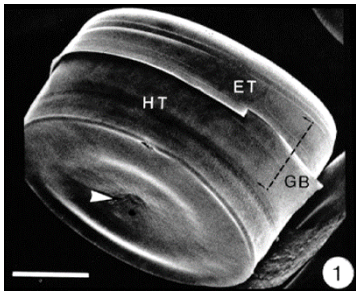
Lecture Marine Zooplankton I

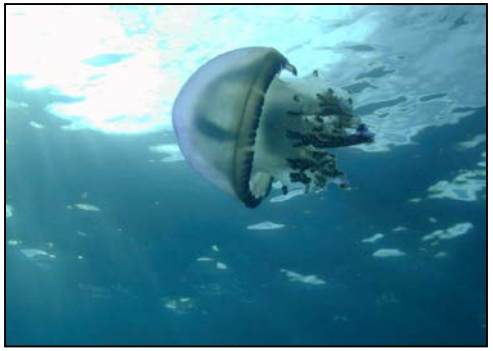
Habitat:

- **Holoplankton**- spends entire lifecycle as plankton
  Ex. Jellyfish, diatoms, copepods
- **Meroplankton**- spend part of lifecycle as plankton
  Ex. fish and crab larvae, eggs



snail

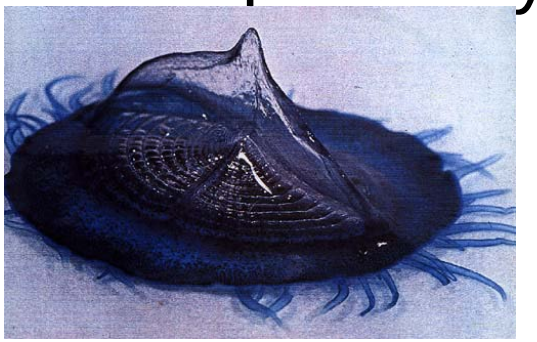
lobster



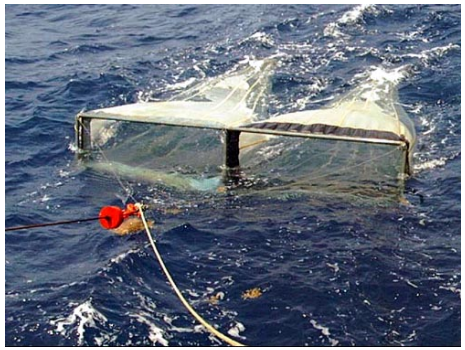
fish

Habitat:

- **Pleuston**- organisms that float passively at the seas surface
  Ex. *Physalia, Velella*

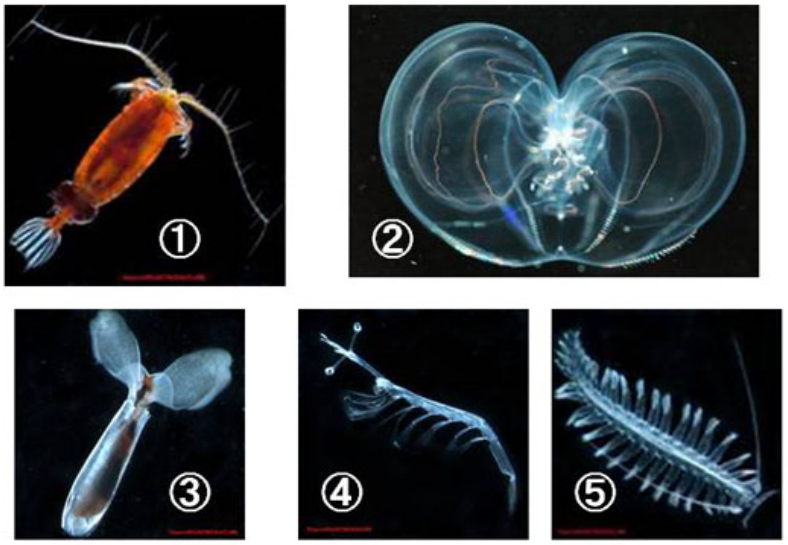


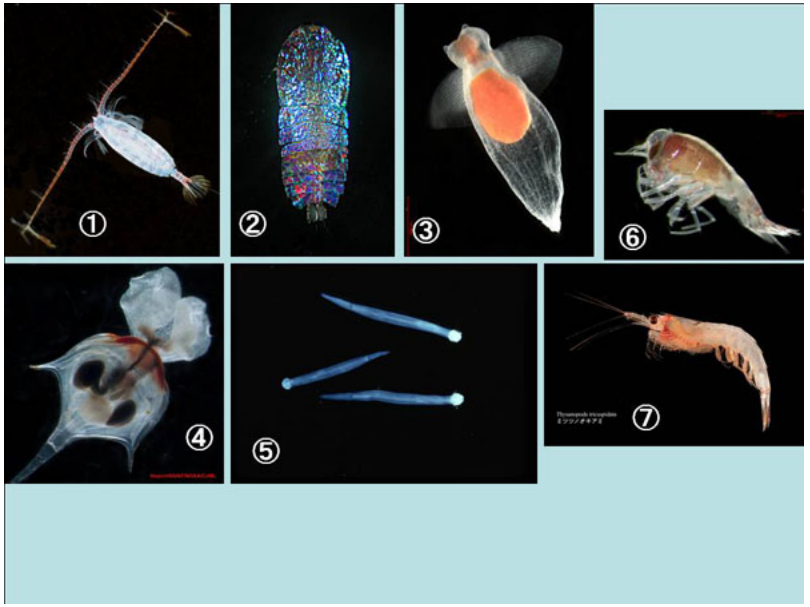
- **Neuston** – organisms that inhabit the uppermost few mm of the surface water
  Ex. bacteria, protozoa, larvae; light intensity too high for phytoplankton



Neuston net

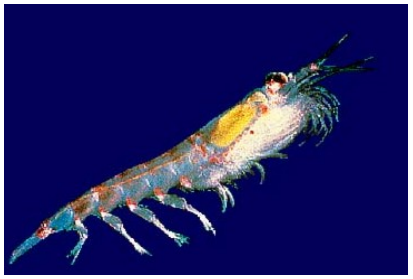
Taxonomy

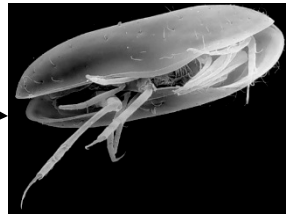




Some important types of zooplankton

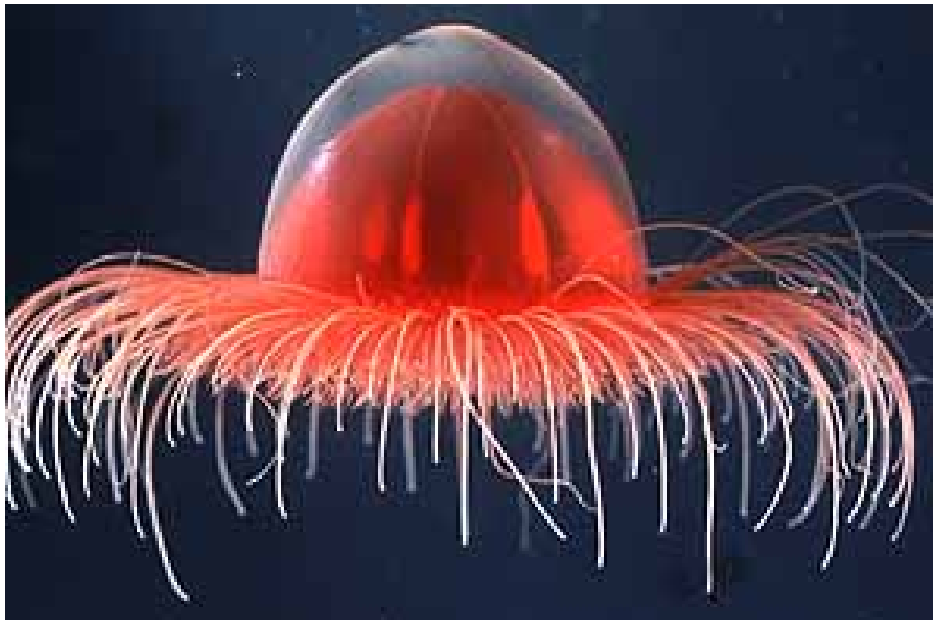
- Crustaceans: Copepods
  - Krill
  - Cladocera
  - Mysids
  - Ostracods
- Jellies
  - Cniderian (True jellies, Man-of-wars, By-the-wind-sailors)
- Ctenophores (comb jellies)
- Urochordates (salps and larvacea)
- Worms (Arrow worms, polychaetes)
- Pteropods (planktonic snails)



