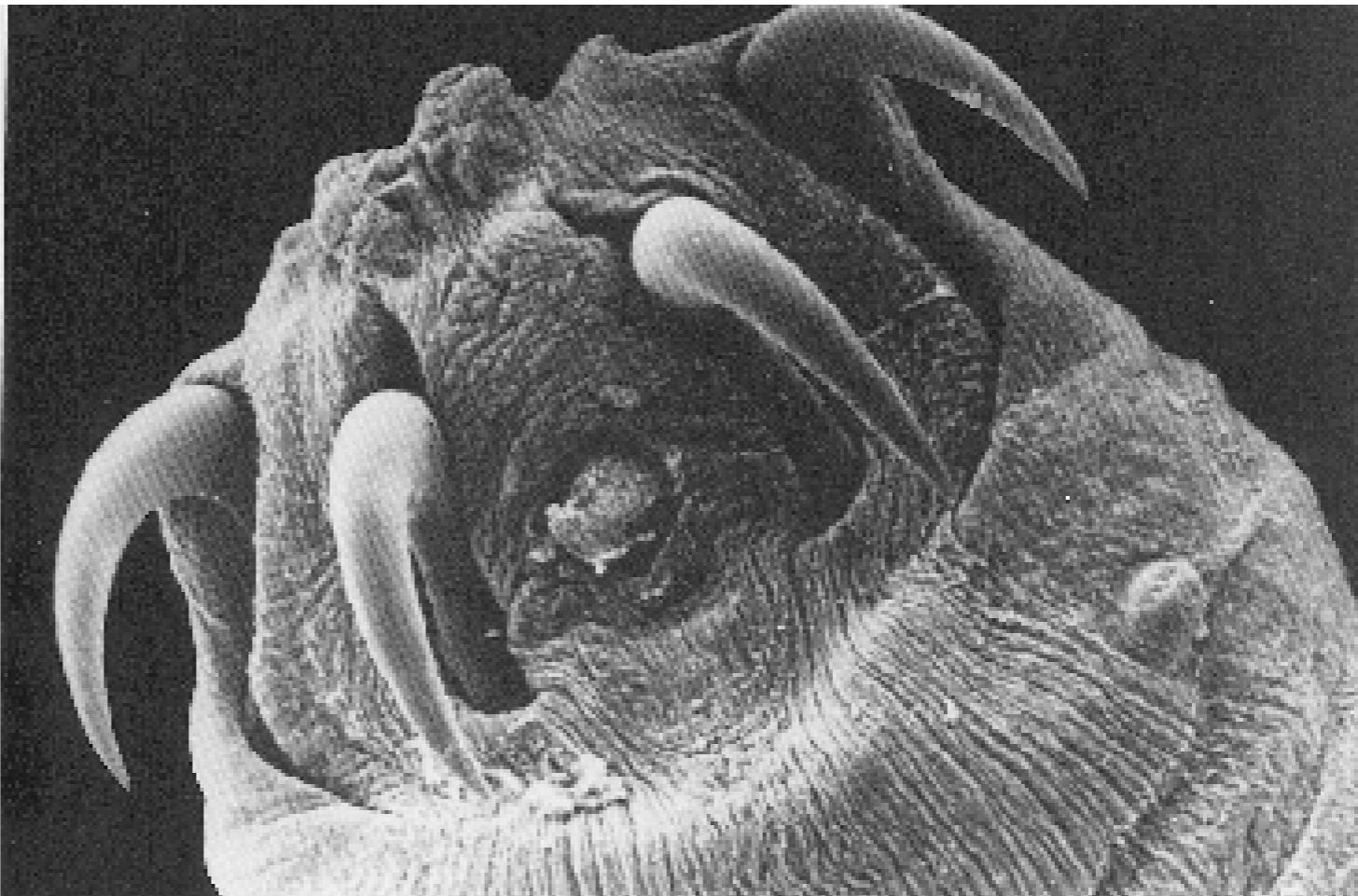
[2 photographs \(1 2\) of encysted larvae, from the Bristol Biomedical Image Archive.](#)

[A page about reptile parasites for concerned owners](#)

