Arthropods

Lec 14

fish310

Phylum Arthropoda

Phylum Arthropoda

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...

- nutrition
- a little appendage loss
- reproduction
- development

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Nutrition

Ancestral feeding

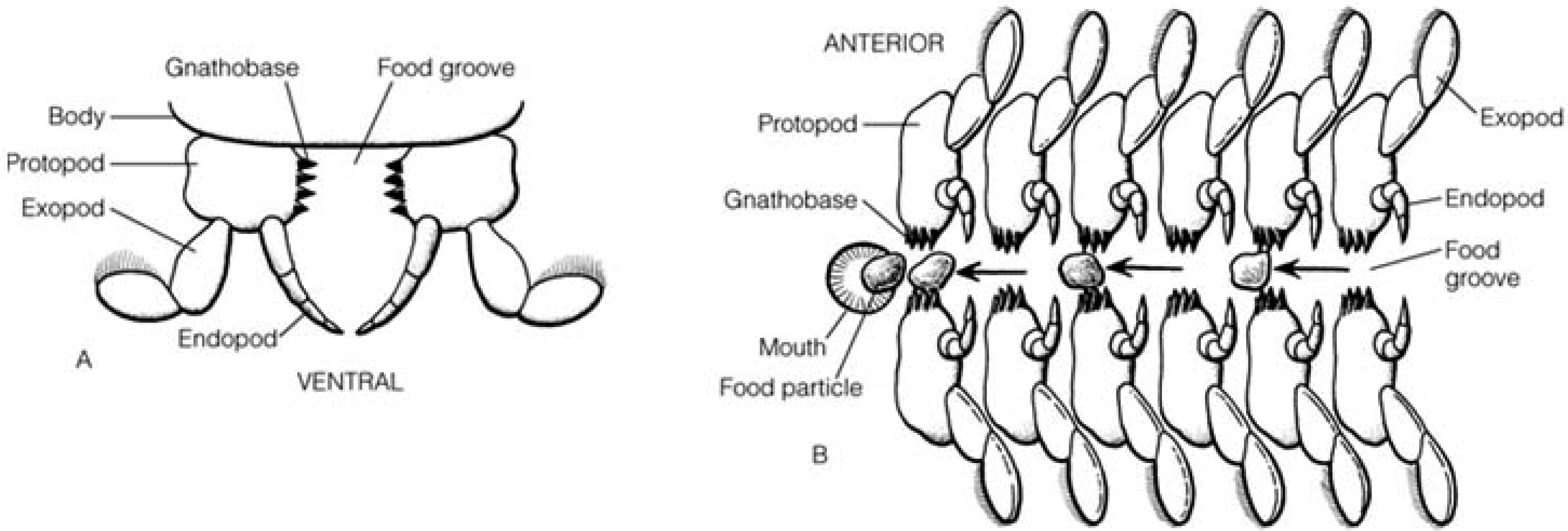
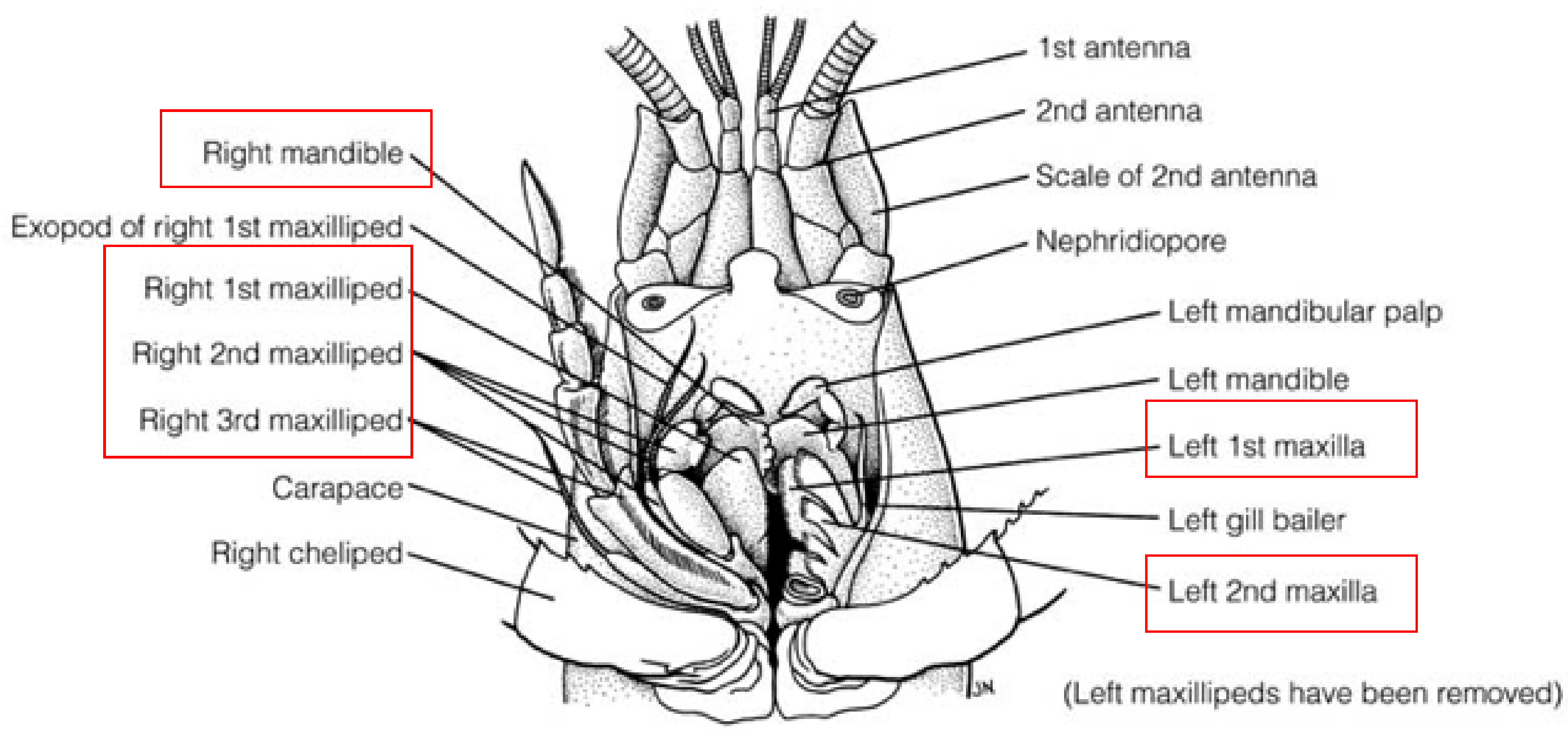


Figure 19-4: **Feeding mechanism of the ancestral crustacean. A, Cross section through a trunk segment showing a typical pair of mixopods. The exopod is a phyllopod, the endopod is a stenopod, and the protopod has a medial gnathobase. B, Ventral view of the anterior trunk, showing the food groove and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

Feeding

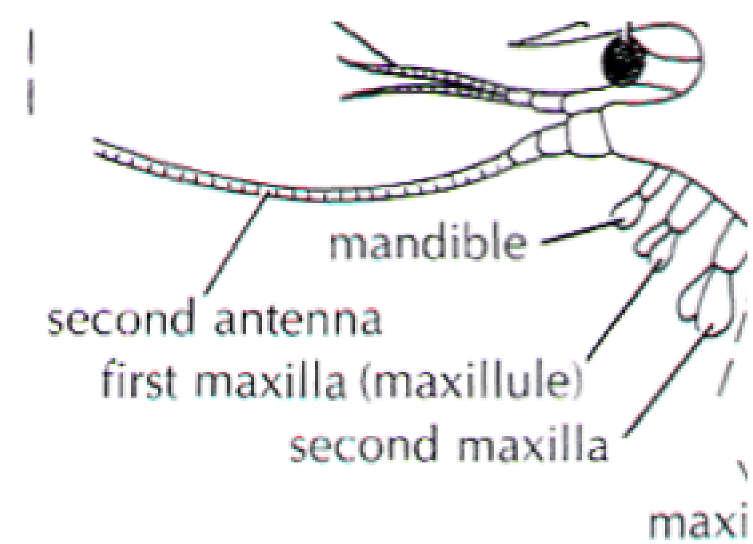
Six pairs of appendages are associated with the decapod mouth

- 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

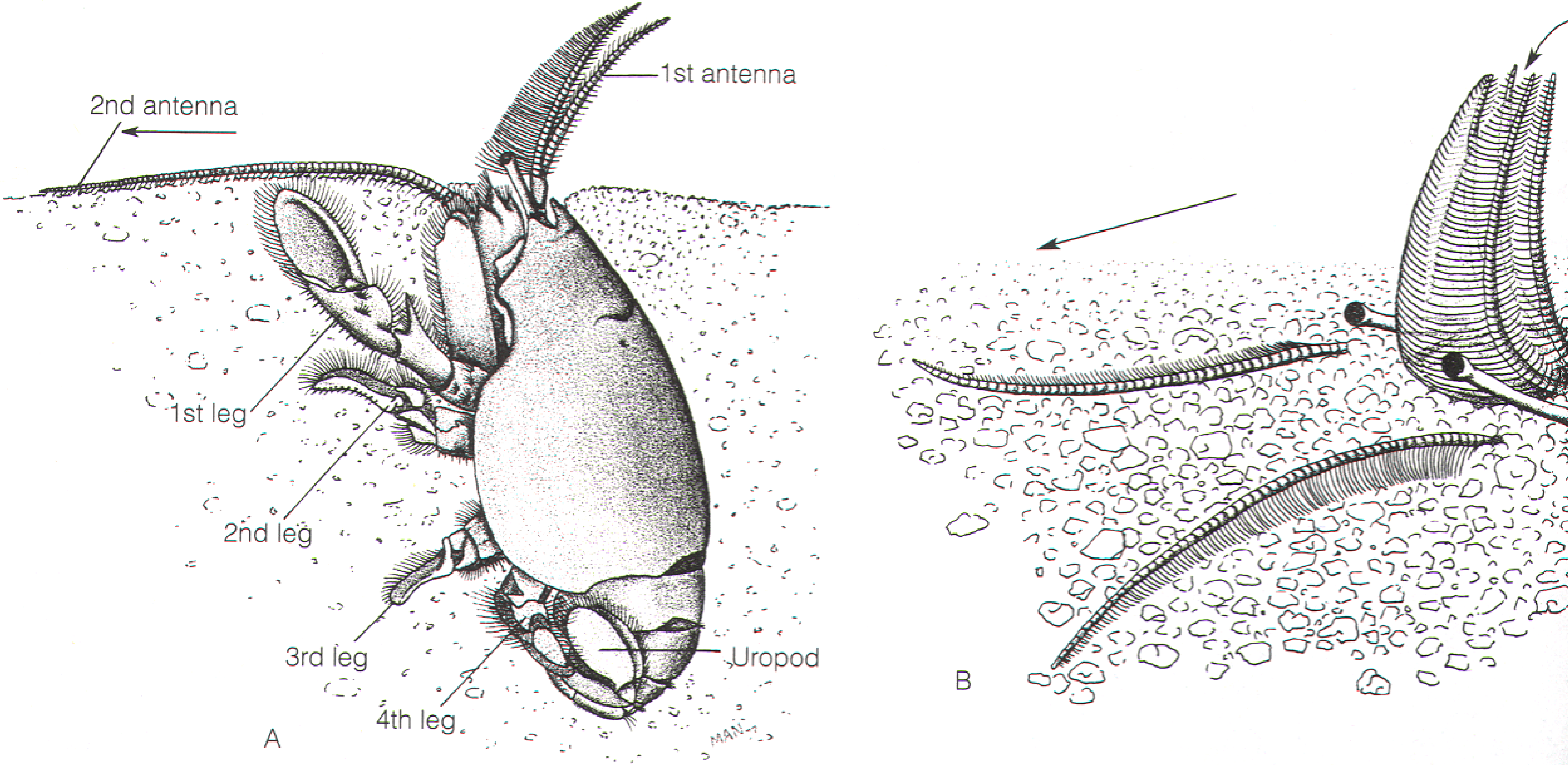


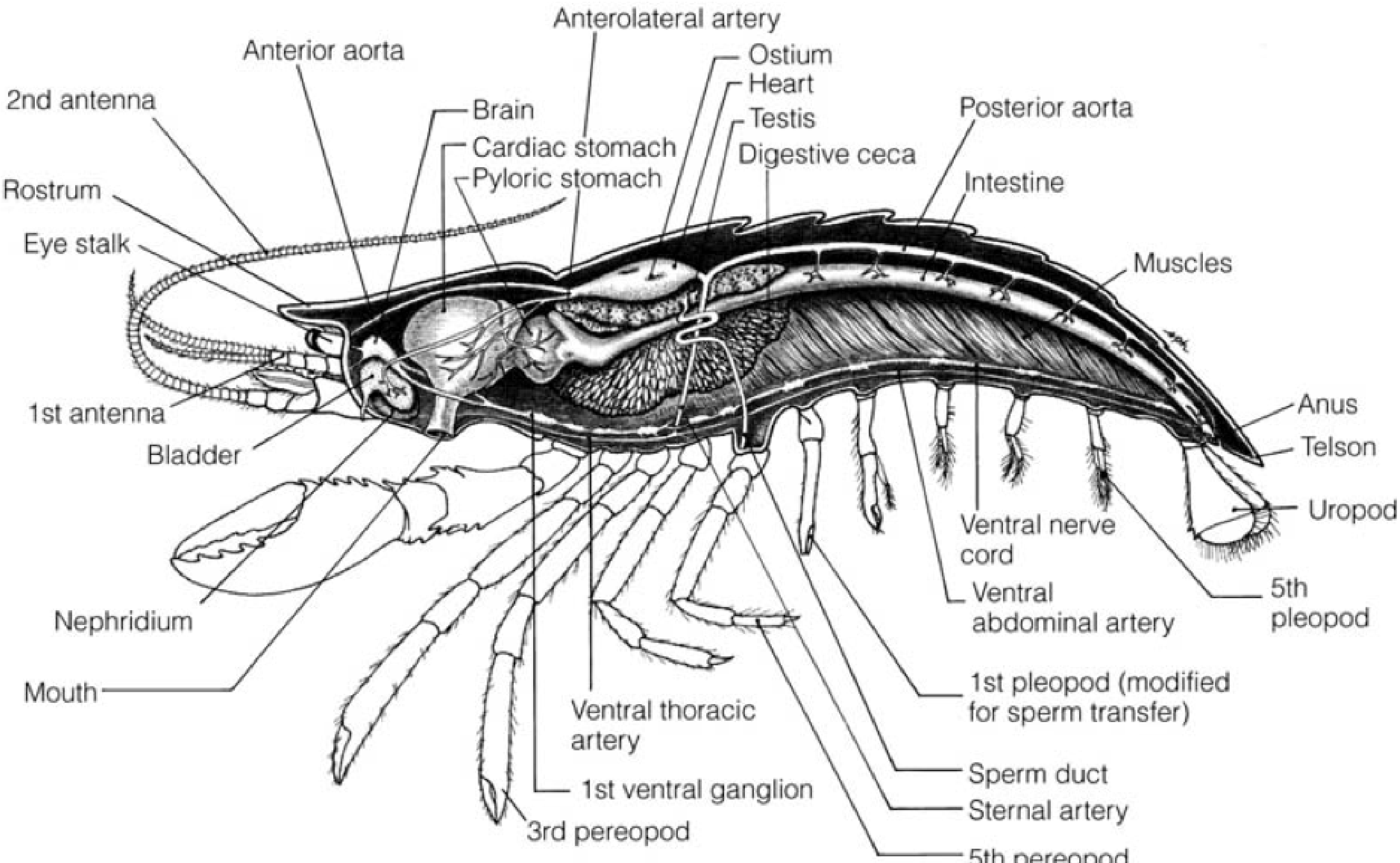
FIGURE 19-29 Decapoda, Anomura: *Emerita talpoida,* the mole crab, in the superfamily Hippoidea. This is a common crab on surf-swept beaches along the east coast of the United States. **A,** Lateral view of the animal buried in the sand. **B,** Surface view of the buried animal. The first antennae form 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