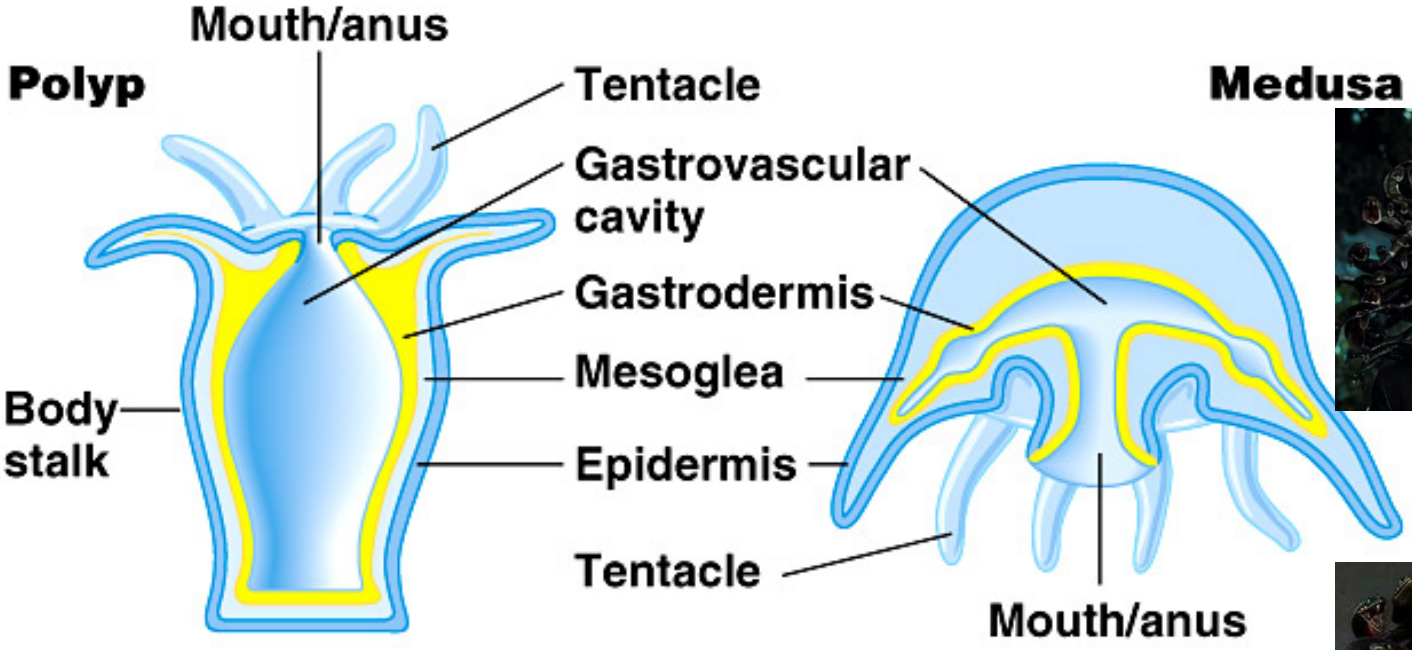


Zooplankton

*Gelatinous Zooplankton - **Cnidaria***



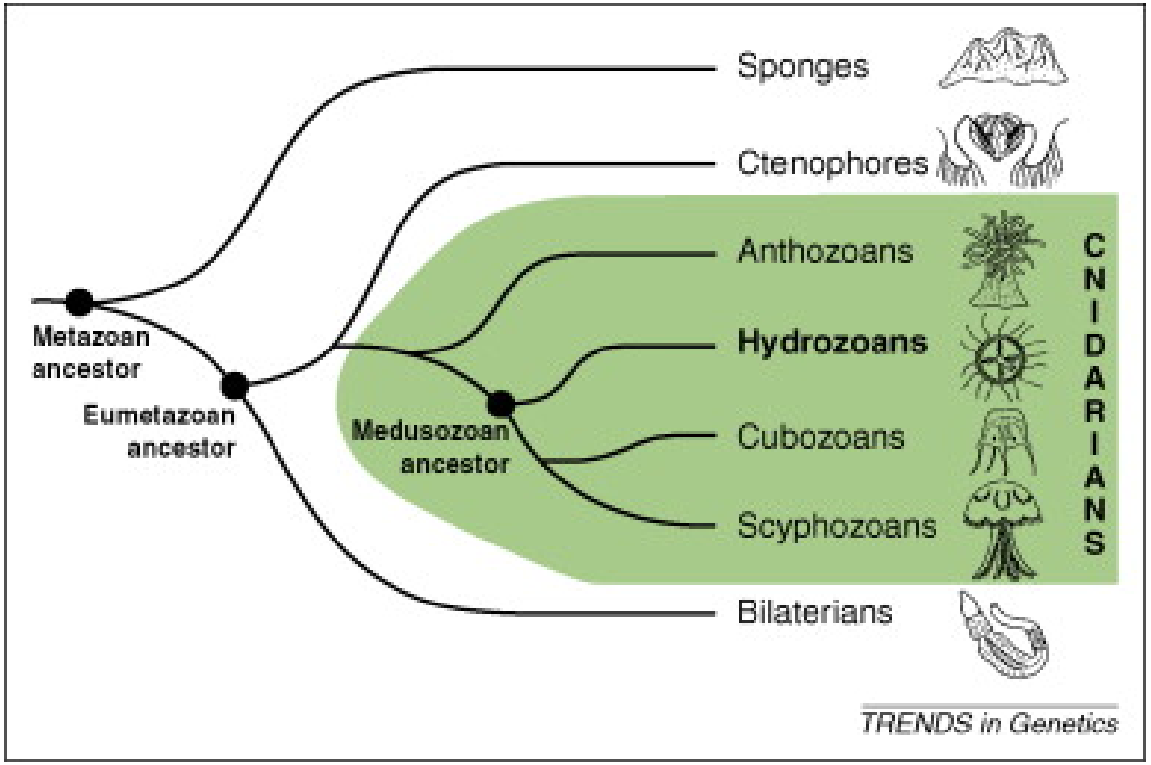
Note muscular bell and tentacles

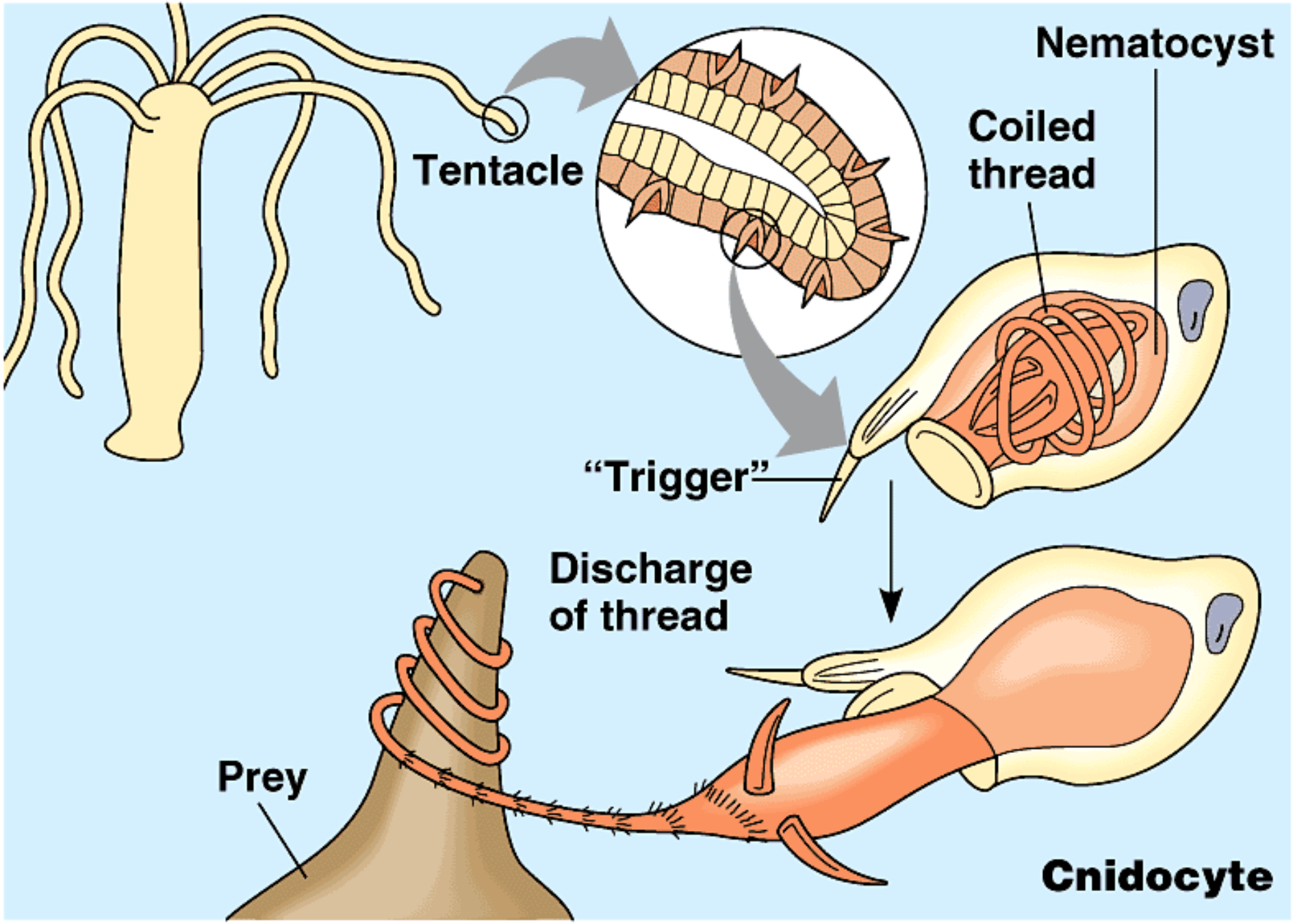


(a) Sea anemone: a polyp

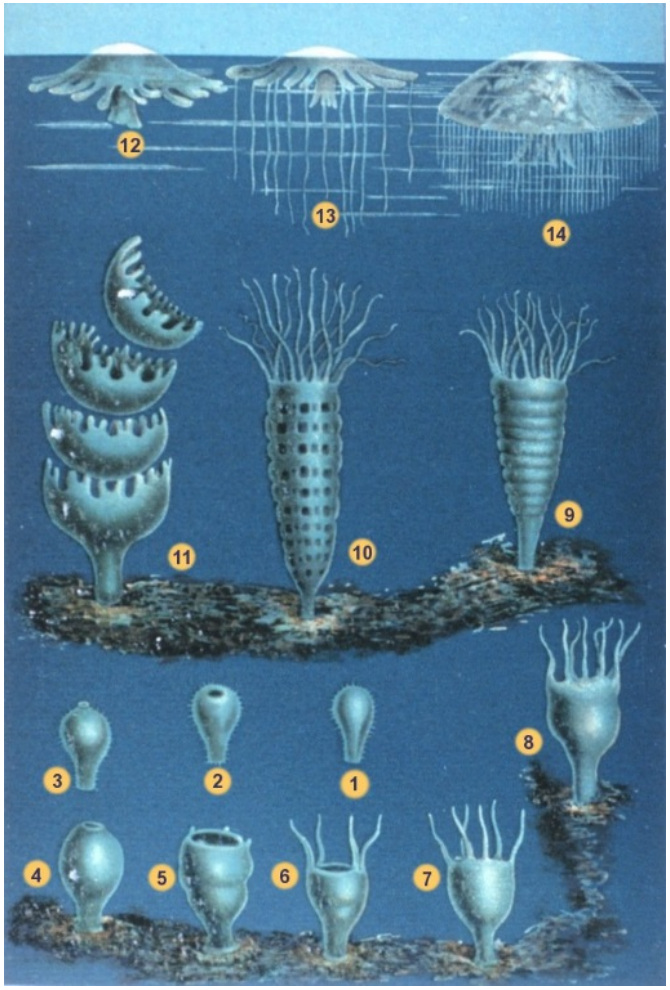
(b) Jelly: a medusa

Evolution of Cnidarians





Feeding polyp
Reproductive polyp
Medusa bud
Gonad
Medusa
Sexual reproduction
MEIOSIS
Egg
Sperm
FERTILIZATION
Zygote
Portion of a colony of polyps
Asexual reproduction (budding)
Developing polyp
Mature polyp
Planula larva
Haploid (*n*)
Diploid (2*n*)



The developmental stages of scyphozoan jellyfish's life cycle:
1–3 Larva searches for site
4–8 Polyp grows
9–11 Polyp strobilates
12–14 Medusa grows

Strobilation or transverse fission is a form of asexual reproduction consisting of the spontaneous transverse segmentation of the body.

"국민과 함께 가는 행복의 길, 바다로 세계로 미래로"

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	배포 일시	2015. 2. 25 총 5 매(본문 2 , 사진 3)
담당 부서: 수산해양종합정보과	담 당 자	▪ 과장 서영상, 연구관 오현주, 연구사 윤원득, 한창훈 ▪ ☎ 051) 720-2222
보 도 일 시	2015년 2월 25일(수) 배포시부터 보도하여 주시기 바랍니다.	

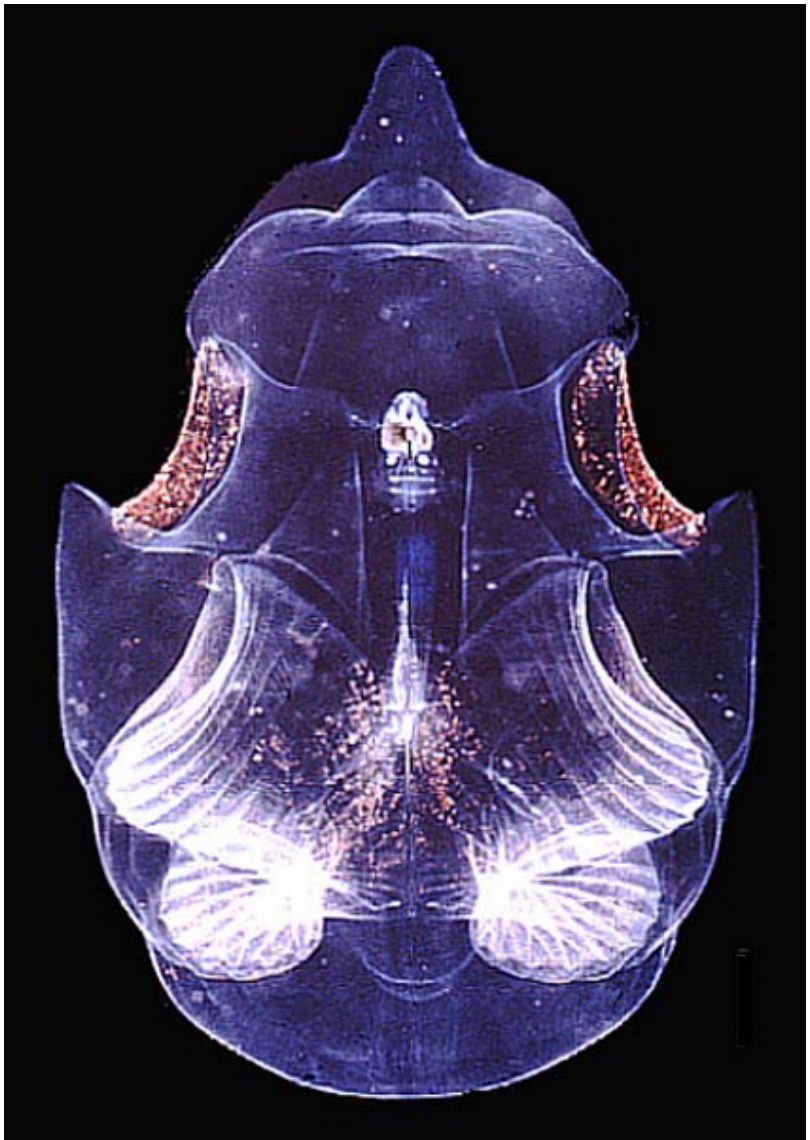
보름달물해파리 월동(越冬) 국내 최초 확인

■ 국립수산과학원(원장 직무대리 최우정 부장)은 봄에 태어나 가을 이후 자연 소멸하는 보름달물해파리가 득량만과 마산만에서 추운 겨울에도 살아있는 것을 국내 최초로 확인했다고 밝혔다.