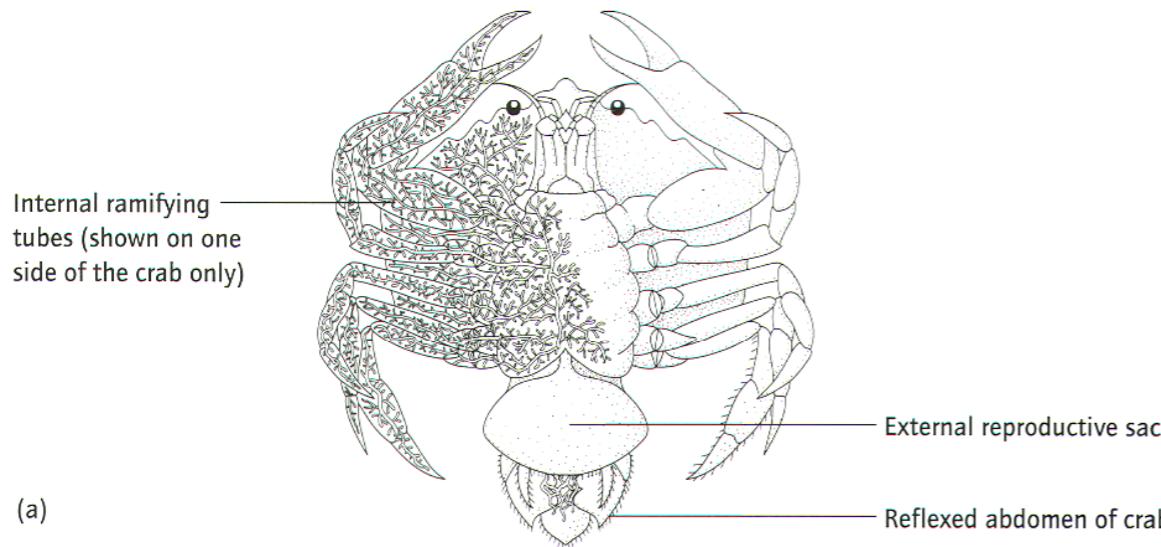
[A page of links to helpful parasite information](#)

## References:

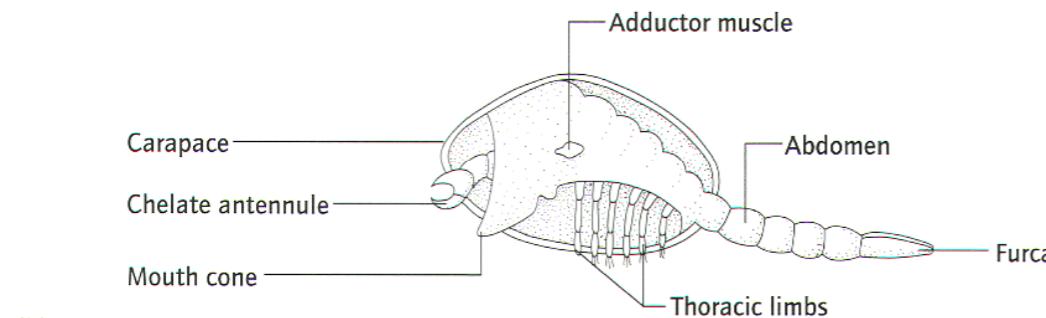
1. Cannon, D. A. "Linguatid Infestation of Man." *Annals of Tropical Medicine*, Vol. 36, No. 4, 1945.
2. Despommier, Dickson D., Gwadz, Robert W., Hotez, Peter J. *Parasitic Diseases*, 3rd ed. Springer, 2003.