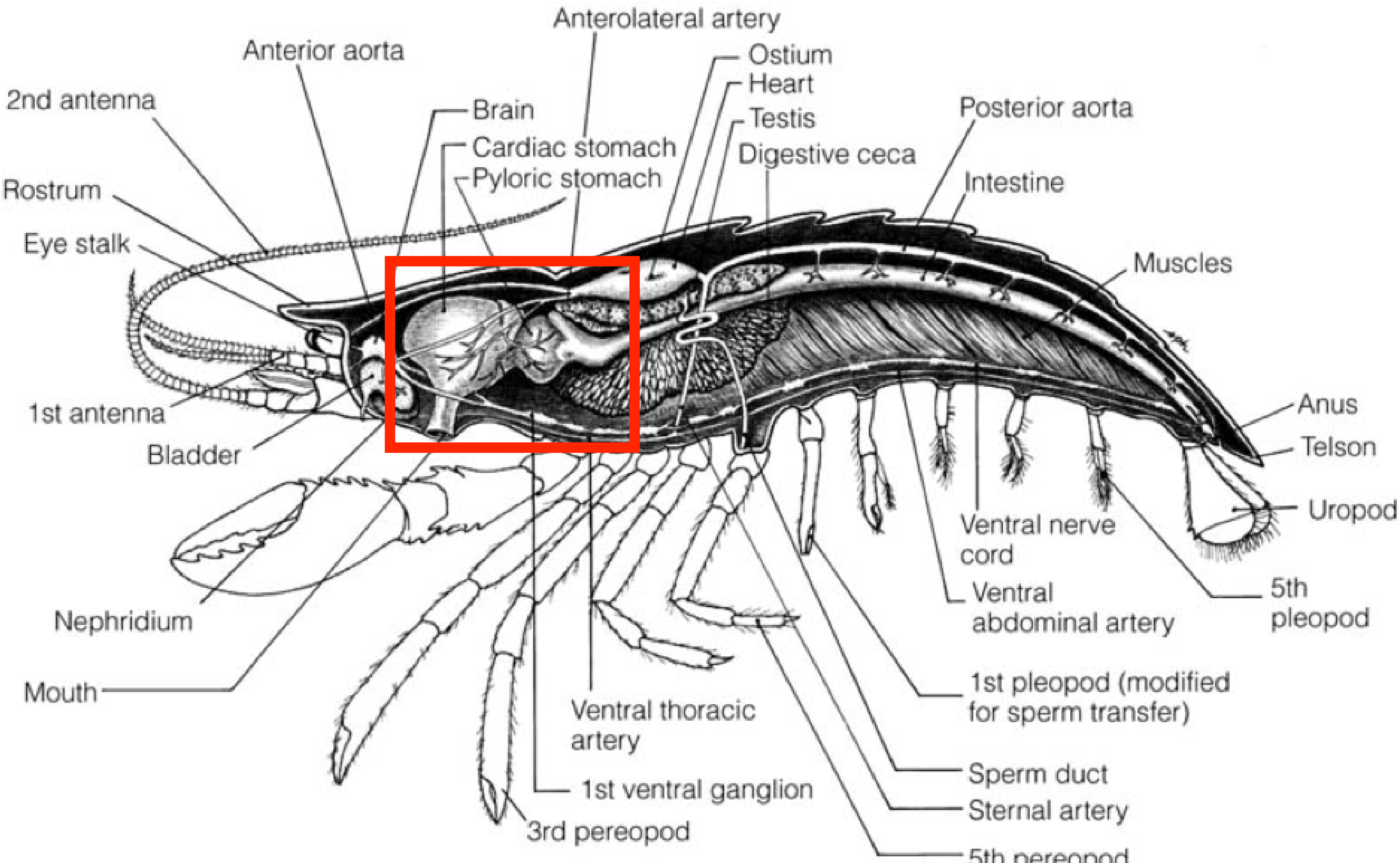
- Uses uropod and fourth leg to dig
- Antennae and eyestalks extended above the sand
- Feeds on receding wave

Digestion

Digestion


Anterolateral artery
Anterior aorta
Ostium
Heart
2nd antenna
Brain
Testis
Posterior aorta
Cardiac stomach
Digestive ceca
Pyloric stomach
Intestine
Rostrum
Eye stalk
Muscles
1st antenna
Anus
Telson
Bladder
Uropod
Ventral nerve cord
Ventral abdominal artery
5th pleopod
Nephridium
1st pleopod (modified for sperm transfer)
Mouth
Ventral thoracic artery
Sperm duct
1st ventral ganglion
Sternal artery
3rd pereopod
5th pereopod

Digestion



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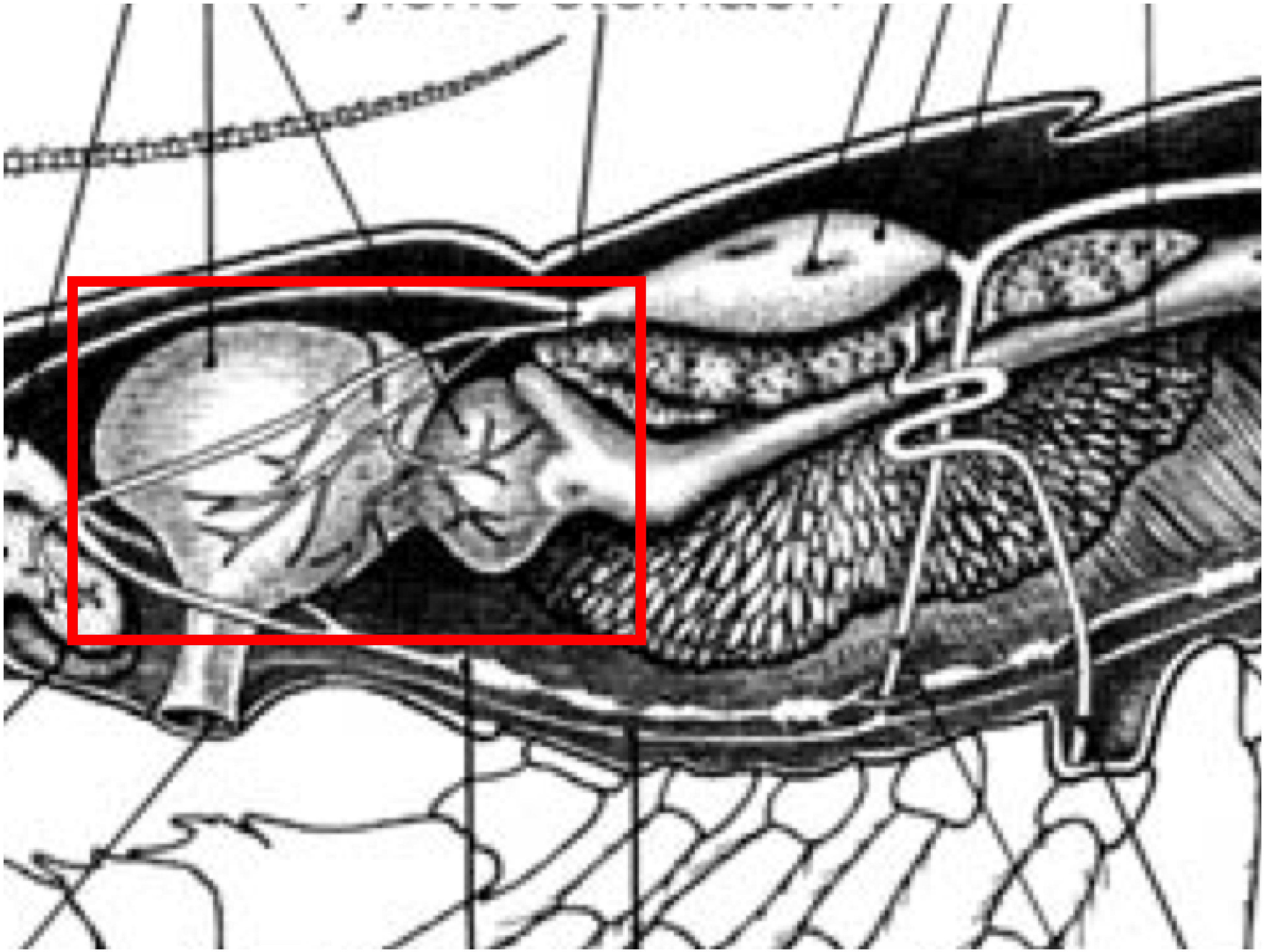
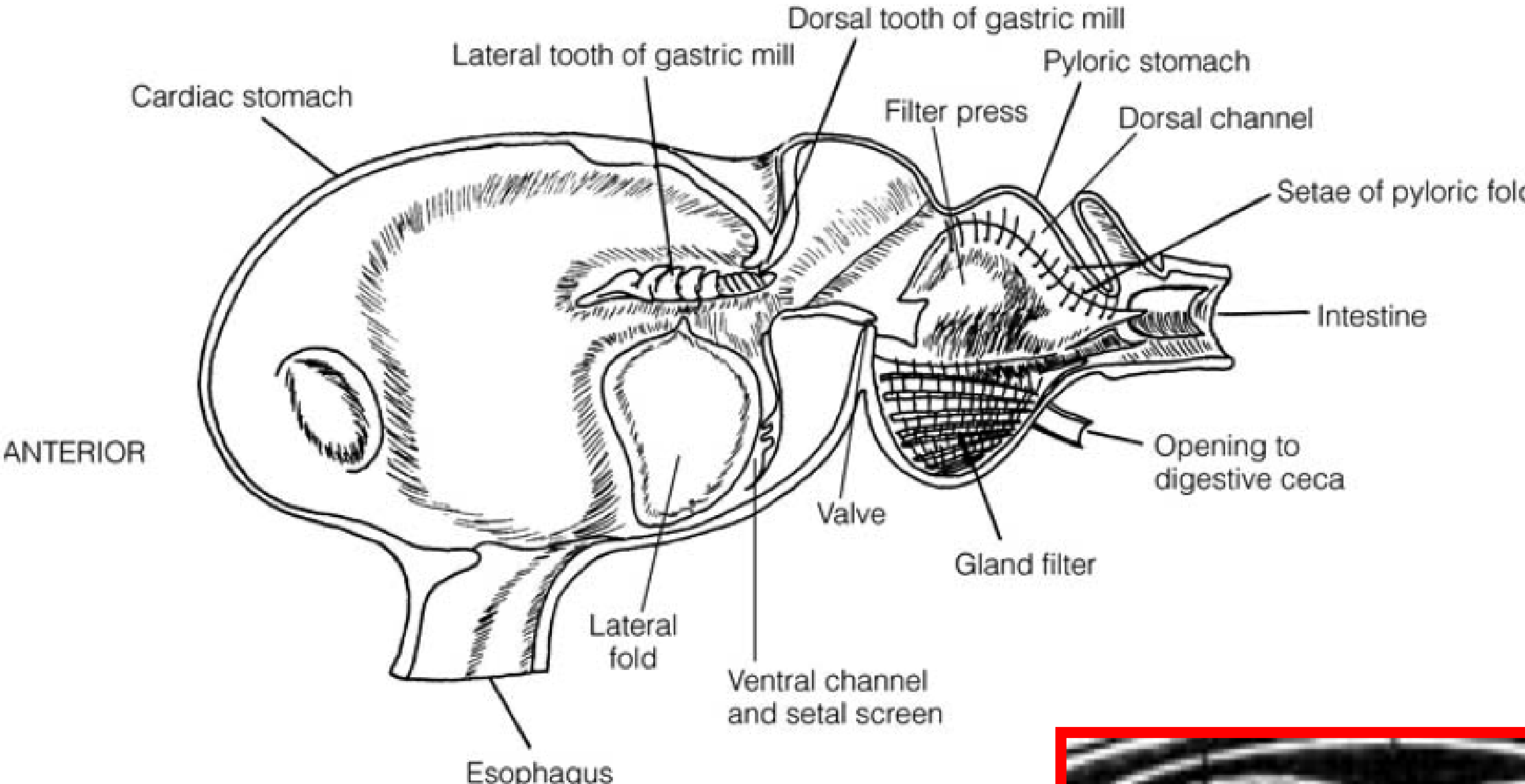
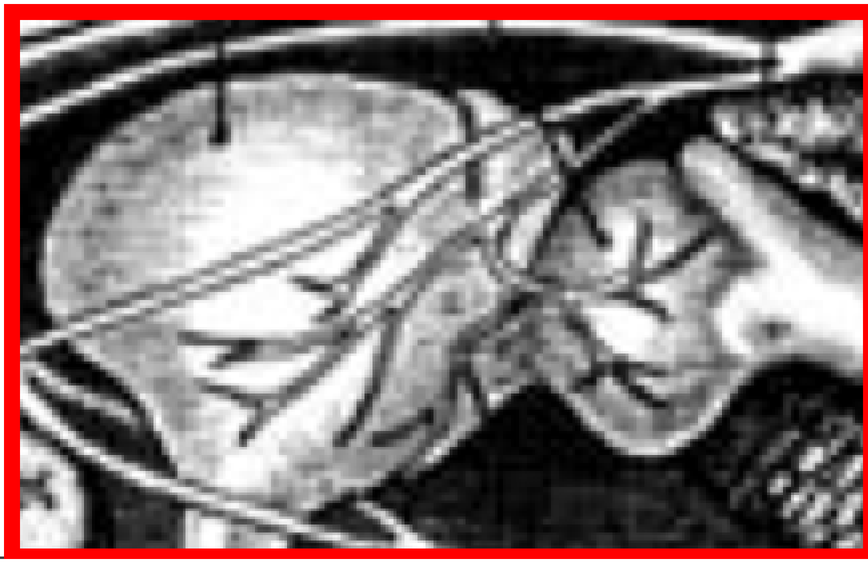


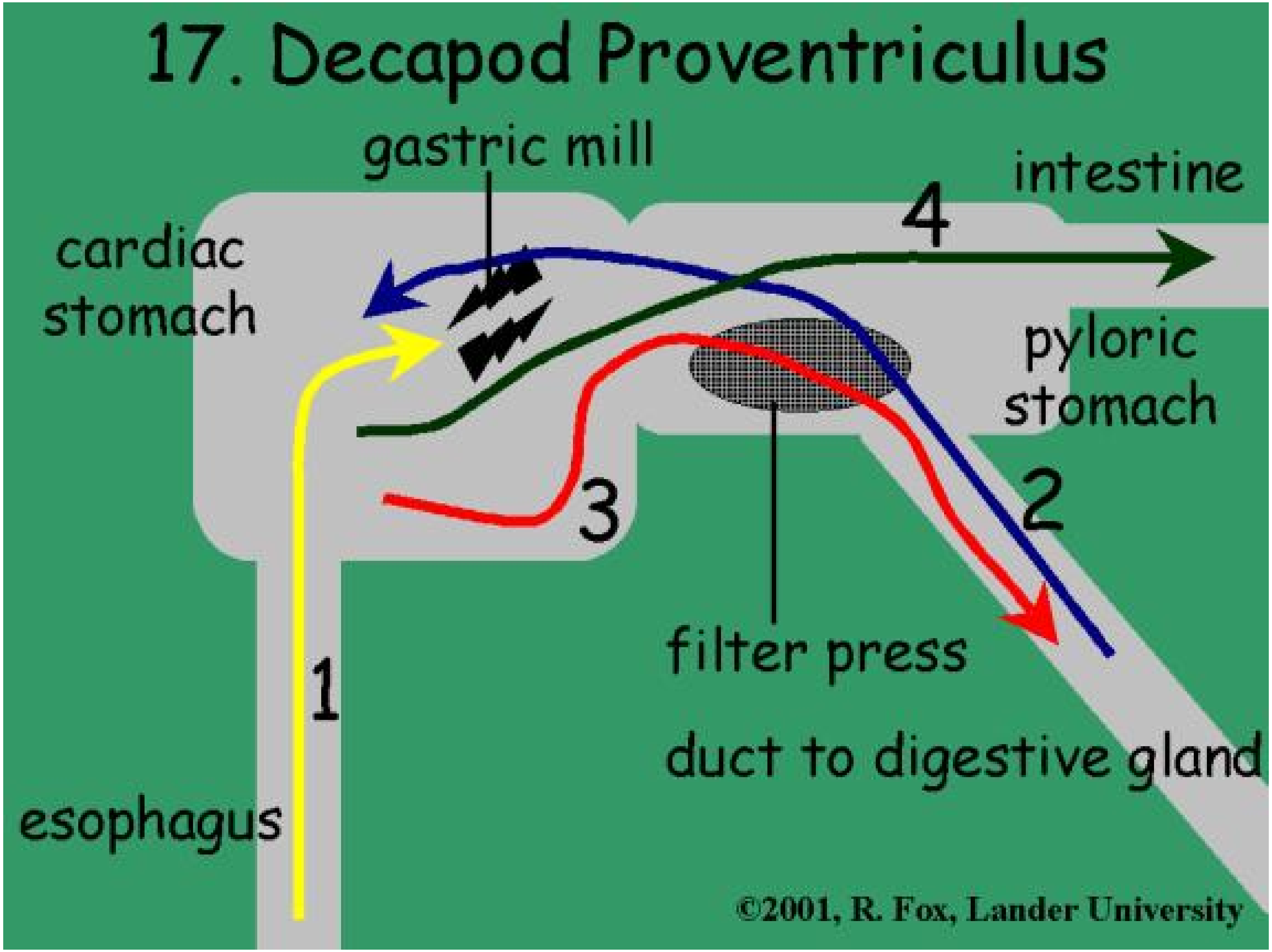
Digestion



Dorsal tooth of gastric mill
Lateral tooth of gastric mill
Pyloric stomach
Cardiac stomach
Filter press
Dorsal channel
Setae of pyloric fold
Intestine
ANTERIOR
Opening to
digestive ceca
Valve
Gland filter
Lateral
fold
Ventral channel
and setal screen
Esophagus