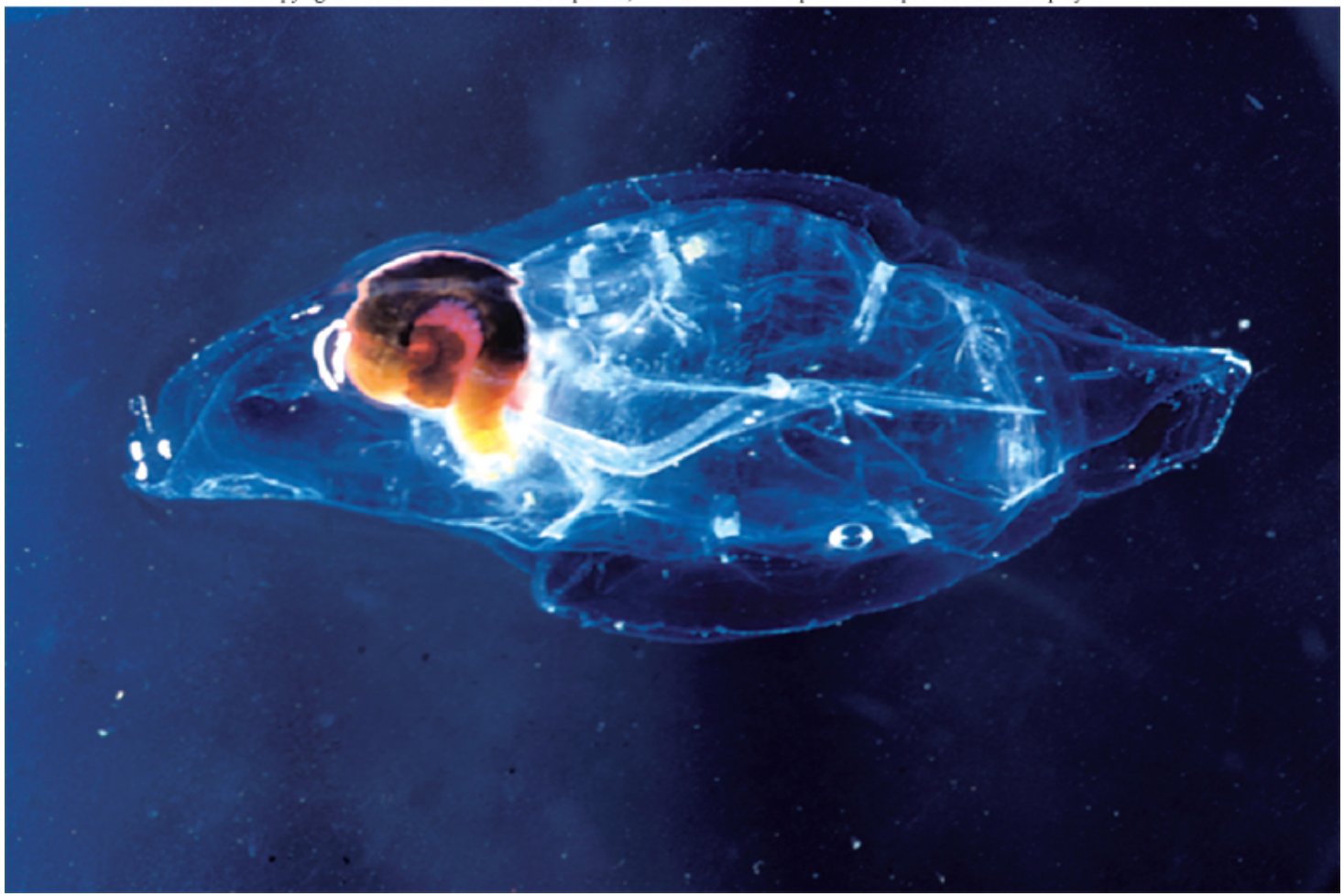
※ 보름달물해파리의 생활사 : 보름달물해파리 성체는 7~8월에 산란·수정하여 플라눌라유생을 생산하고, 플라눌라유생은 인공구조물 등에 부착하여 가을 및 겨울을 부착유생(폴립, polyp)의 상태로 지남. 이후 분화(分化)와 복제(複製) 시기를 거친 후 다음해 3~4월경에는 부유유생(에피라, ephyra)을 거쳐 5~6월경에 성체로 성장

Class Larvacea (APPENDICULARIANS)