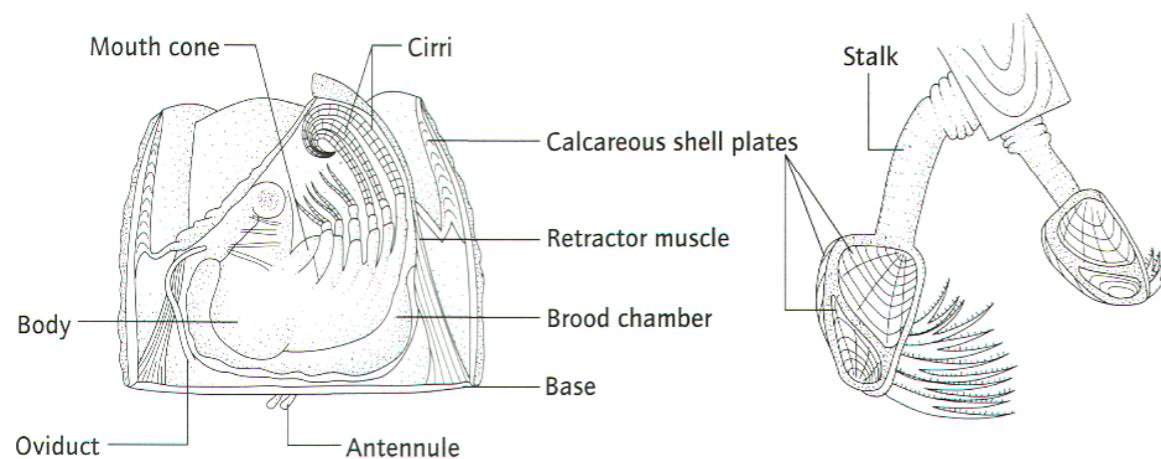
# Subclass Cirripedia



(a)



(b)