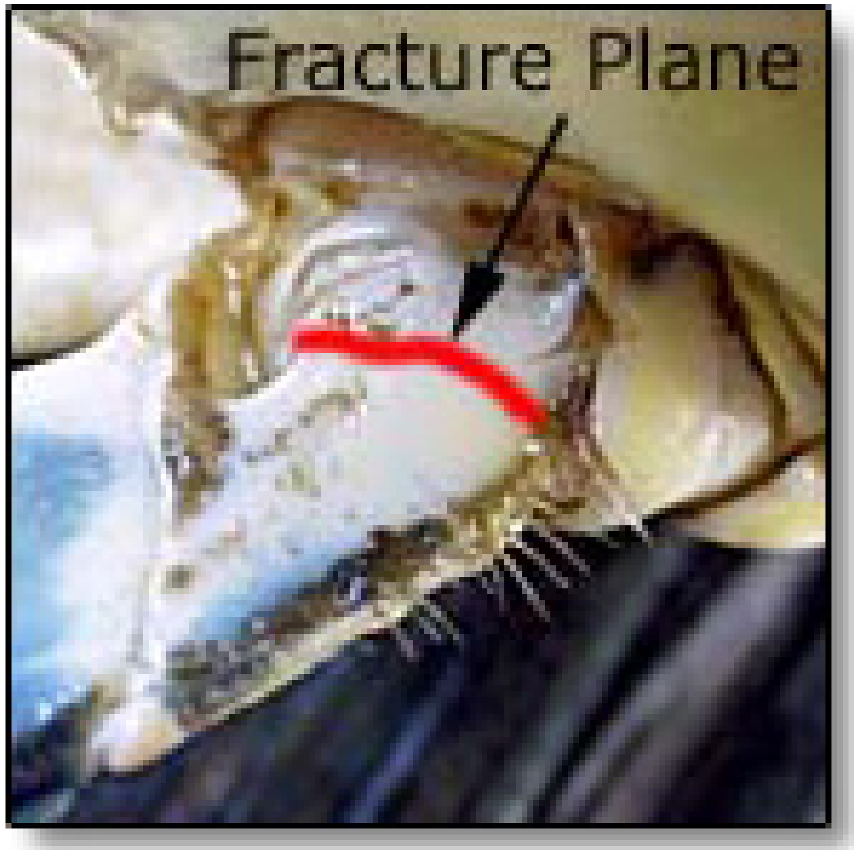


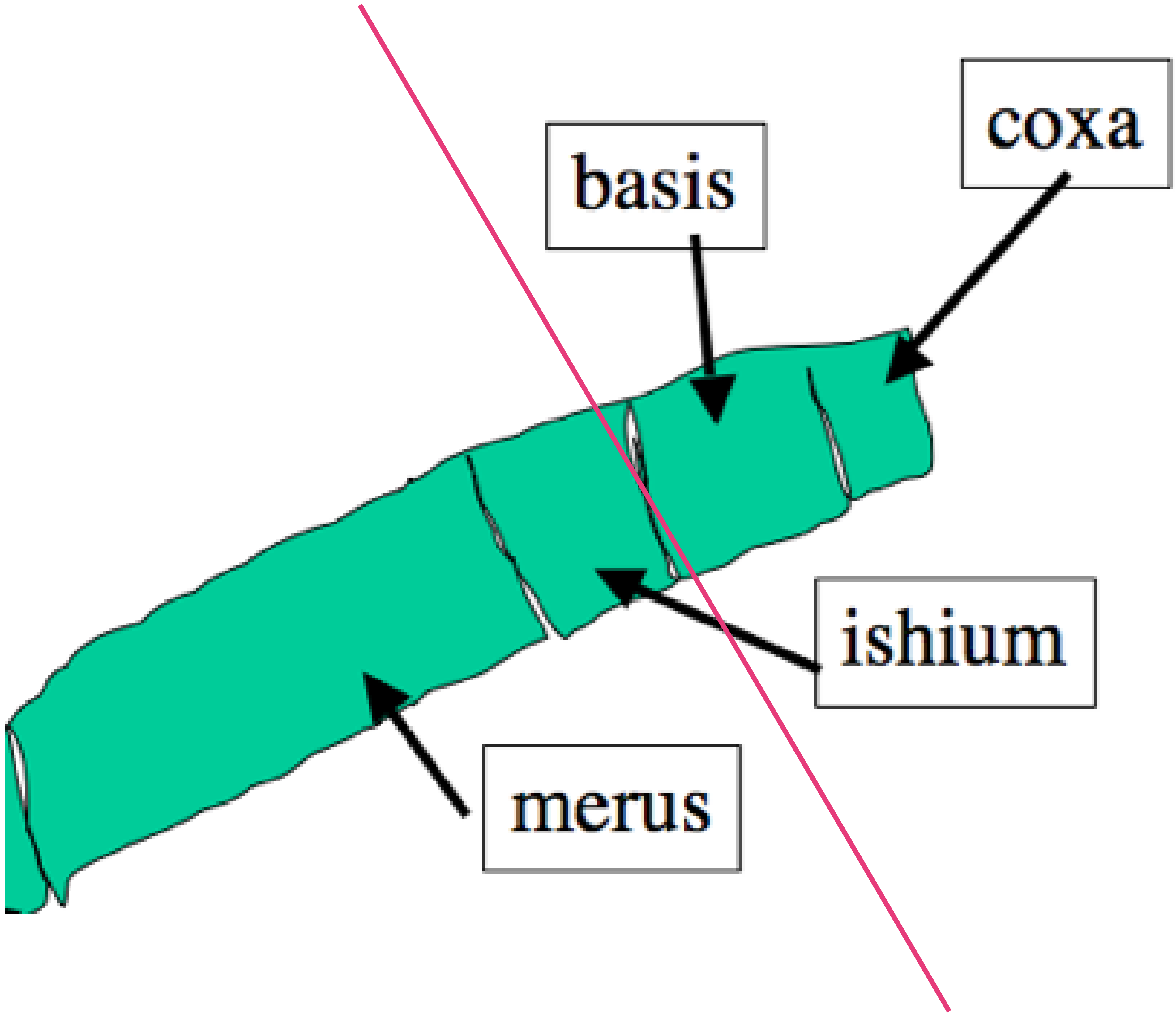
Digestion


17. Decapod Proventriculus
gastric mill
intestine
4
cardiac
stomach
pyloric
stomach
3
2
1
filter press
duct to digestive gland
esophagus
©2001, R. Fox, Lander University

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


Fracture Plane


basis
coxa
ishium
merus

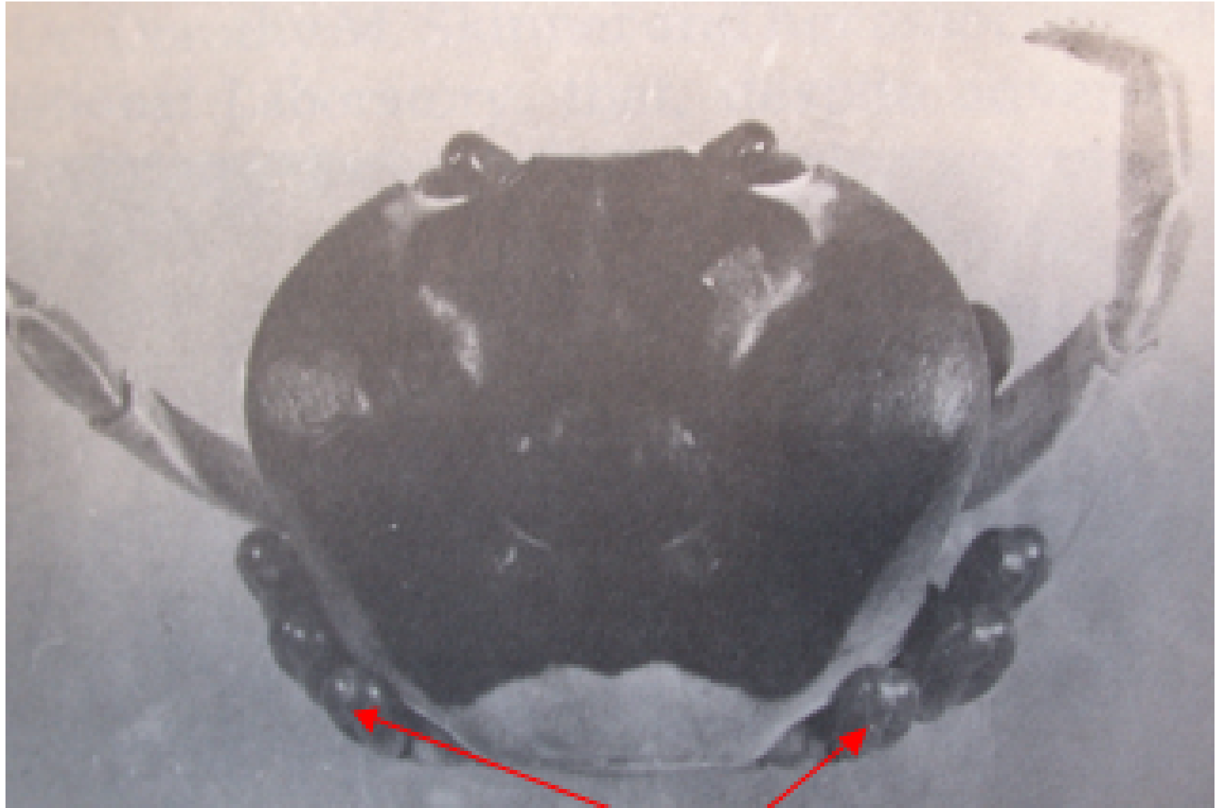
Autotomy

- 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

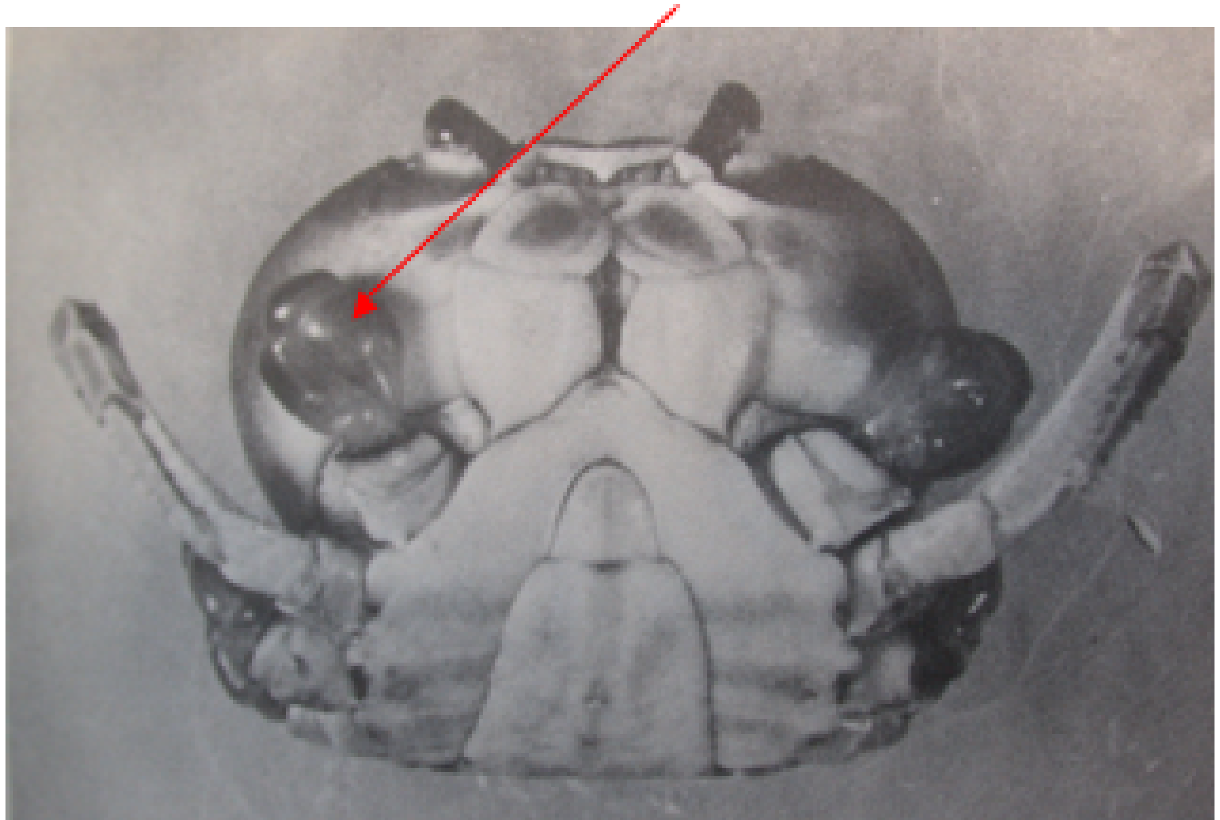
Before

After

Petrolisthes eriomerus



Limb buds



Bliss

Reproduction

Pheromones

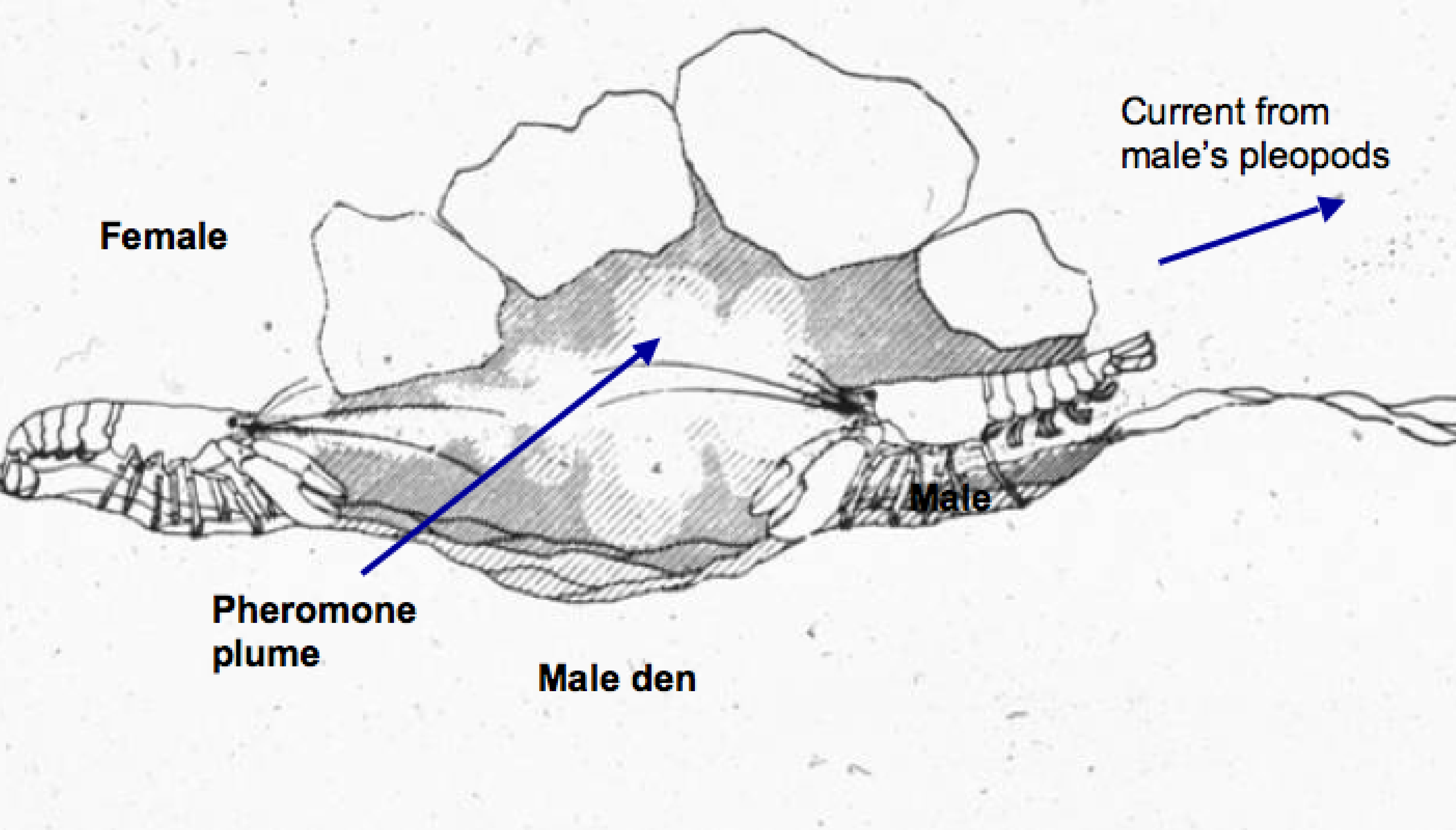
- **Strict definition: "Chemical produced by an organism that influences the behavior of another"**