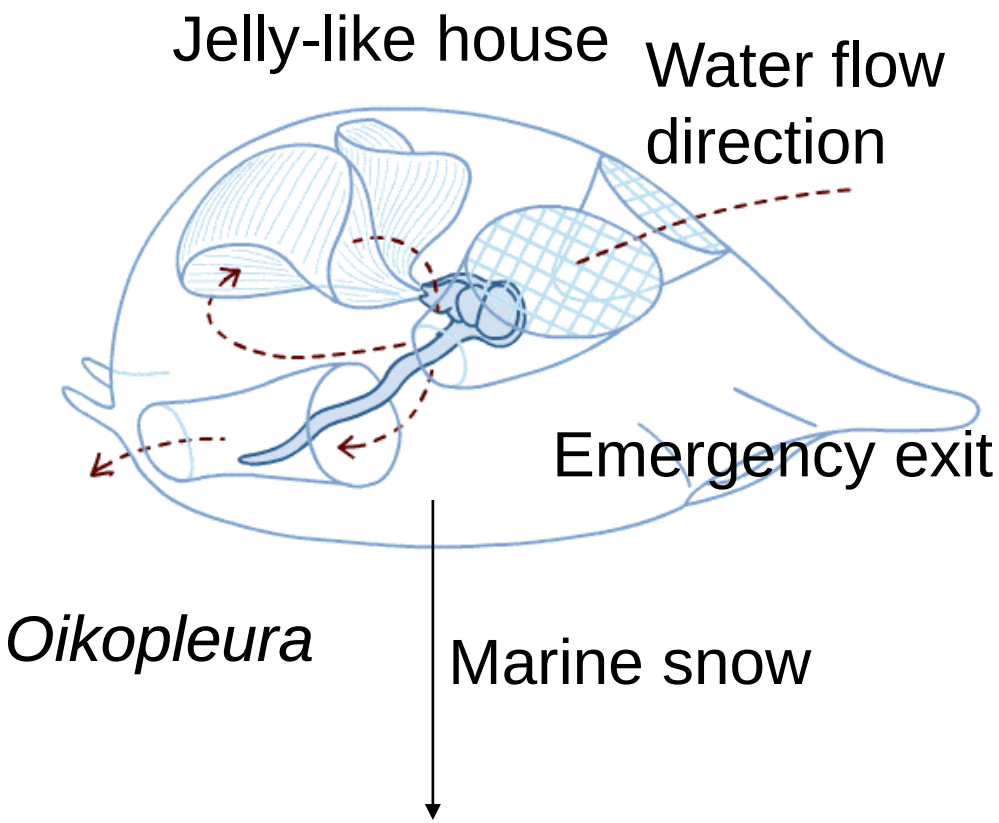
Oikopleura



salp

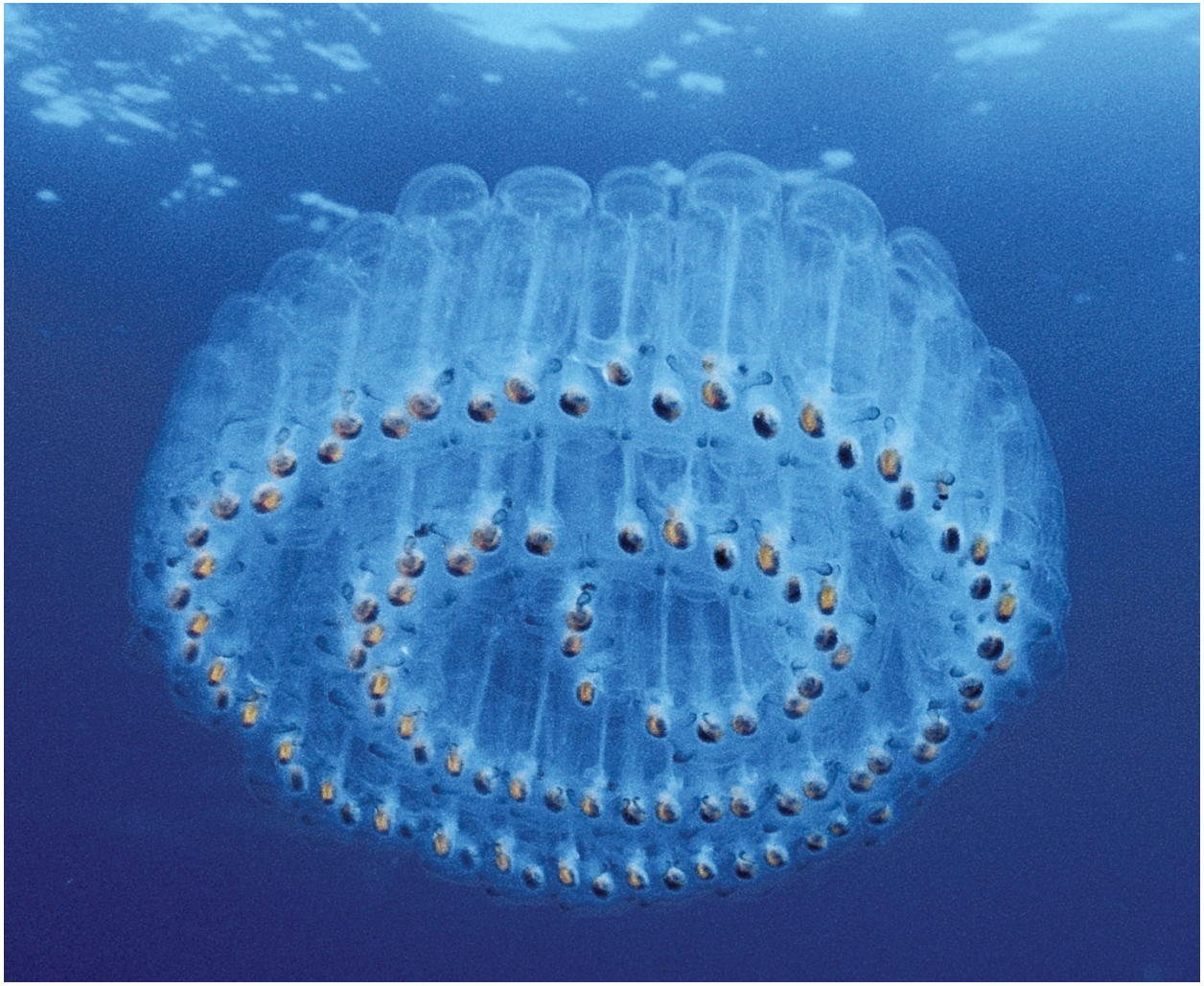


Class Larvacea - Gelatinous house, planktonic

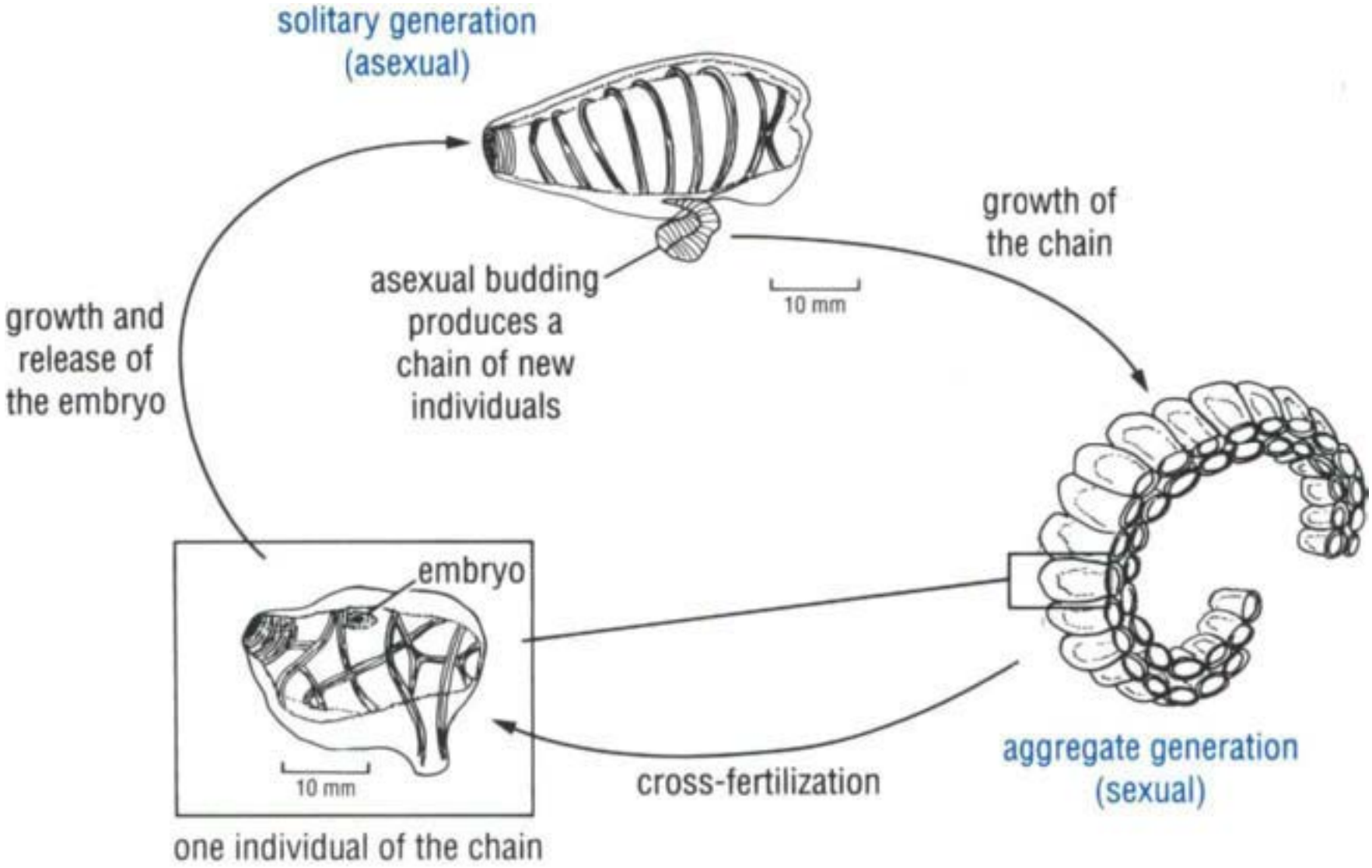


- http://planktonchronicles.org/en/episode/larvaceans-their-houses-are-nets/
- The red line shows the water flow (through one entrance) created by the undulating tail of the larvacean. Large particles are blocked by protective grids. The filters on the left, filter tiny organisms from the water which are then passed to the mouth.

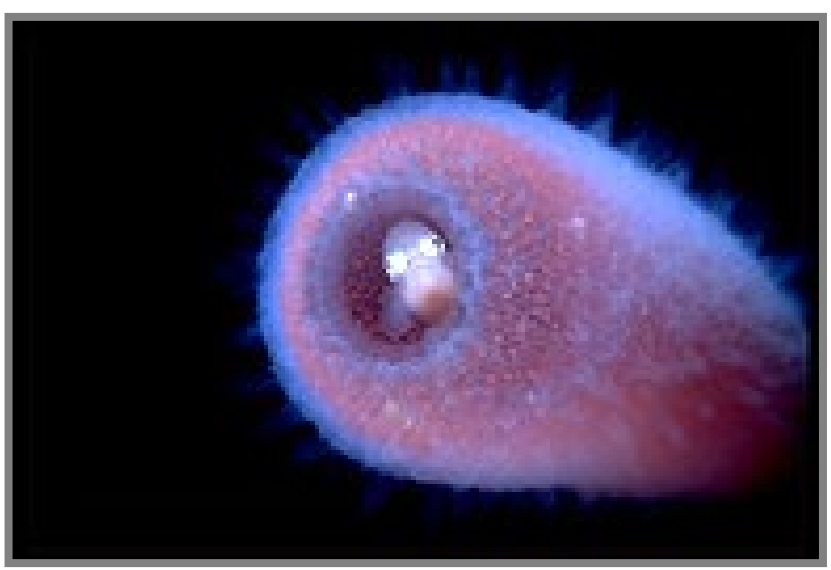
They aren’t always “small!”