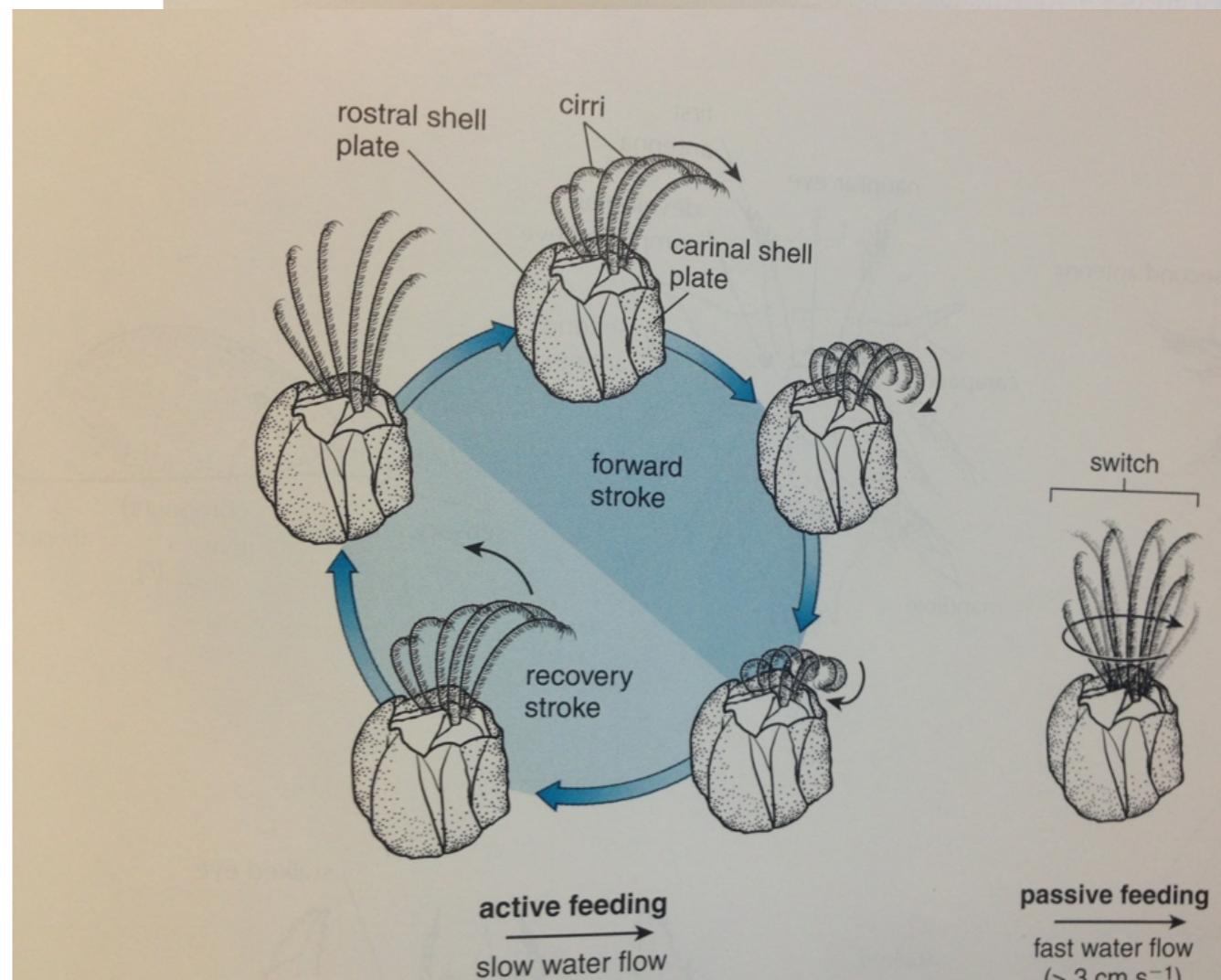
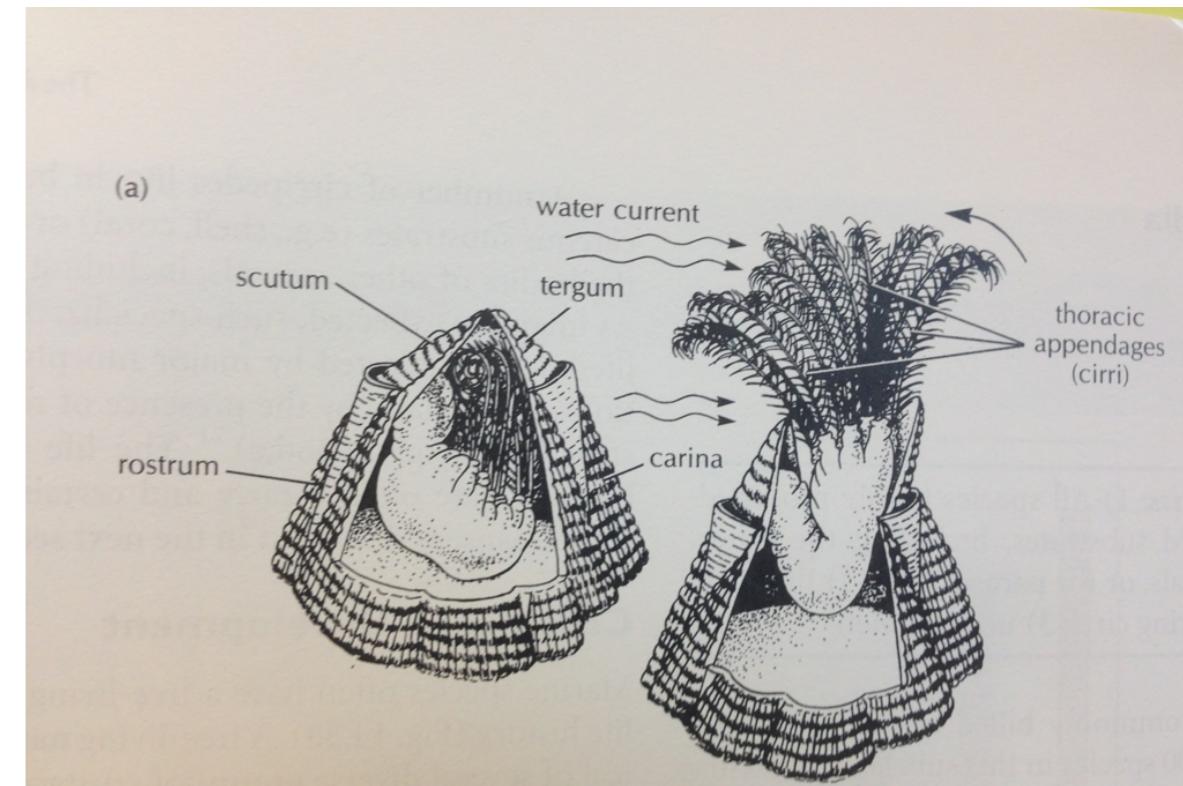