- **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



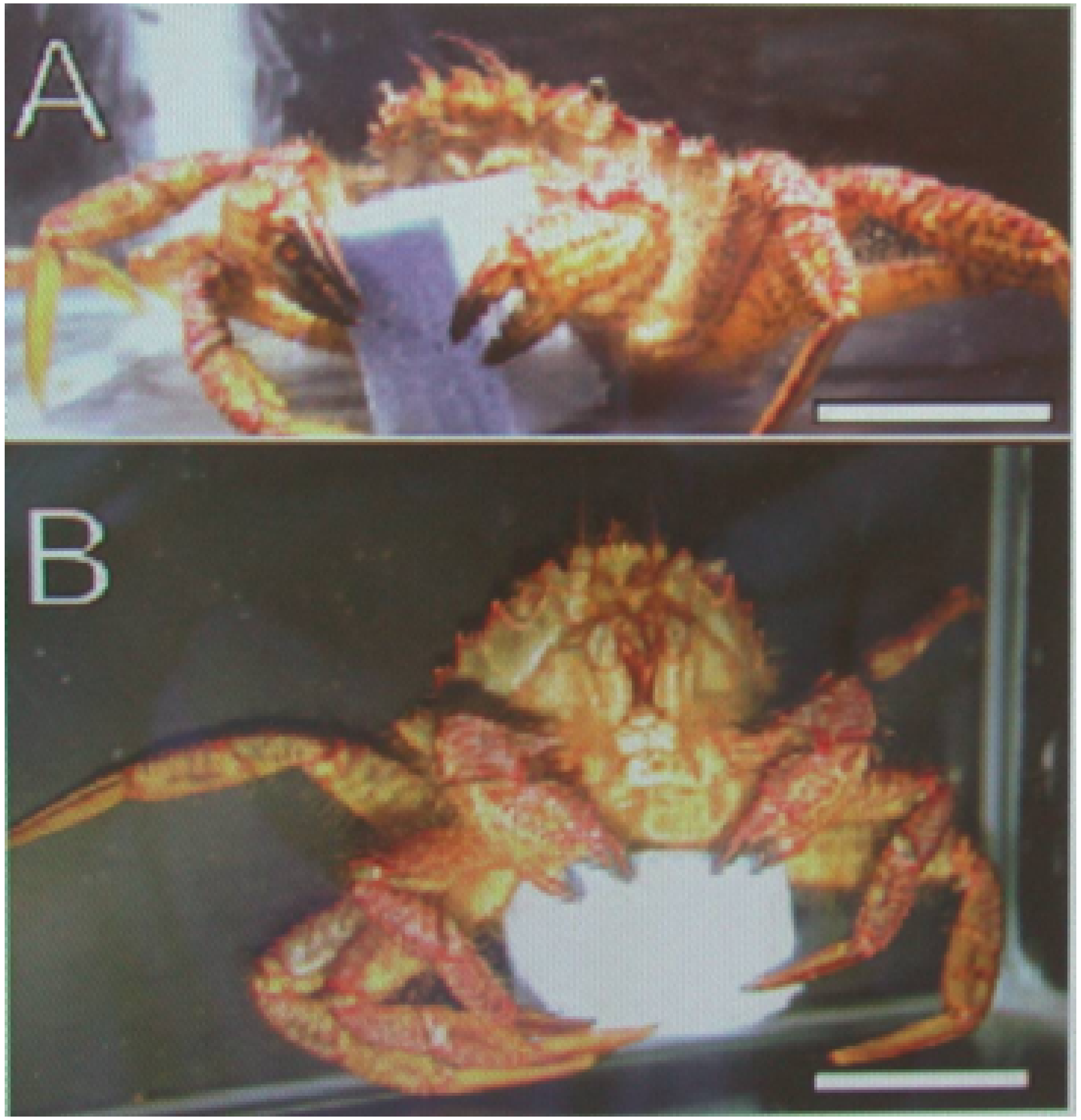
Atema 1986

Pheromones

Breithaupt & Eger

Pheromones

Kamio et al 2002

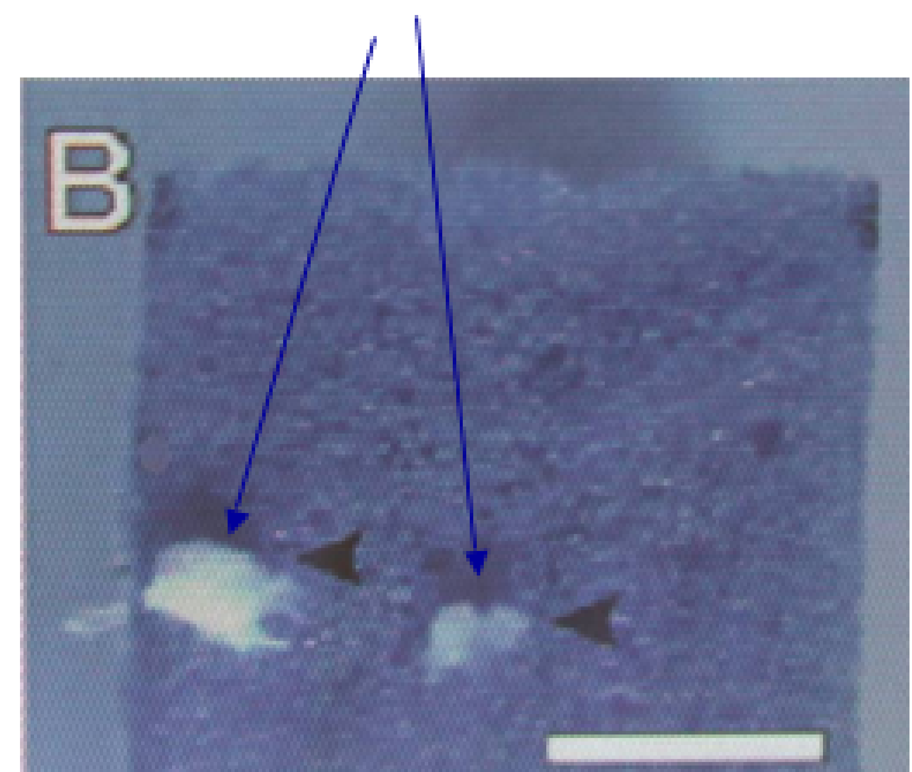


Telmessus

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

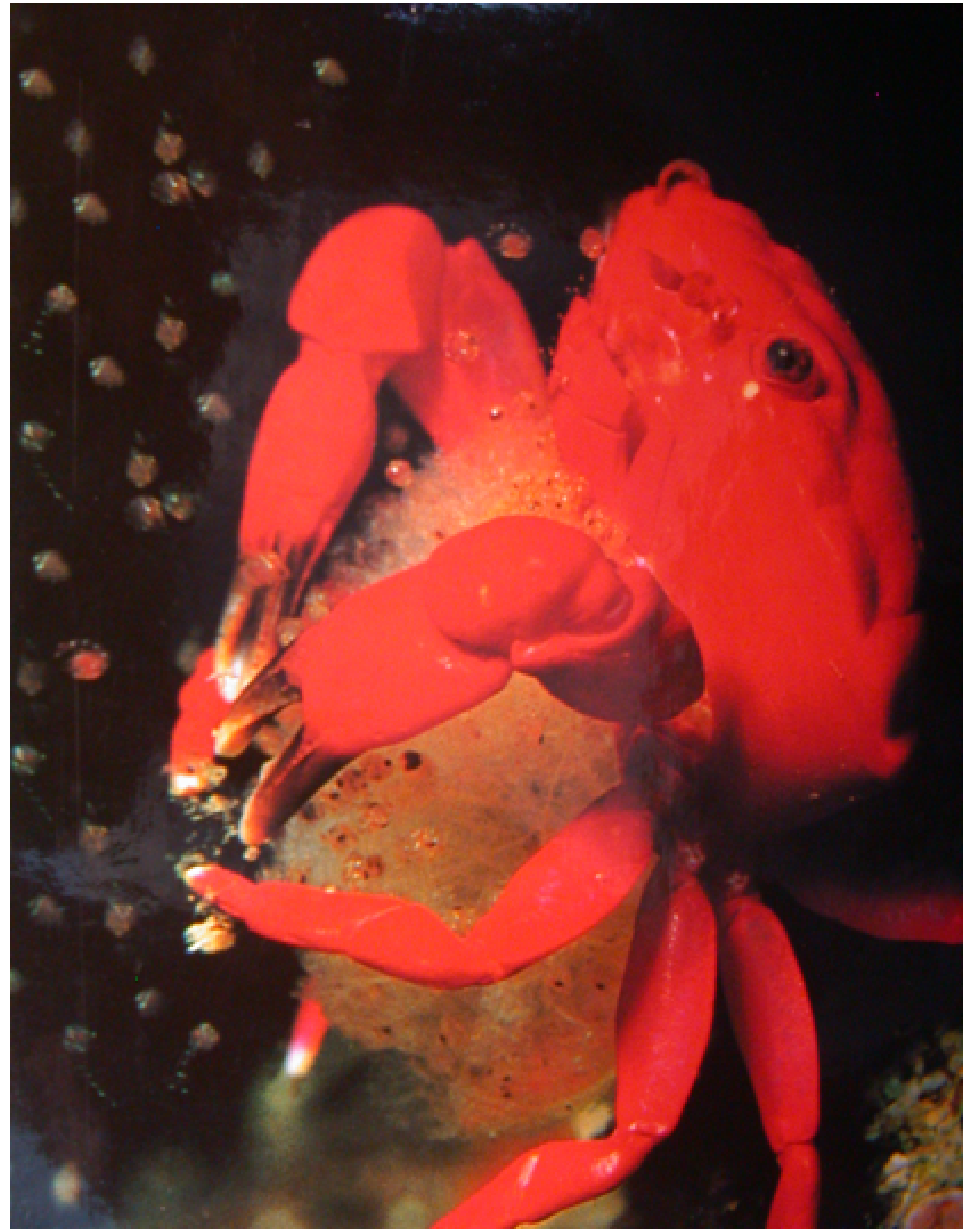
- With the exception of penaeid shrimps, all decapods brood their eggs on their pleopods
- Development times vary from several weeks to a year or more: larger eggs take longer to hatch
  - Biggest eggs hatch into large, lecithotrophic larvae—reproduction is year round in these species
  - Hatch for most 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

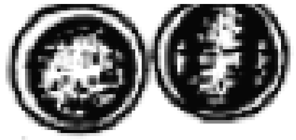
Brachyura- all eggs usually hatched at same time (minutes to hours)

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



H. Januschke

Length of larval stages varies with species and environment: days to months



1. Eggs

Shrimp eggs are thought to sink to the bottom at the time of spawning. Egg diameter is less than 1/64 inch. Most spawning is believed to occur in high salinity oceanic waters.

2. Nauplius

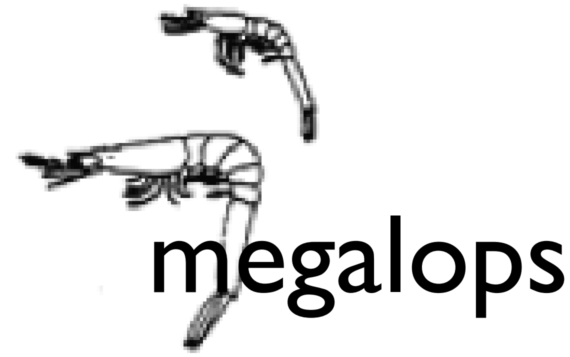
There are five naupliar stages. The first stage is about the size of the egg and succeeding stages are slightly larger. Nauplii have limited swimming ability and usually are a part of the oceanic plankton.

3. Protozoea

The three protozoeal stages range in size from 1/25 to 1/12 in. These planktonic forms are found in oceanic waters. Protozoea have undergone development of their mouth parts and the abdomen has begun to develop.

4. Mysis

There are three mysid stages ranging in size from 1/8 to 1/5 in. These are planktonic in the ocean. Mysids have early development of legs and antennae.

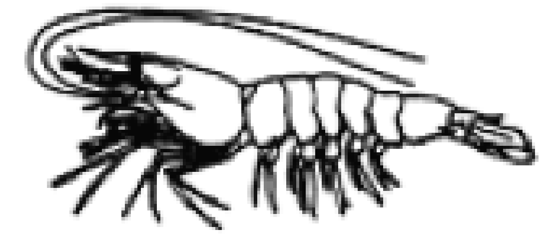


5. Postlarva

The two postlarval stages for white shrimp are about 1/6 to 1/4 in. Brown shrimp postlarvae are larger, up to 1/2 in. The walking and swimming legs have developed and the postlarvae appear as miniature shrimp. The second postlarval stage rides the flood tides into the estuaries, apparently becoming active during flood tide and settling to the bottom during ebb tides. The postlarvae ultimately settle in the upper parts of tidal creeks.

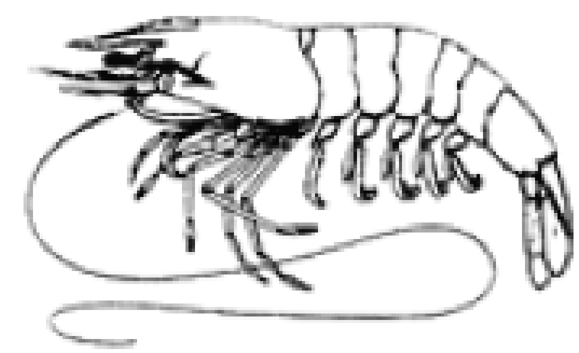
6. Juvenile

Postlarval shrimp develop directly into juvenile shrimp. Growth is rapid, up to 2 1/2 inches per month. Juveniles are similiar to adults except they are characterized by amuch longer rostrum (horn). Juveniles typically remain in the marsh creeks until reaching about 4 to 4 1/2 inches before moving into the deeper rivers.



7. Sub-adults

Sub-adults move into the deeper waters of the estuaries and may remain there for a month or more before moving seaward. These shrimp continue to grow but at a slower rate than juveniles. Sub-adults usually do not exhibit any signs of ovarian maturity.



8. Adults

Adults may be 5 to 8 inches in length. Adults are usually found in the ocean, but in dry years may delay migration until cold weather occurs. Spawning females are characterized by brightly colored ovaries that can be seen under the shell on the upper side of the body. Adults may be found near the beaches out to 5 or 6 miles from shore. Some species are known to migrate hundreds of miles along the coast.

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

LOCOMOTION

N P Z M M ..

N P Z M M ..