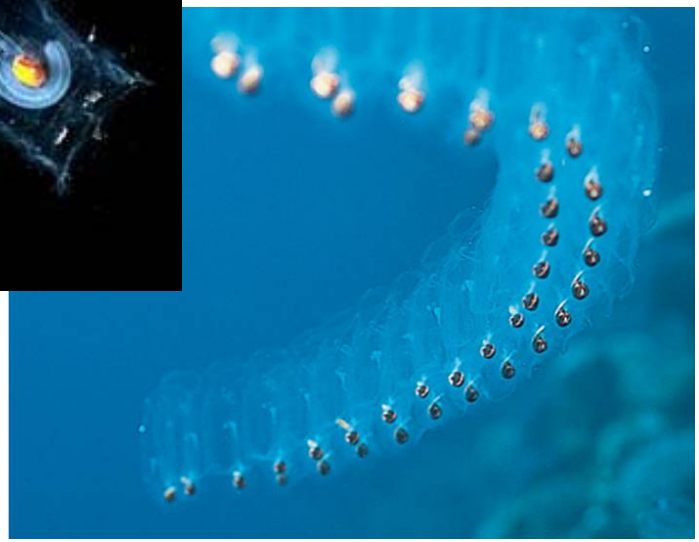


Some large gelatinous zooplankton: (c) A colony of salps (*Pegea*) cloned from a single parent.


solitary generation
(asexual)
asexual budding
produces a
chain of new
individuals
10 mm
growth of
the chain
growth and
release of
the embryo
embryo
10 mm
one individual of the chain
cross-fertilization
aggregate generation
(sexual)

Class Thaliacea - Salps (free swimming), planktonic





Pyrosoma- bioluminescent
Colonial salp

$$\text{luciferin} + O_2 \xrightarrow{\text{luciferase}} \text{oxyluciferin}^* \rightarrow \text{oxyluciferin} + \text{light}$$

The reaction shown above can be carried out in special cells called **photocytes**, or in complex organs known as **photophores**.

Microscopic floating organisms: Copepods

- Copepods have a hard exoskeleton and a segmented body with jointed legs
- Relatives of shrimp, crabs, and lobsters

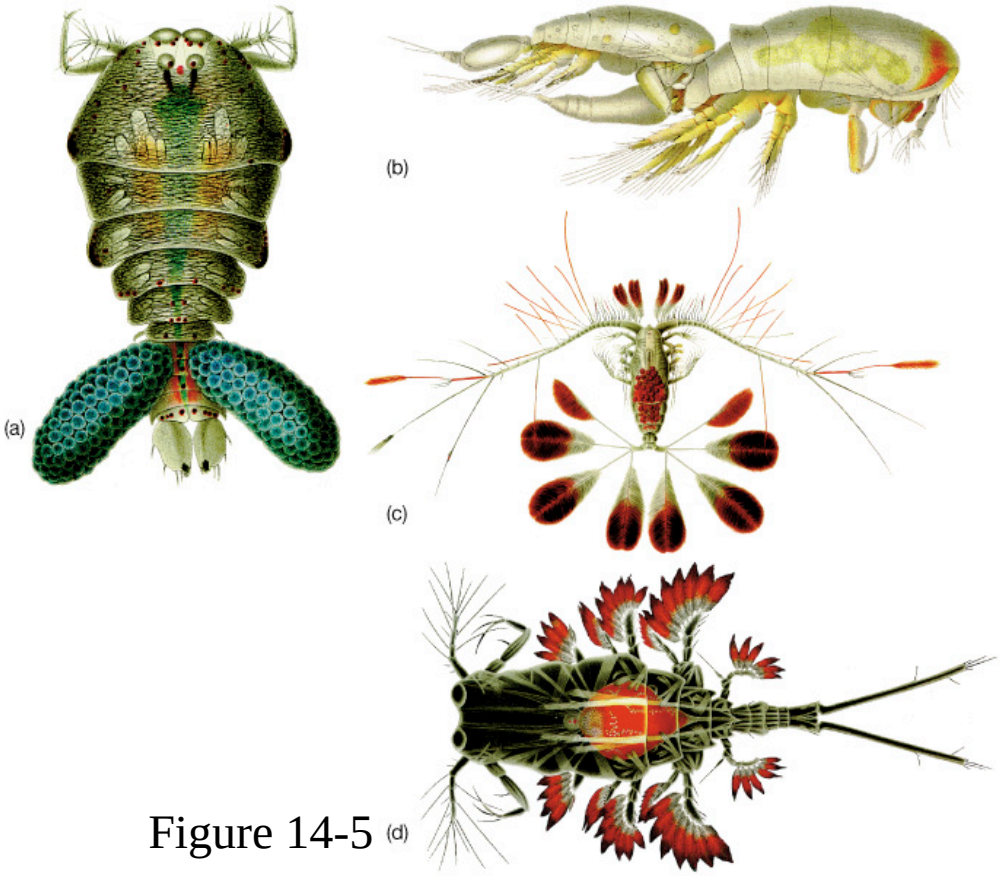
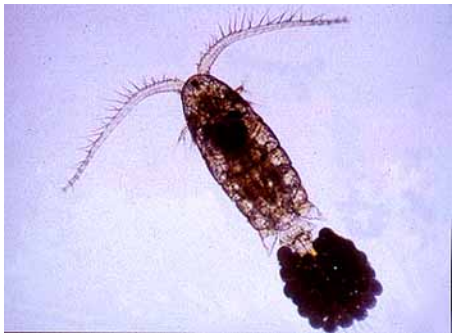
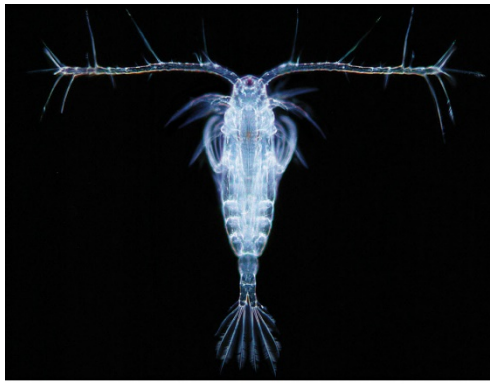


Figure 14-5

Copepods





Females of different species with eggs

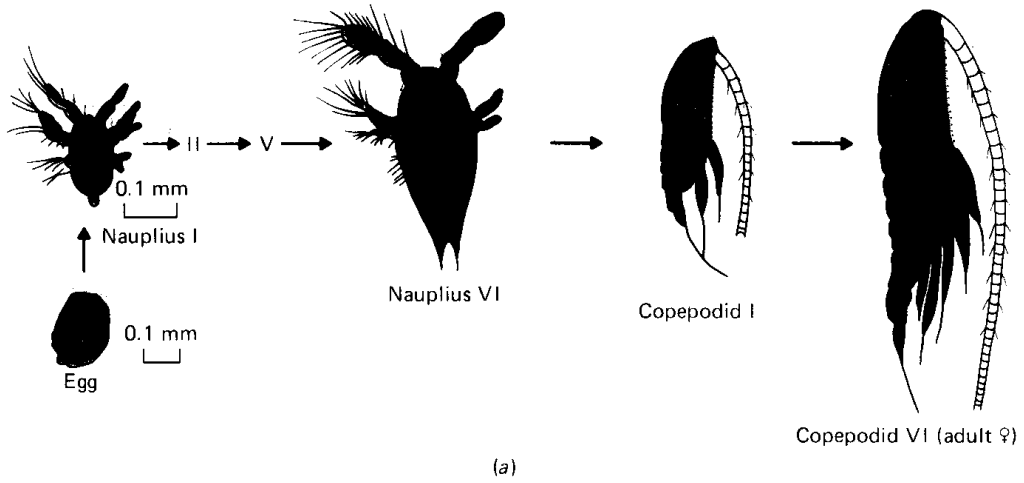
Copepods - Characteristics

- Small invertebrate arthropods
- Multicellular, heterotrophic, eukaryotic
- Use jointed appendages for swimming and feeding
- Found in freshwater, estuaries and the ocean
- Very characteristic of marine zooplankton
- Some are passive filter feeders, but most go after individual particles
- Take algae and small invertebrates
- Adults range from 0.5 mm to 5 mm

Copepods - Characteristics

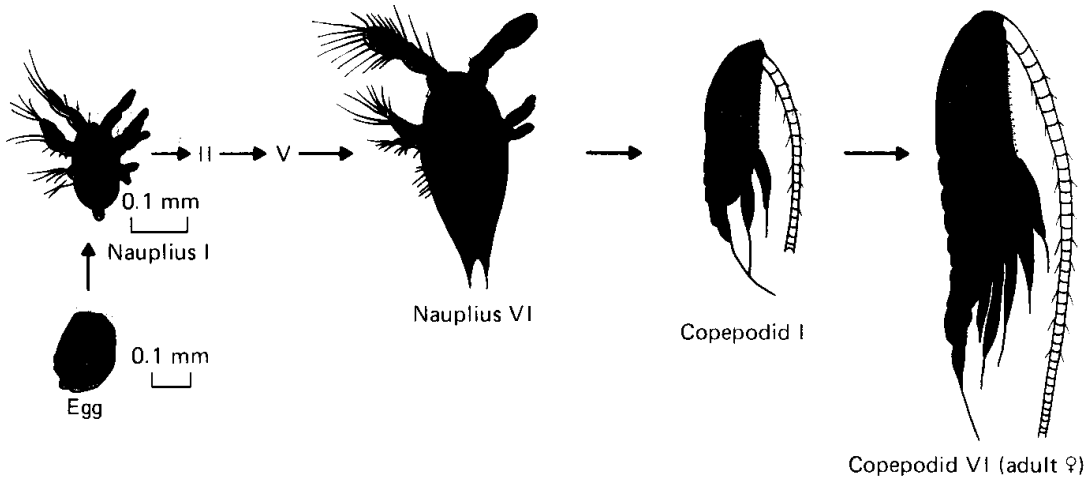
- No asexual reproduction, Fertilized egg hatches into a larva called a nauplius
- Nauplius undergoes a series of molts (6) before changing into a form that looks like an adult (copepodid)
- Copepodid undergoes 6 further molts before becoming an adult Males and females look similar, but males have clasper
- Generation time:

  months to one year



Zooplankton - Characteristics

- Copepods
  - No asexual reproduction
  - Fertilized egg hatches into a larva called a nauplius
  - Nauplius undergoes a series of molts (6) before changing into a form that looks like an adult (copepodid)
  - Copepodid undergoes 6 further molts before becoming an adult (sexually mature)
  - Males and females look similar, but males have clasper
  - Generation time: months to one year