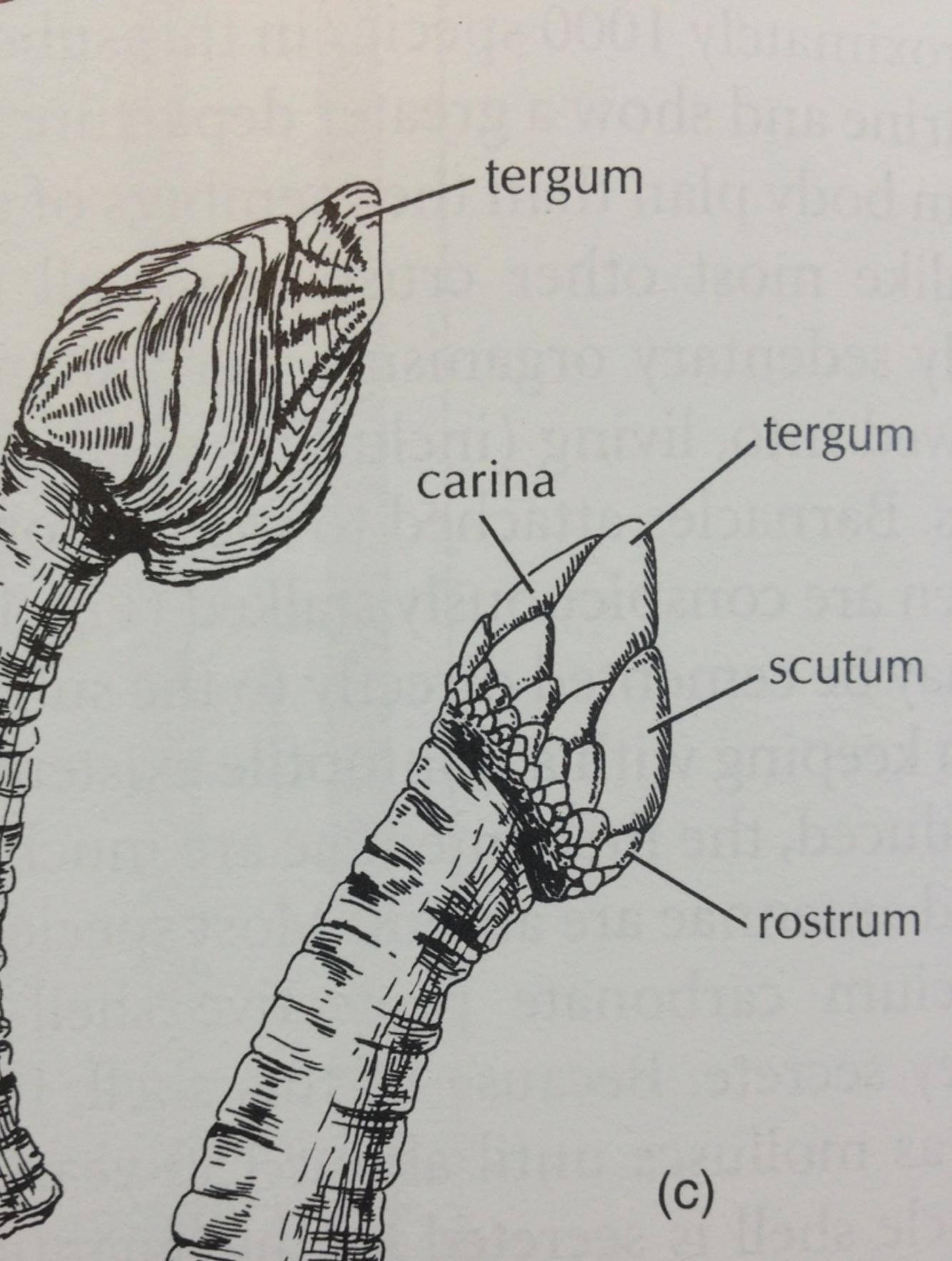
(c)