<u>N</u>ever <u>P</u>lay w/a <u>Z</u>ebra <u>M</u>ussel's <u>M</u>antle

Classification

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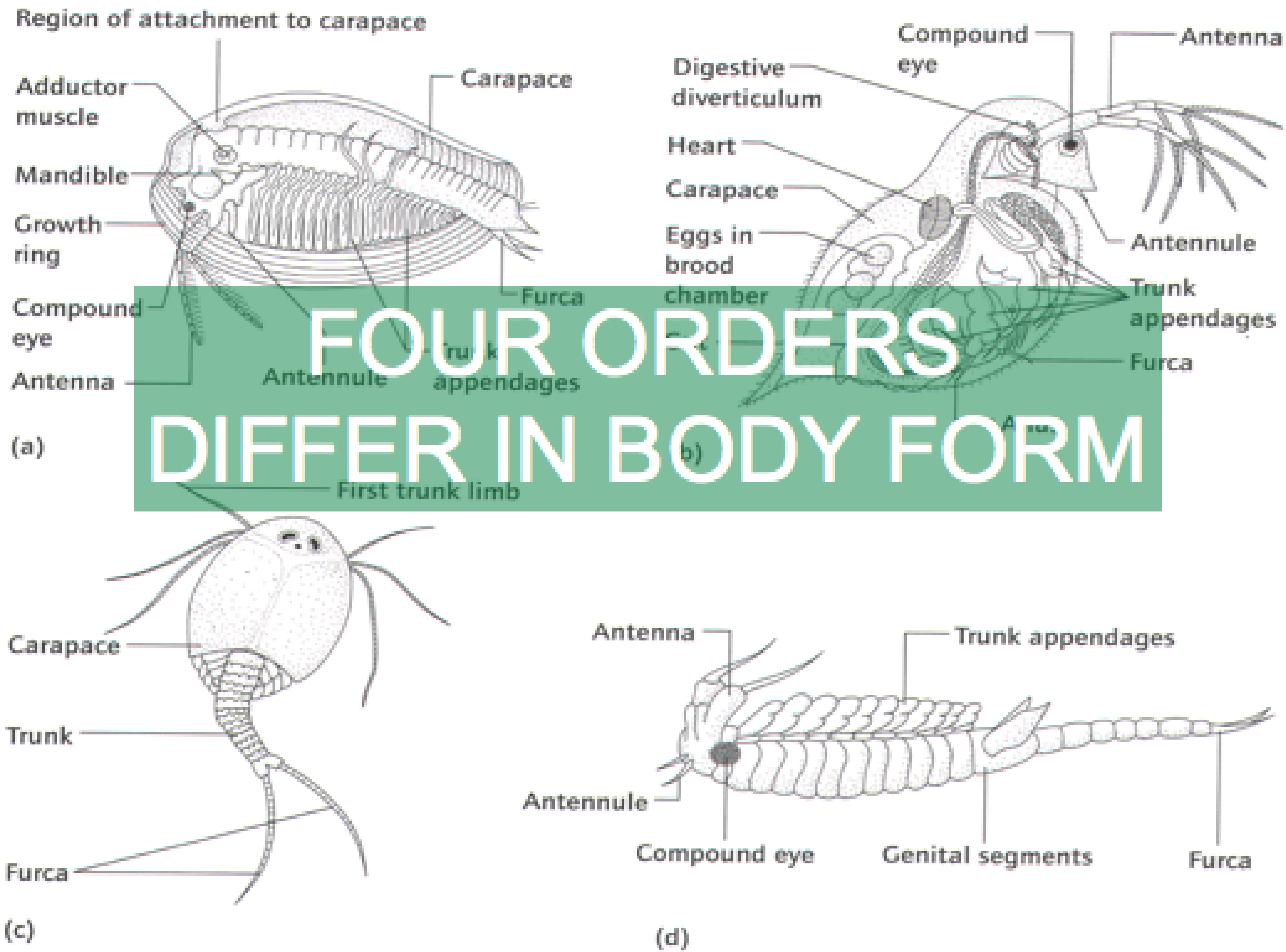
    - Subclass Pentastomida
    - Subclass Cirripedia—the barnacles

Subclass Branchiopoda

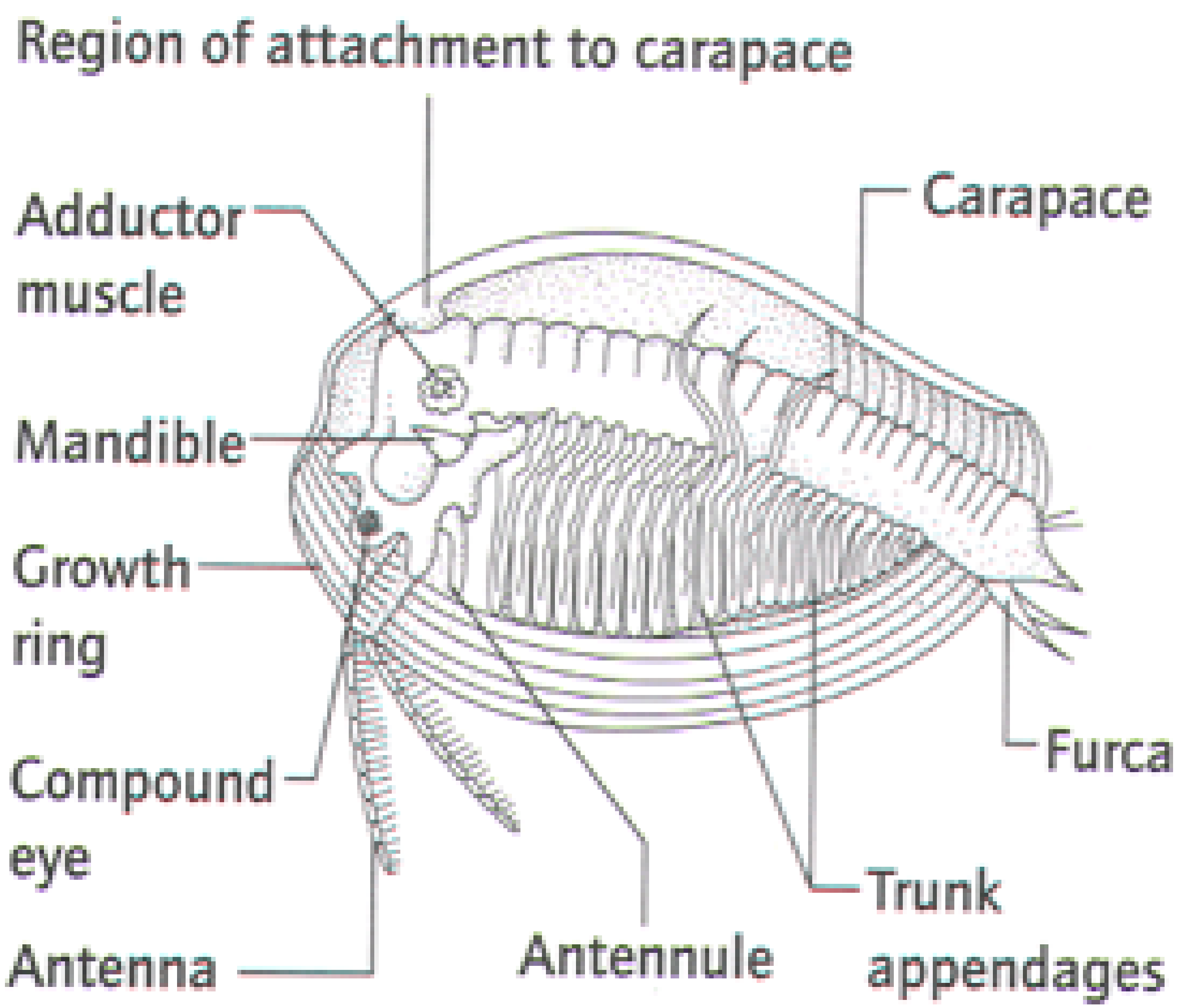
- Primarily Freshwater
- Coxa is modified to form flattened paddel
  - gas exchange / locomotion
- *branchio* - *poda*

FOUR ORDERS DIFFER IN BODY FORM



Branchiopoda

Conchostraca, lateral view with shell removed

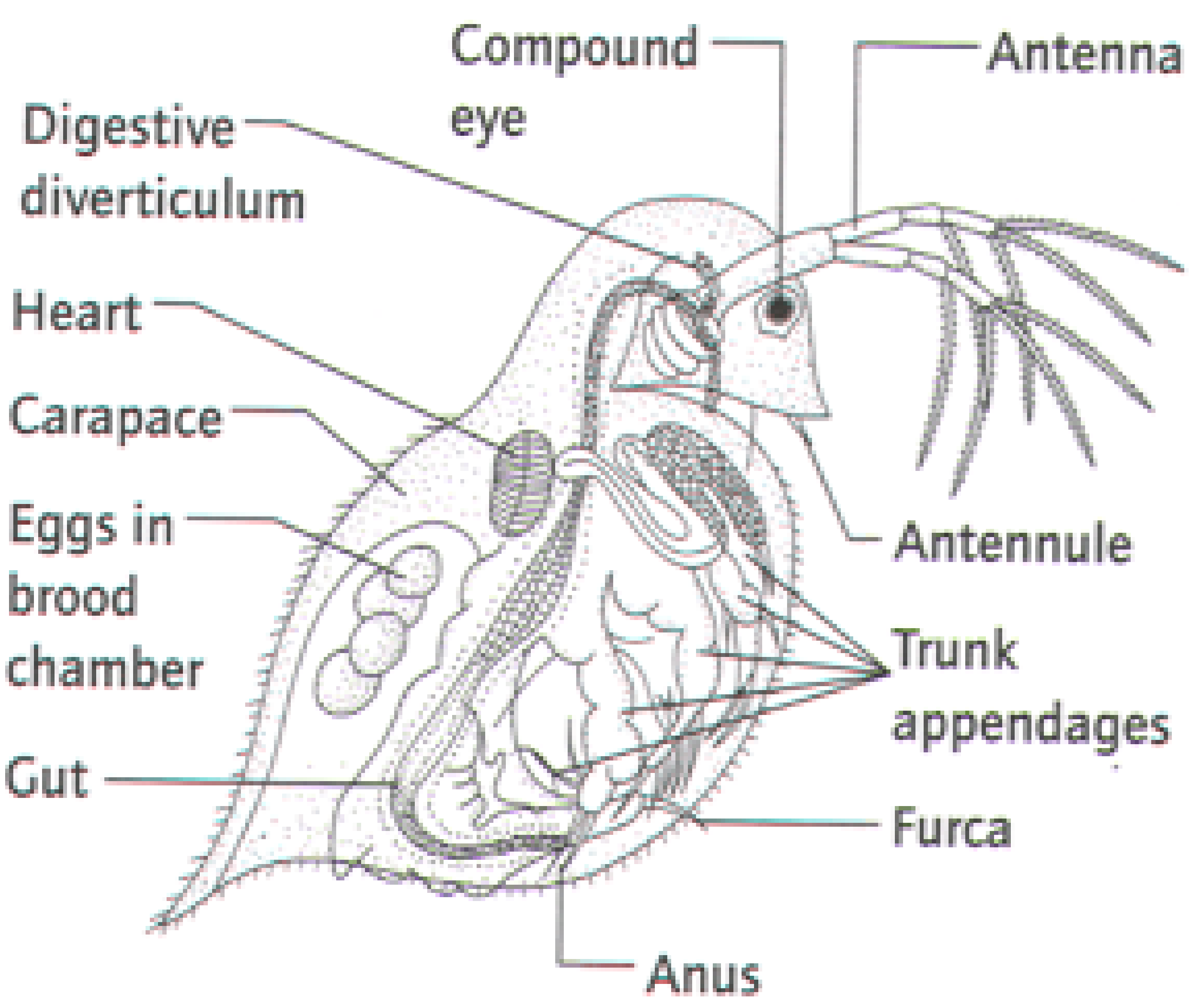


- Clam Shrimps
- Short, circular bodies
- Locomotory antennae
- Claw-like furca
- Dorsal brood chamber
- Laterally compressed carapace
- 30+ trunk segments
- Carapace encloses head
- Carapace not molted
- Grows by addition of concentric rings like….