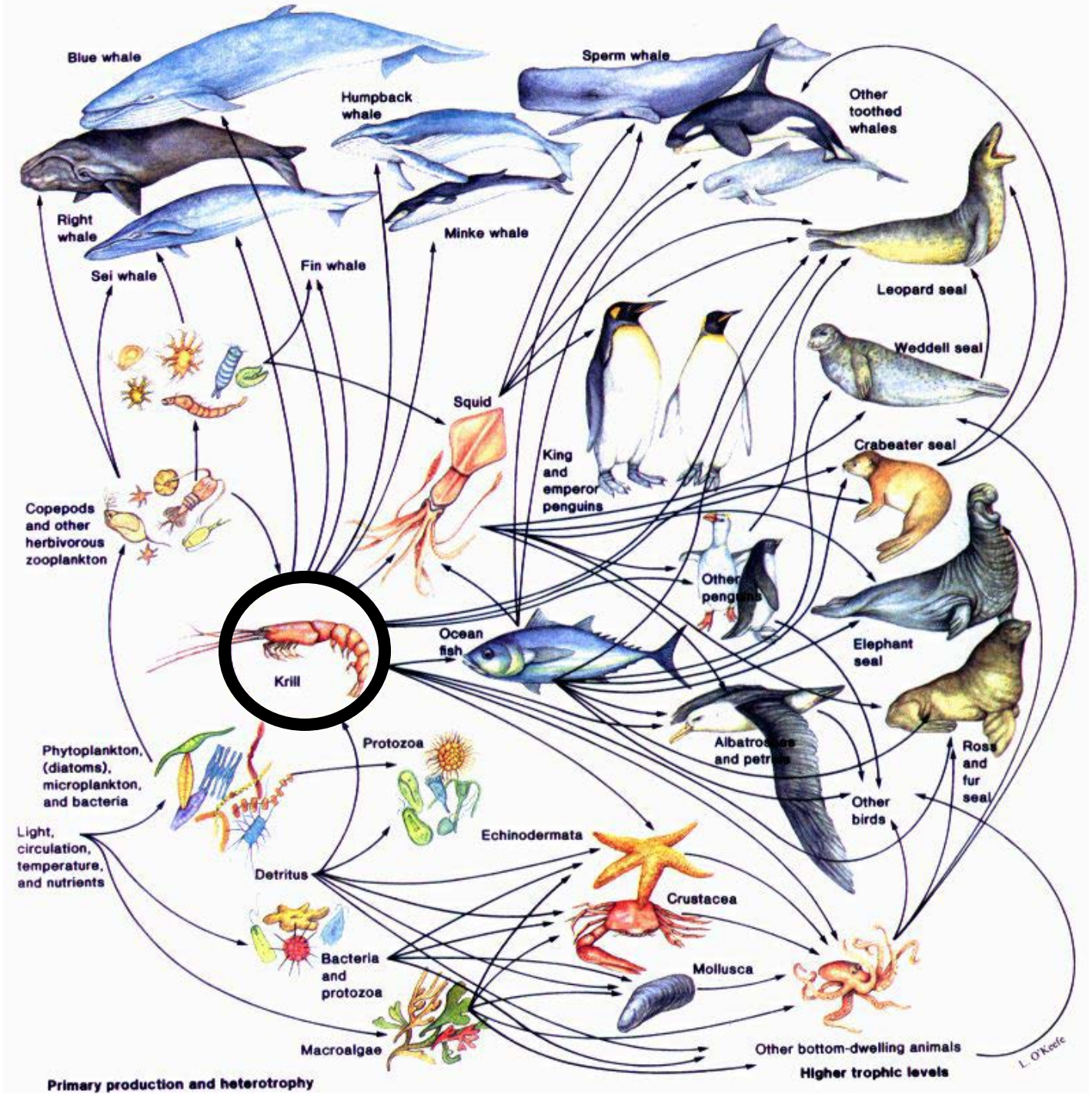
(*a*)

Macroscopic floating organisms: Krill

- Krill are related to copepods but are larger in size
- Abundant in Antarctic waters, Critical in Antarctic food chains

Figure 14-6

Importance of krill in Antarctic food web



V • T • E	Orders of Malacostraca	[hide]
Kingdom Animalia · Phylum: Arthropoda · Subphylum: Crustacea		
Phyllocarida	†Archaeostraca · †Hoplostraca · Leptostraca · †Canadaspidida? · †Hymenostraca?	
Hoplocarida	†Aeschronectida · †Archaeostomatopoda · Stomatopoda (mantis shrimp)	
Eumalacostraca	**Syncarida**	Anaspidacea · Bathynellacea · Palaeocaridacea
	Peracarida	Spelaeogriphacea · Thermosbaenacea · Lophogastrida · Mysida (opossum shrimp) · Stygiomysida · Mictacea · **Amphipoda** · **Isopoda** · †Pygocephalomorpha · Tanaidacea · Cumacea (hooded shrimp)
	Eucarida	Amphionidacea (*Amphionides reynaudii*) · Euphausiacea (krill) · **Decapoda** (shrimp, prawns, crayfish, lobsters, crabs, etc.)
The three most speciose orders are marked in **bold**; obelisks (†) mark extinct orders.		

Eucarida is characterised by having the carapace fused to all thoracic segments, and by the possession of stalked eyes.

Peracarida is defined by the presence of a brood pouch, or marsupium, formed from thin flattened plates (oostegites) borne on the basal most segments of the legs.

Euphausiacea

•commonly called krill whose pleopods (abdominal appendages) function as swimmerets.

•the biomass of the Antarctic krill Euphausia superba' is 500 million tons.

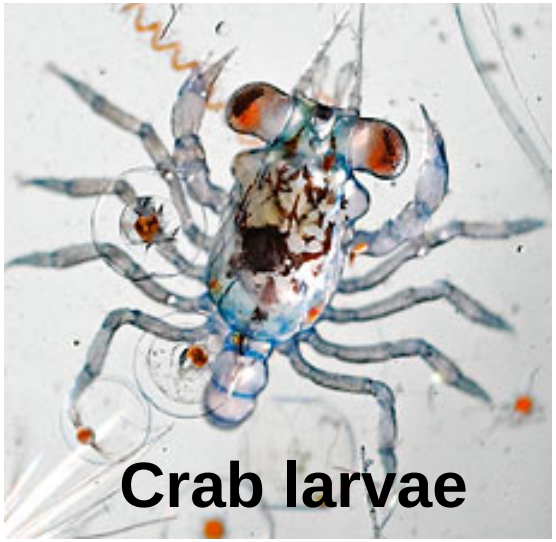
Decapoda

•have 5 pairs of thoracopods and a well-developed carapace that covers the gills (which are exposed in krill).

•The decapods are further subdivided on the basis of the gill structure into two suborders Dendrobranchiata (prawns) and Pleocyemata (shrimps, crabs, lobster).