(d)

- Highly modified
  - Sessile or Parasites
- Headless
- Lack abdomen
- Little / No segmentation
- Rhizocephala
- Ascothoracica
  - Some chelate antennule
  - 6 pairs of swimming legs
  - Carapace
- Thoracica
  - “legs” becoming cirri
  - Reinforced carapace, calcareous
- Acrothoracica
  - Like barnacles w/o plates

**TRUE**

# Subclass Cirripedia



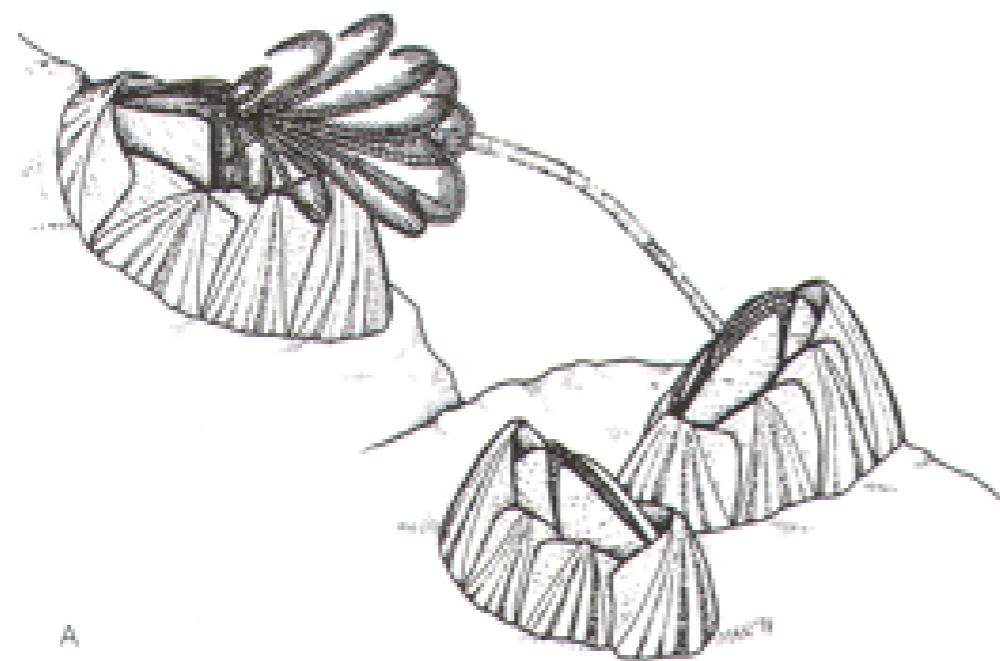
# Subclass Cirripedia



# Subclass Cirripedia

## Reproduction

- Many hermaphrodites
- External fertilization
  - Mantle cavity
- Some broadcast spawn





# Tanner or snow crab

## *Chionoecetes*

**Hardshell and softshell mating**

**Only morphologically mature males can mate with hardshell females**



**Female mound**



B. Stevens



# Tidal phasing of larval launch pads?

BRADLEY G. STEVENS & JAN A. HAAGA

*National Marine Fisheries Service, Kodiak Laboratory, Kodiak, USA*

WILLIAM E. DONALDSON

*Alaska Dept. of Fish and Game, Kodiak, USA*

## ABSTRACT

Female Tanner crabs, *Chionoecetes bairdi*, aggregate and form mounds at a deepwater (150 m) site in the spring (Stevens et al. 1994). This paper reviews observations of crab behavior, which were made each spring for 6 years (1991-1995, and 1998), via submersible, ROV, and/or video camera sled in Chiniak Bay, Alaska. Timing of mound formation was compared to water temperature, lunar cycle, tidal exchange, storm frequency, and Secchi disk depth. Mound formation was observed in 3 years (1991, 1994, and 1995) within 0-4 days of the maximum spring tide; no other environmental indicator was coincident. Crabs captured from mounds (1991, 1995) were observed releasing larvae in tanks or buckets, whereas crabs captured prior to mound formation (1995) or afterwards (1992, 1998) were not releasing larvae. Based on these data, we hypothesize that mound formation is triggered by tidal rhythms associated with the highest spring tide in April or May, coincides with larval release, and functions to improve larval dispersal by elevating spawners above the bottom sediments.