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

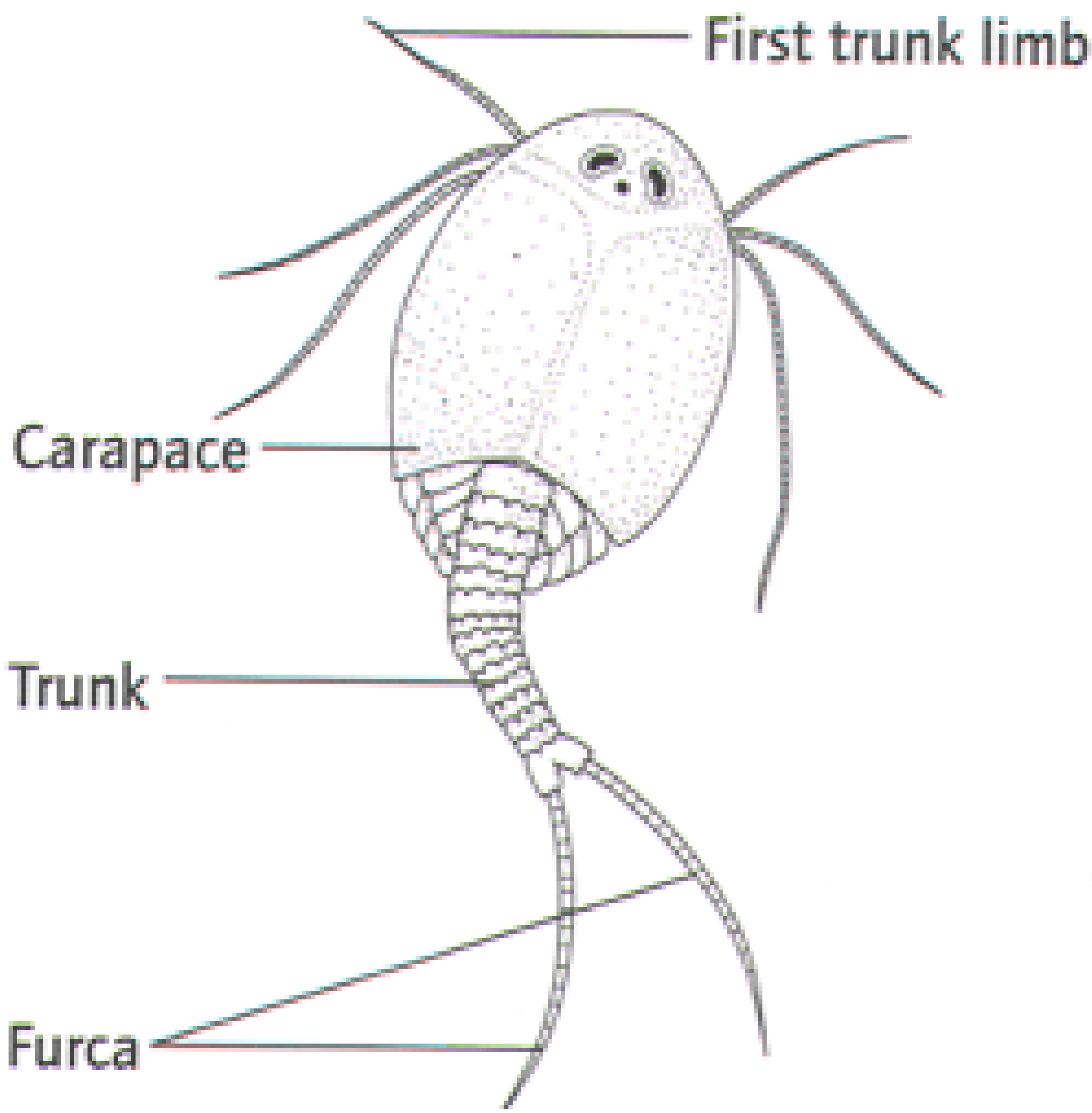
Branchiopoda

Daphnia

Cyclomorphosis

Branchiopoda

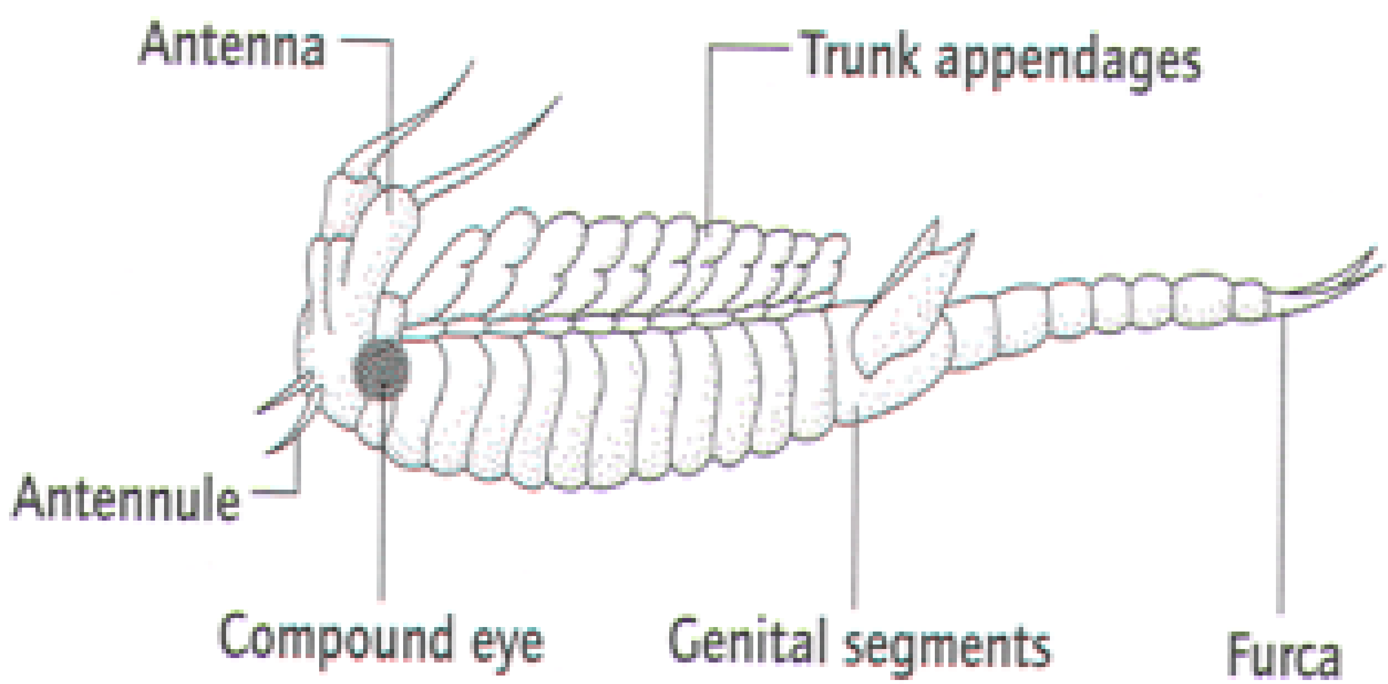
Notostraca



- 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



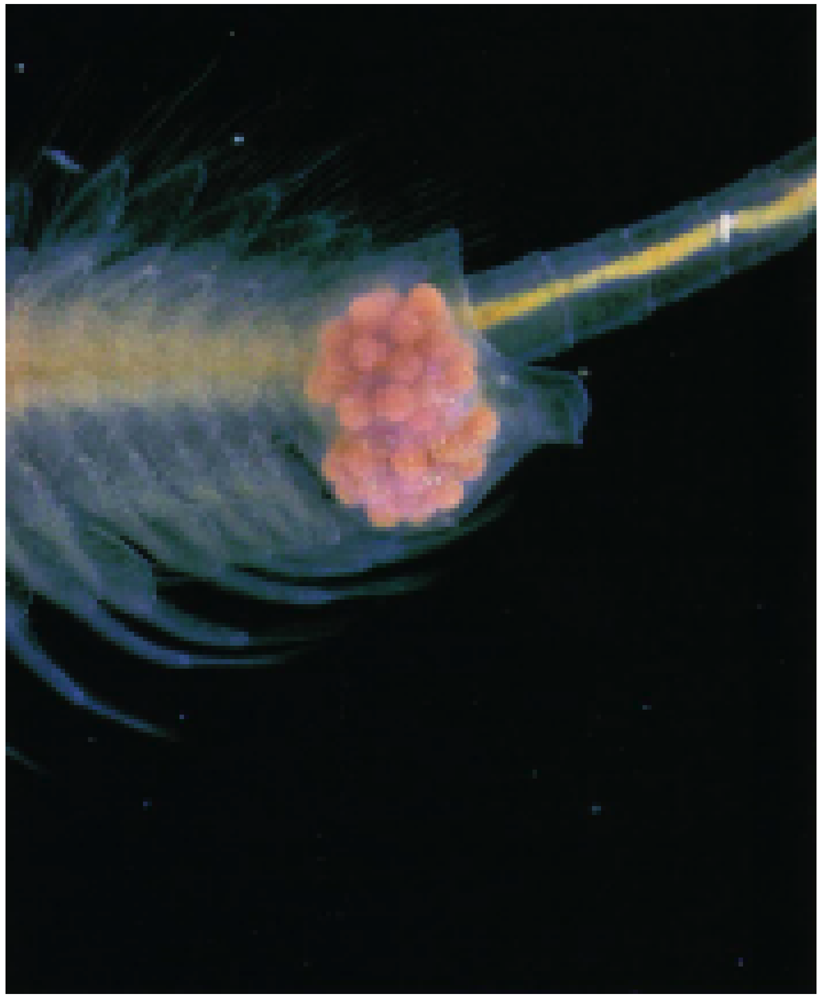
- Brine or Fairy Shrimps
- Lack carapace
- Brood chamber in body
- Harsh environments
- Extreme resting forms

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

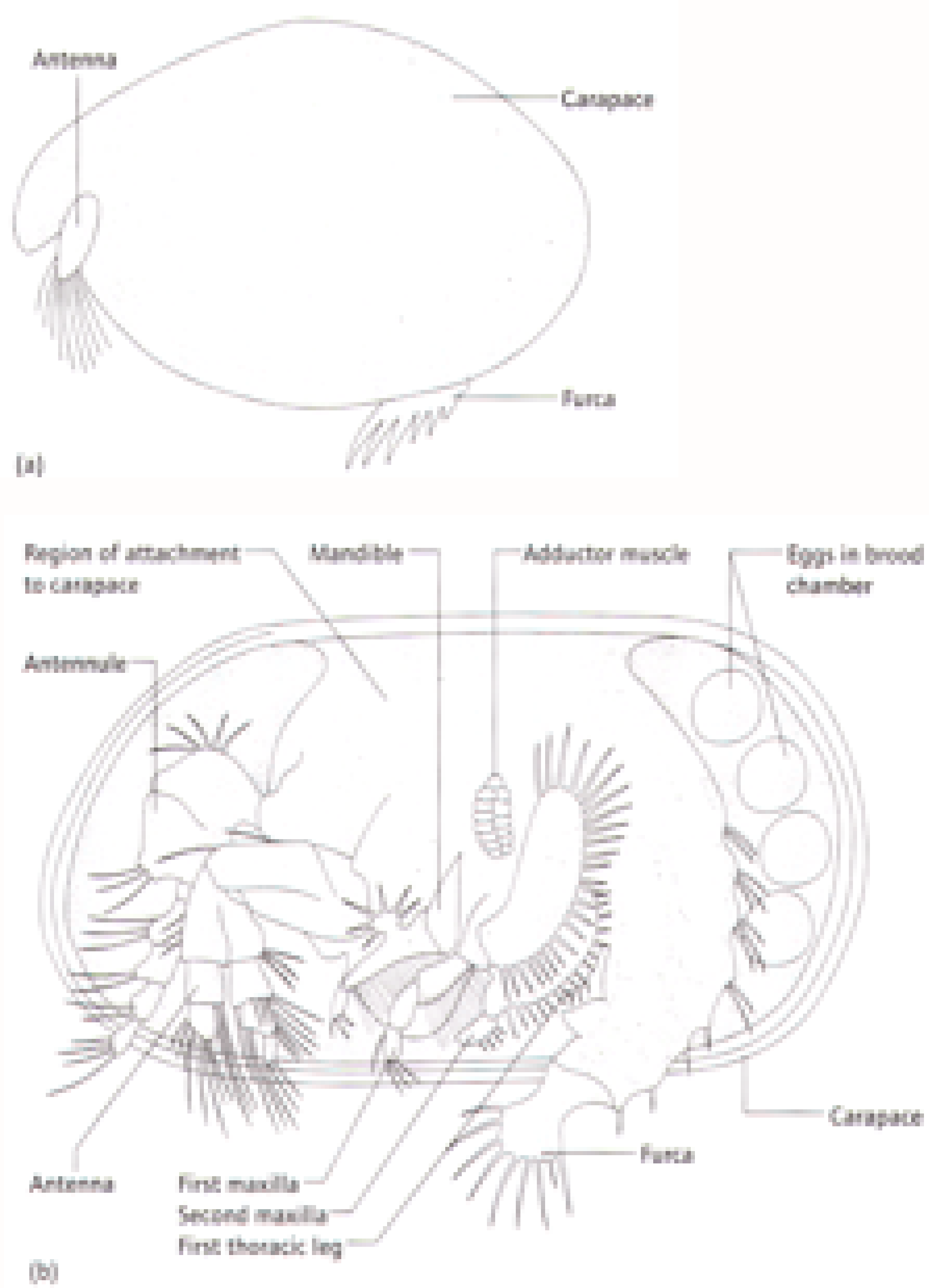
by Robert A. Browne



Subclass Ostracoda

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

Subclass Ostracoda



- Short oval body
- Bivalved, often calcarous shell from by carapace

- Molting does occur
- No segmentation evident

Subclass Ostracoda

Reproduction

- Some FW - parthenogetic
- External genitalia and gonopores are ventral
- Zenker's organ
  - Peristalic sperm pump
- Largest Sperm
  - Larger than organism?

- Male clasps female dorsally and posteriorly with 2nd antennae or 1st thoracopods

Subclass Ostracoda

Reproduction

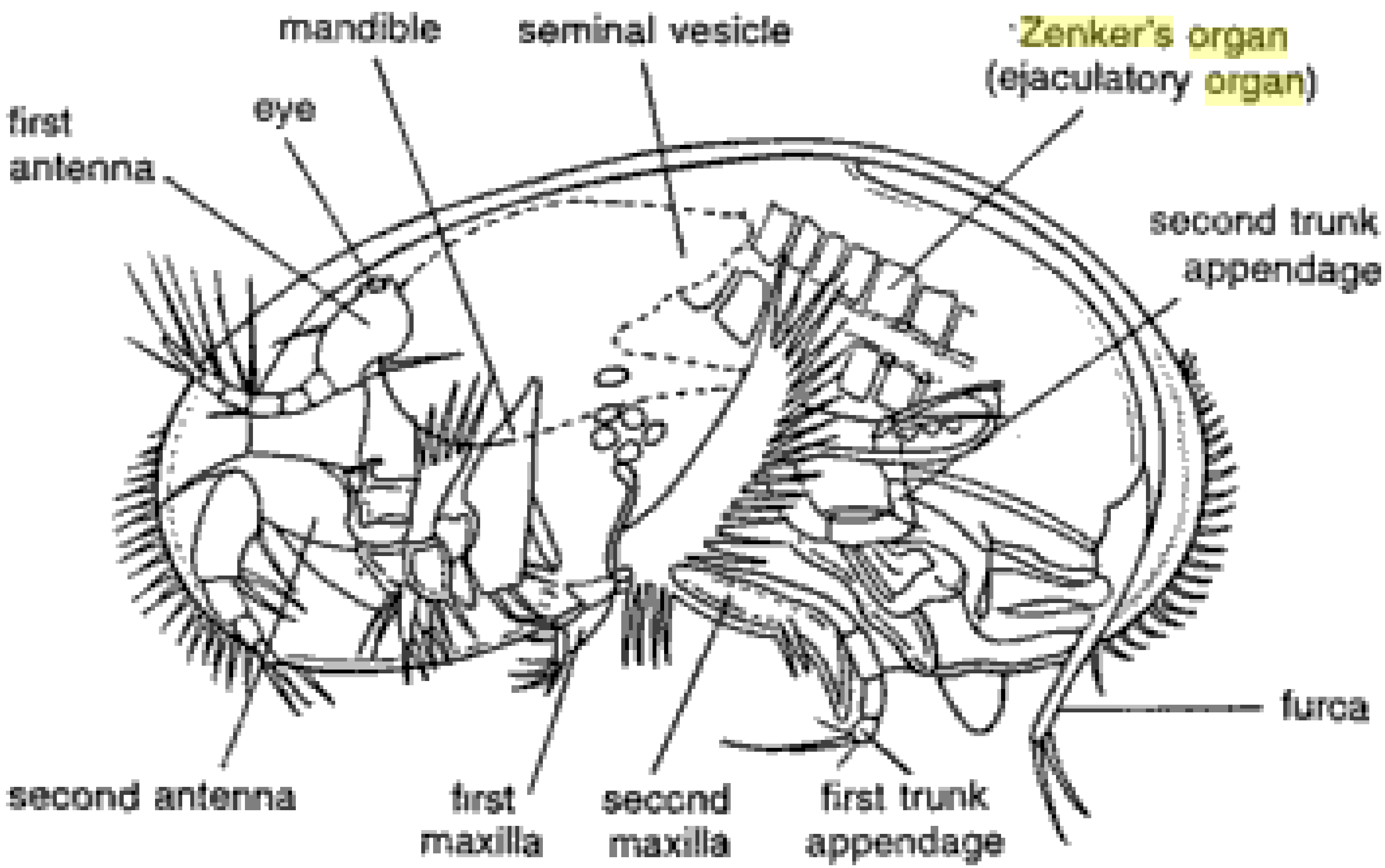


Fig. 34.5 *Candona suburbana.*

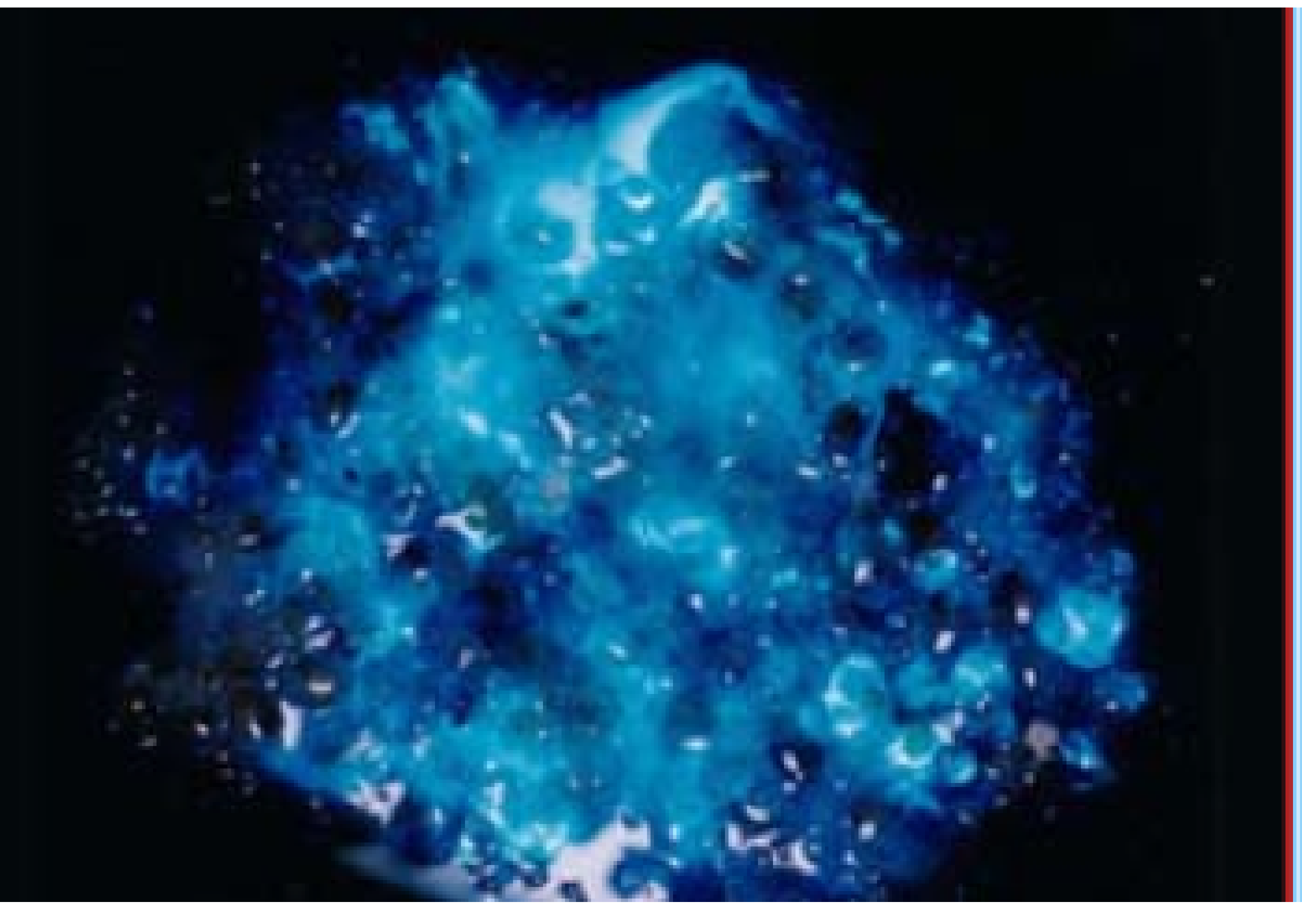
Subclass Ostracoda

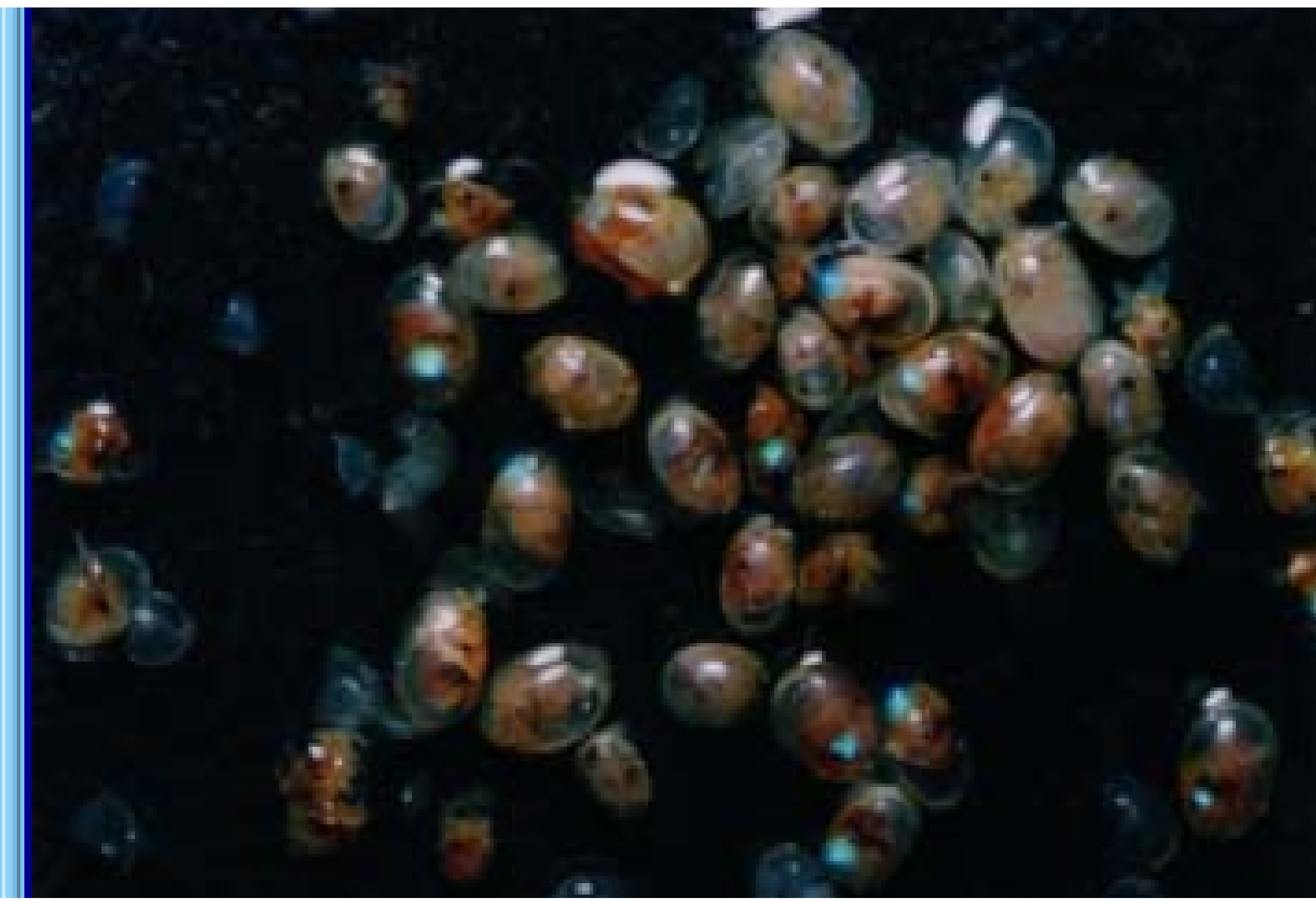
Deep-sea

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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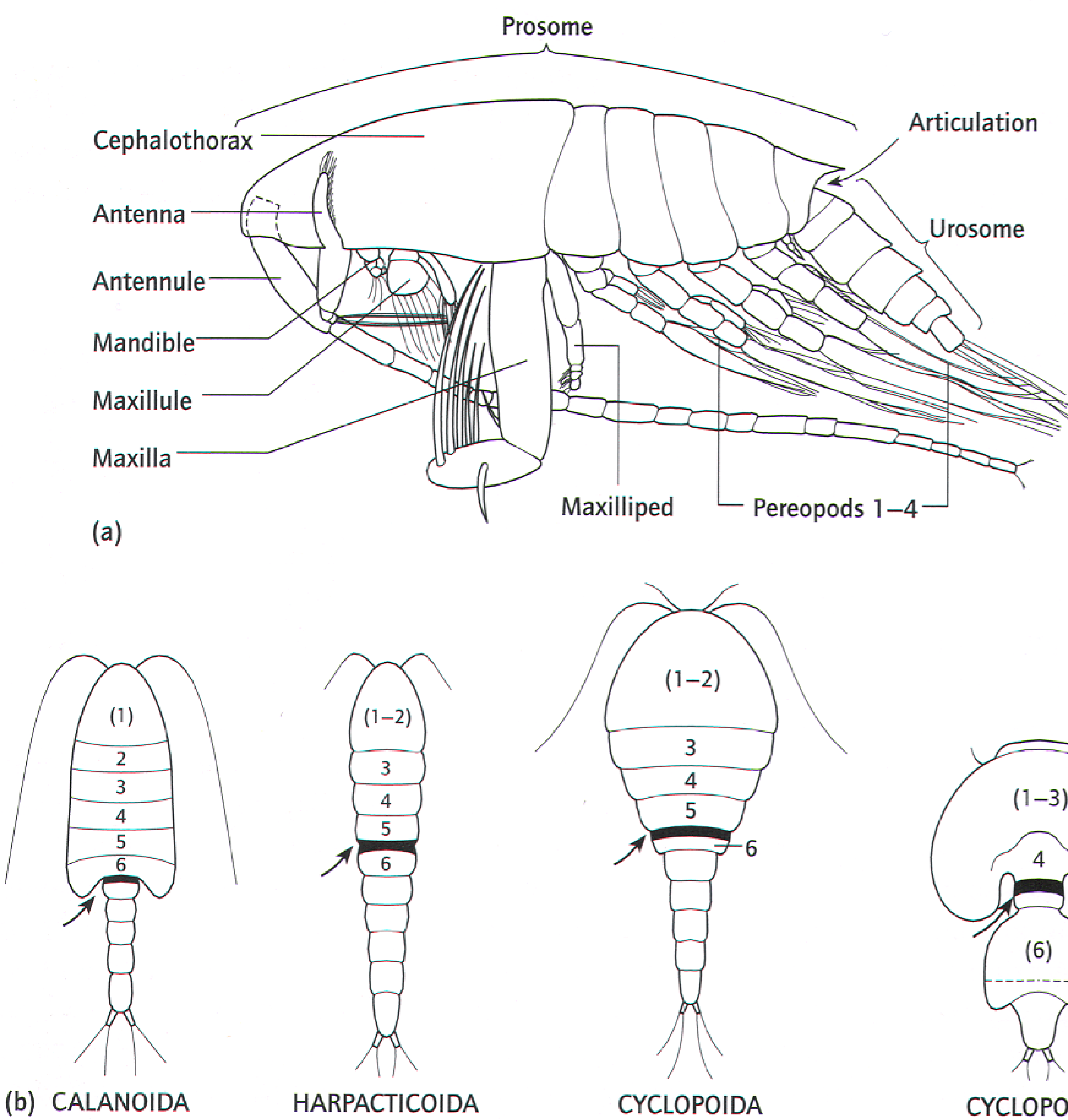
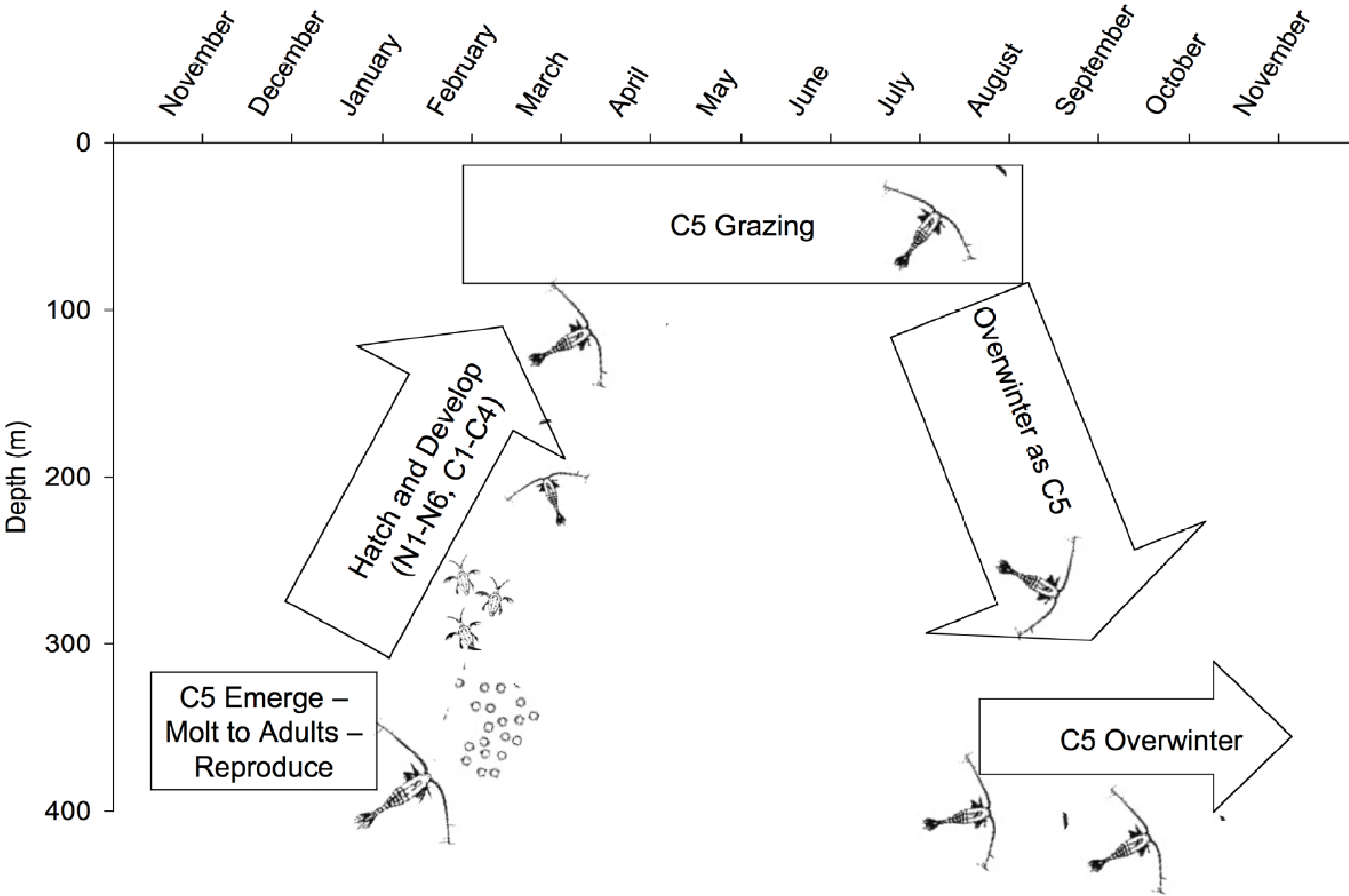
Subclass Copepoda

- 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



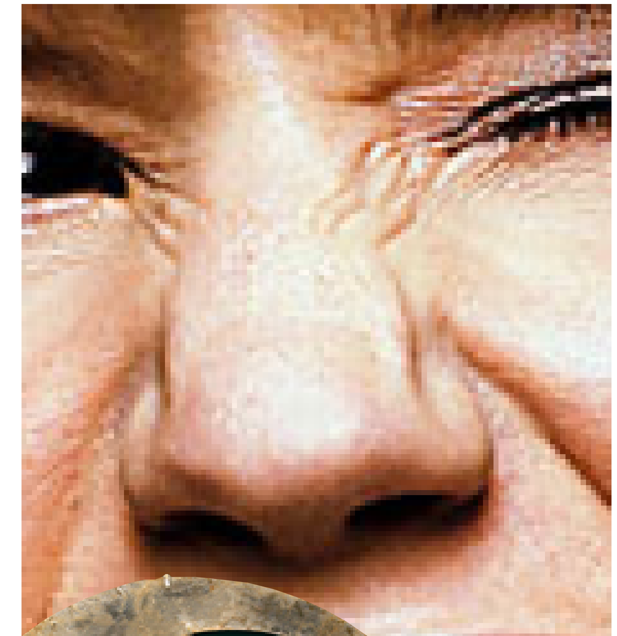
- Dominant member of plankton
- 25% parasitic
- Body parts
  - Head with well developed mouth parts and antenna
  - Segmented (6) thorax w/ limbs
- Dramatic diversity
  - Parasitic forms lose segmentation
- Lack carapace and compound eyes
- Eggs



November
December
January
February
March
April
May
June
July
August
September
October
November
0
100
200
300
400
Depth (m)
C5 Grazing
Hatch and Develop
(N1-N6, C1-C4)
Overwinter as C5
C5 Emerge –
Molt to Adults –
Reproduce
C5 Overwinter

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, s

Epidemiology:

Pentastomiasis is found mostly in tropical and subtropical areas. It's been reported relatively typically found in West Africa, where it infects the respiratory tracts of pythons and other re 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 Pentastomiasi people to the risks of eating uncooked 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.

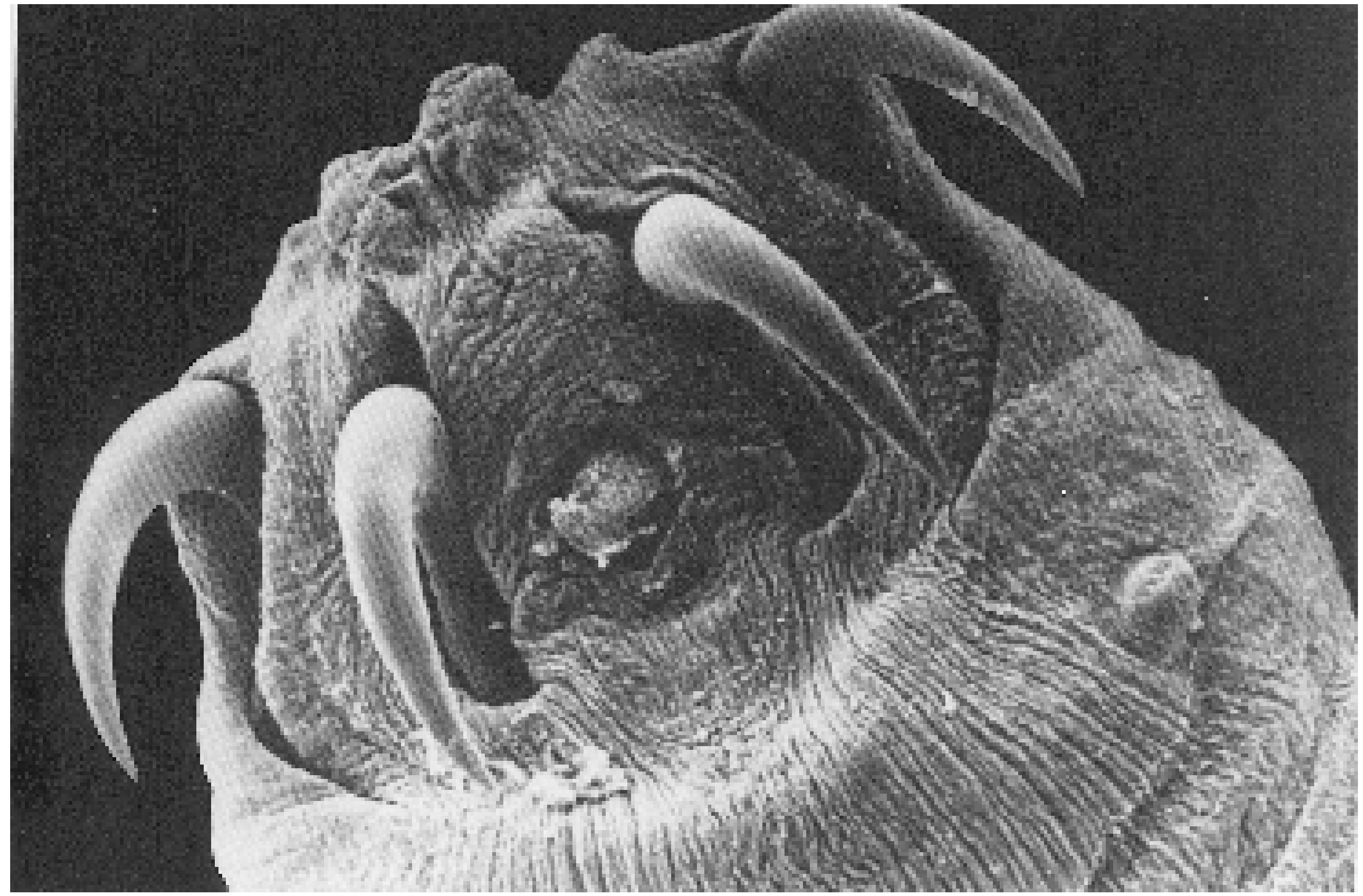
A page about reptile parasites for concerned owners

A page of links to helpful parasite information

References:

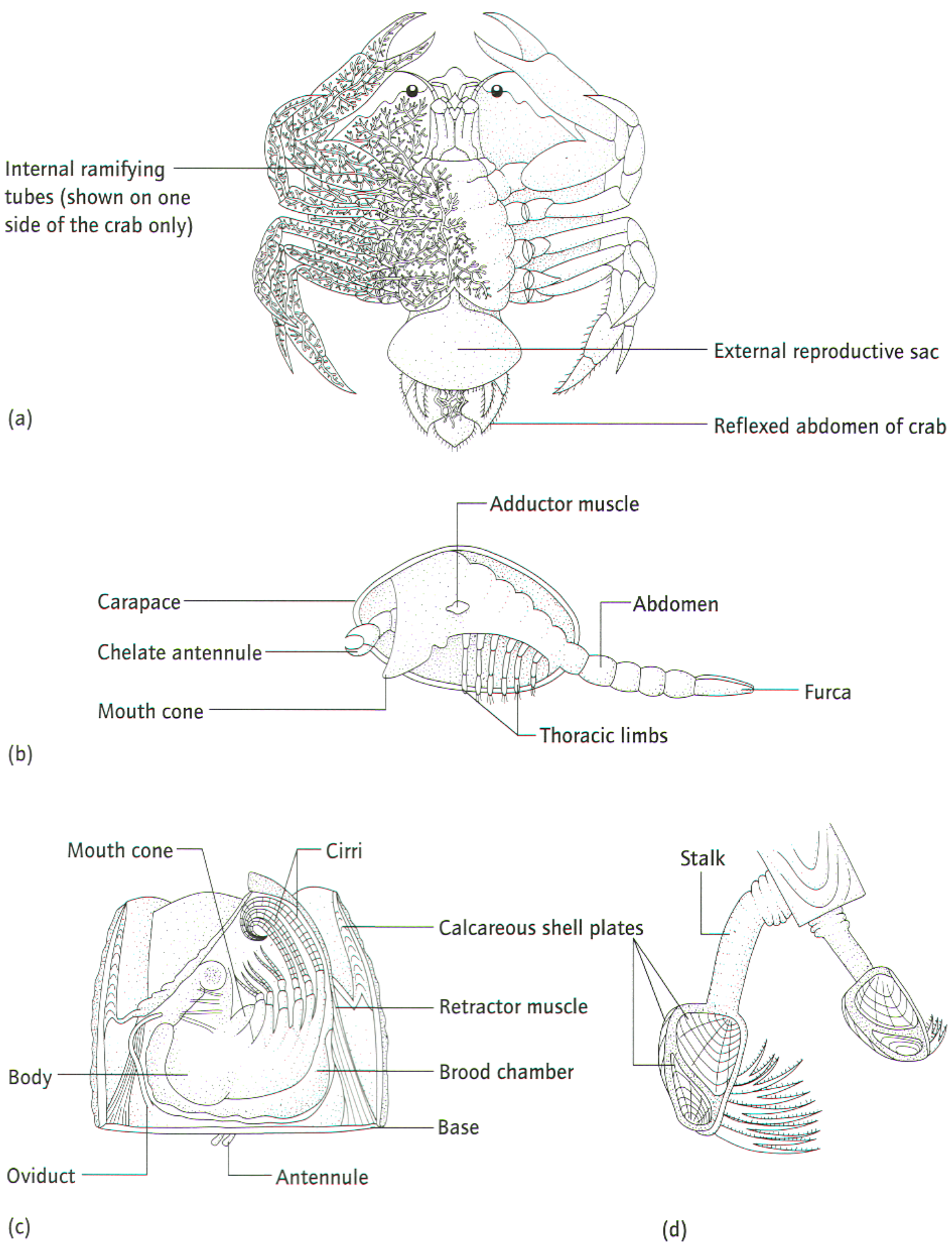
1. Cannon, D. A. "Linguatid Infestation of Man." *Annals of Tropical Medicine*, Vol. 36, No. 4,

2. Despommier, Dickson D., Gwadz, Robert W., Hotez, Peter J. *Parasitic Diseases, 3rd ed.* Sp



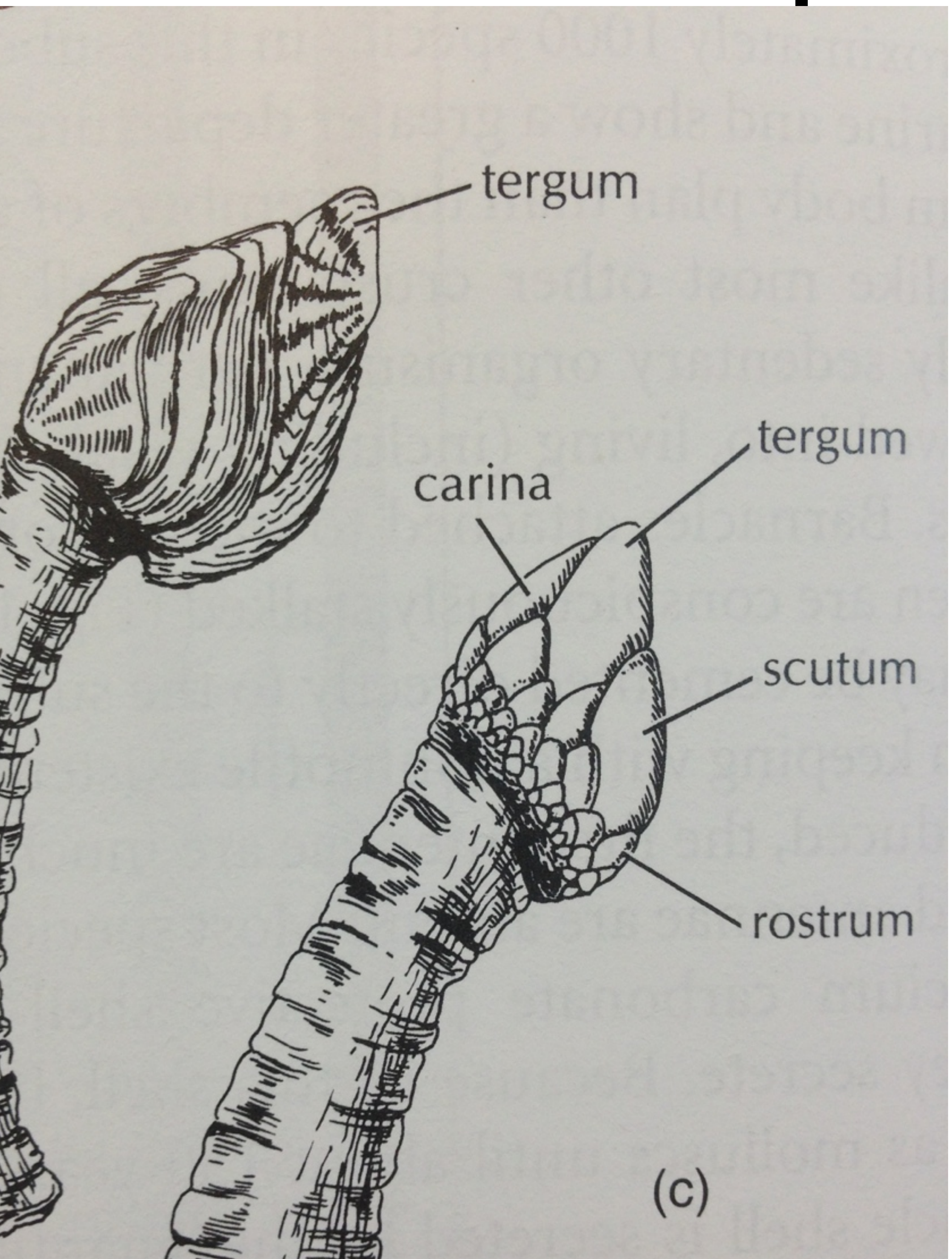
http://www.stanford.edu/class/humbio103/ParaSites2001/pentastomiasis/Erica%20parawebsite.html

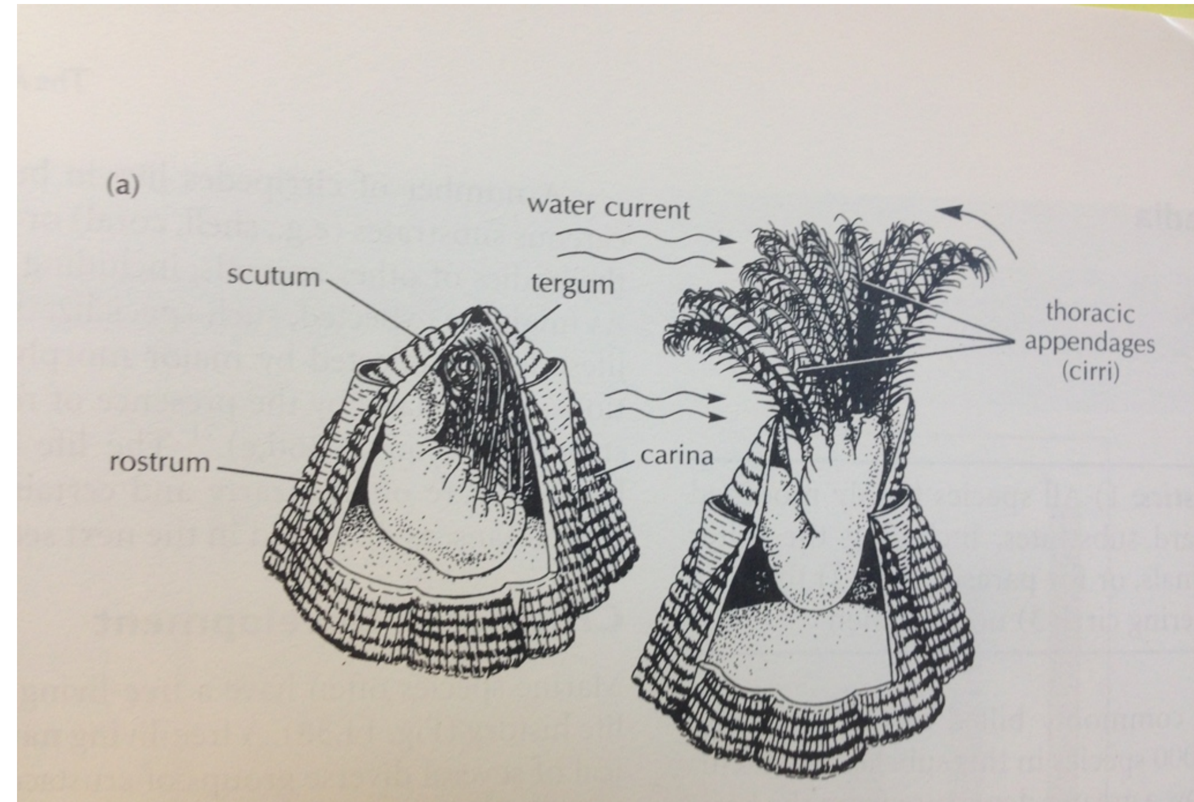
Subclass Cirripedia

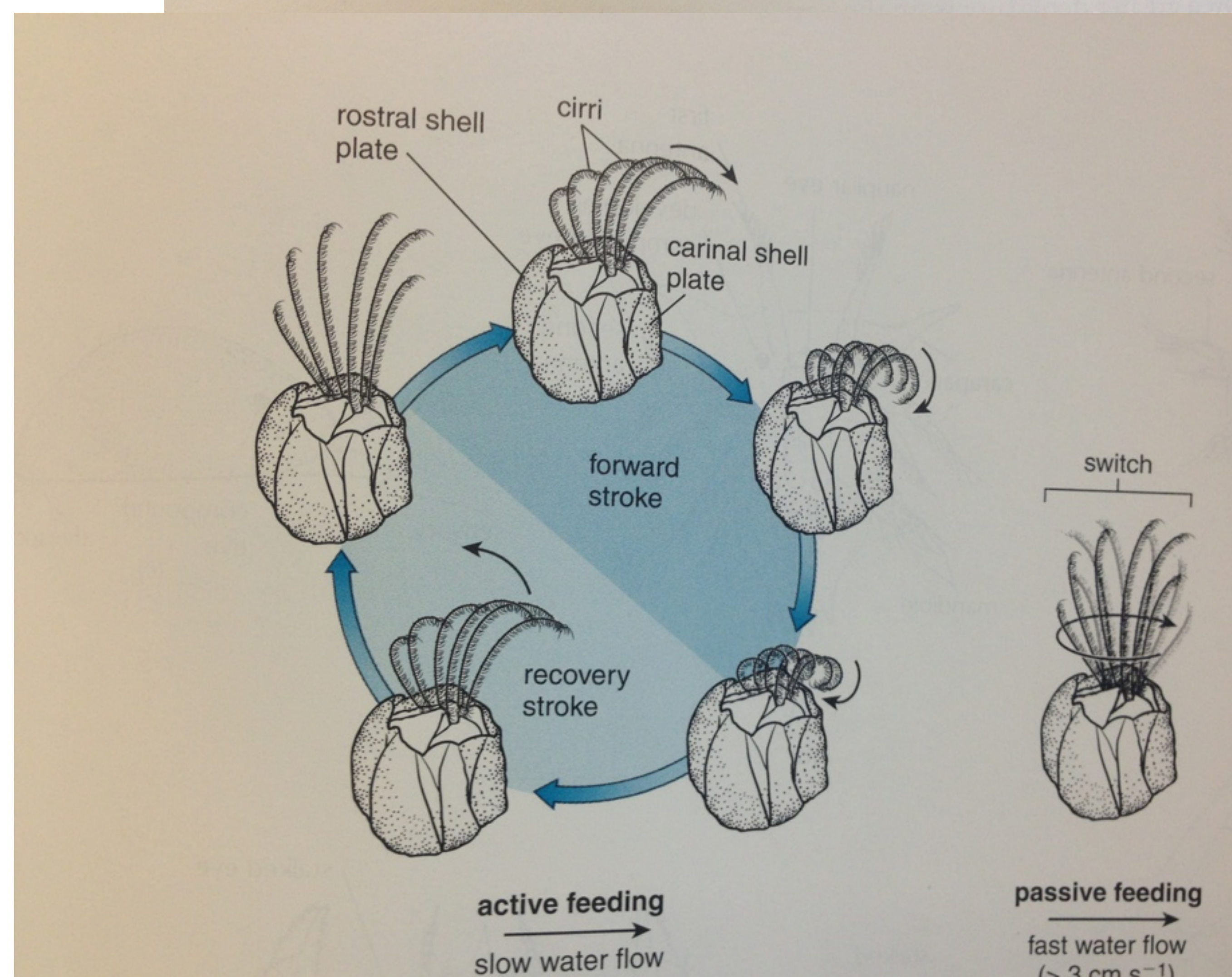


- Highly modified
  - Sessile or Parasites
- Headless
- Lack abdomen
- Little / No segmentation
- Rhizocephala
- Ascothoracica
  - Some chelate antennule
  - 6 pairs of swimming legs
  - Carapace
- Thoracica TRUE
  - “legs” becoming cirri
  - Reinforced carapace, calcareous
- Acrothoracica
  - Like barnacles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

Subclass Cirripedia





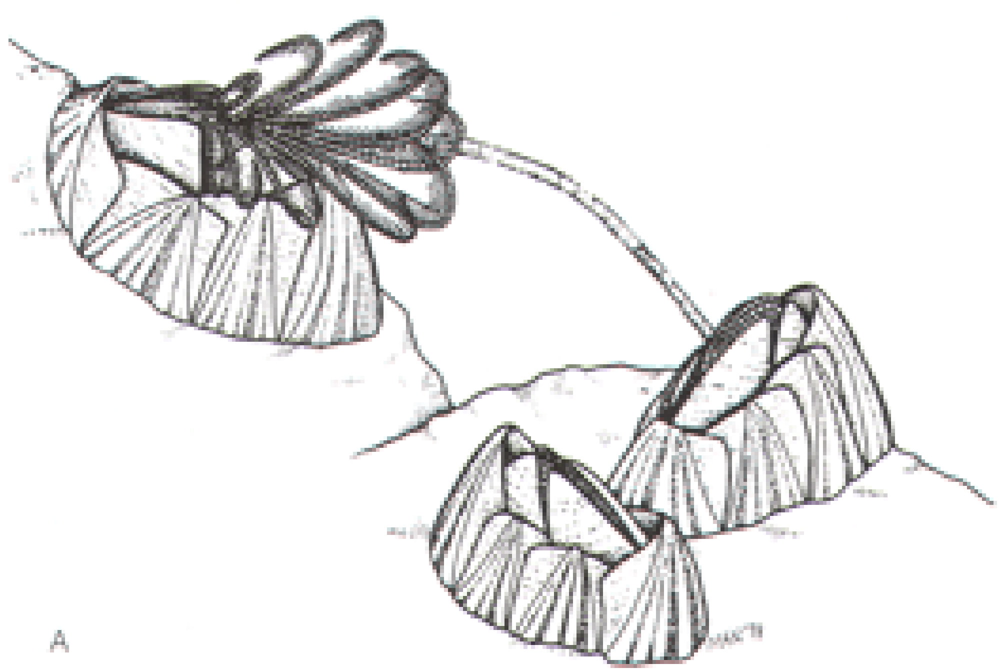


Subclass Cirripedia

Subclass Cirripedia

Reproduction

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




MarLIN
The Marine Life Information Network for Britain & Ireland
Image: Sue Scott

Tanner or snow crab
Chionoecetes

Hardshell and softshell mating

Only morphologically mature males can mate with hardshell females

Female mound

Tidal phasing of larval launch pads?

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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.