Chaetognath

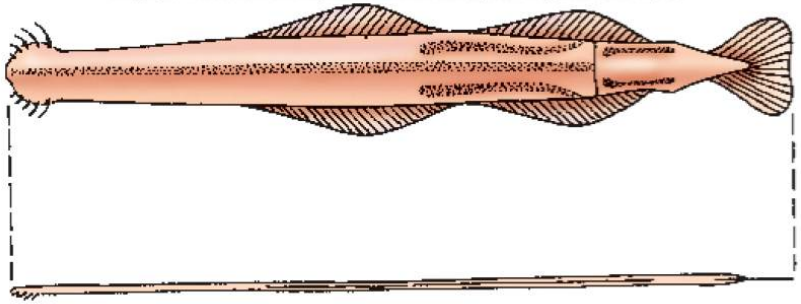
Copepod



Crab larvae

jellies

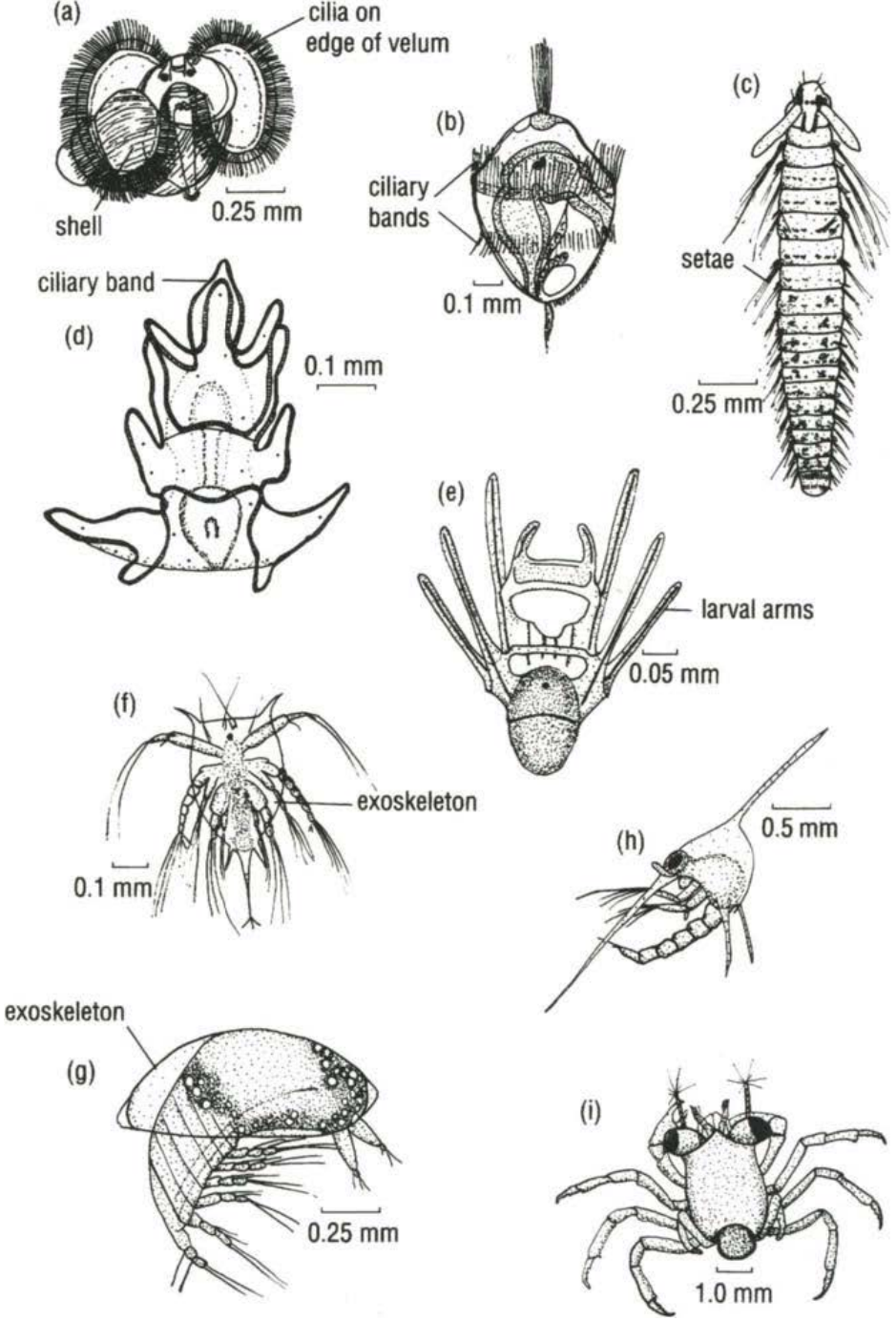
Chaetognaths

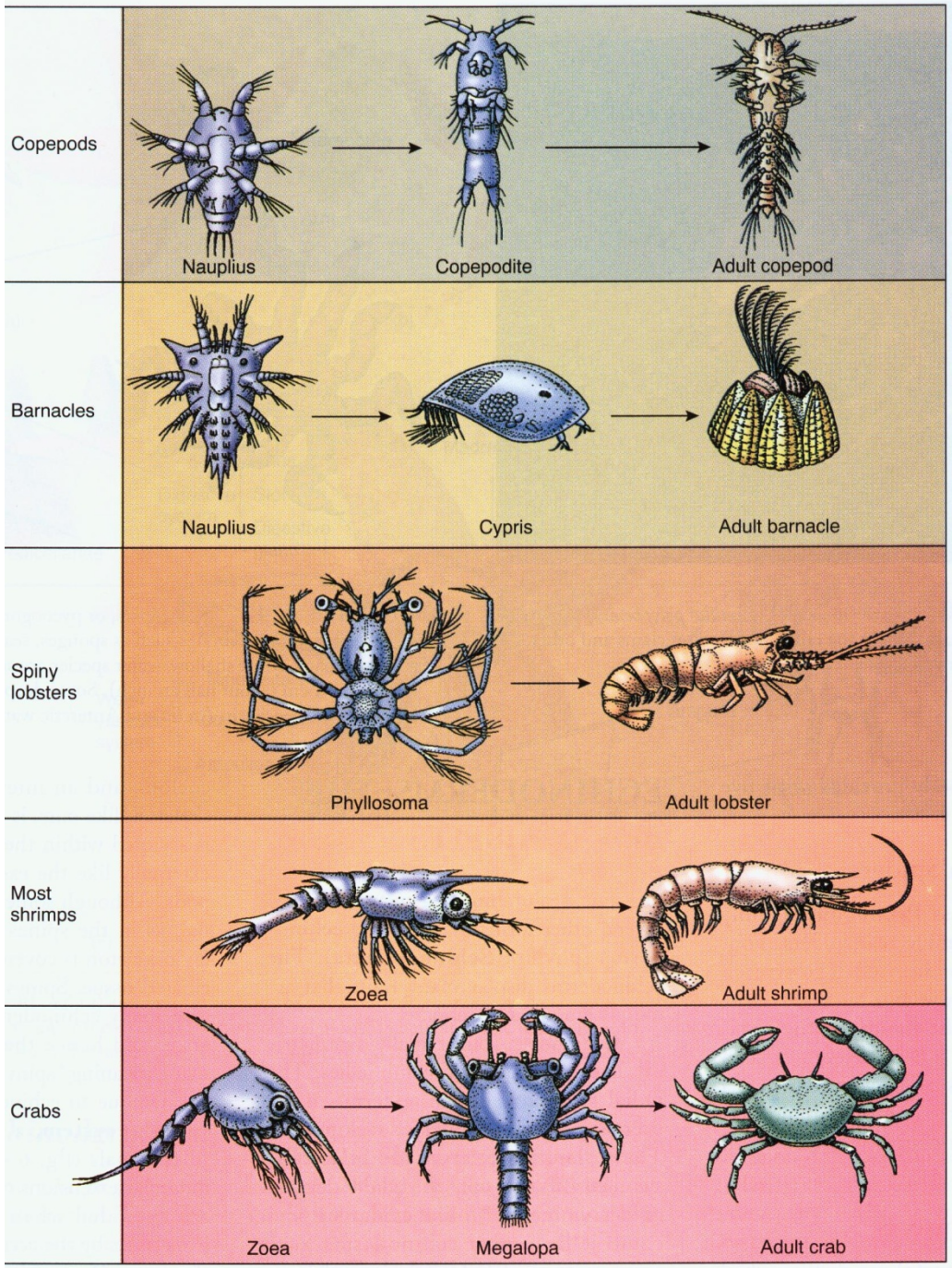


(a) Arrow worm

- Chaetognaths are a dominant part of the plankton, outnumbered only by copepods
- chaetognaths use their mechanoreceptors to follow the vertical migration of prey,
- some species have a specialized venom in the head region that helps to subdue captured prey.
- chaetognaths are an important food source for fish and other marine animals.

Meroplankton




Copepods
Nauplius
Copepodite
Adult copepod
Barnacles
Nauplius
Cypris
Adult barnacle
Spiny lobsters
Phyllosoma
Adult lobster
Most shrimps
Zoea
Adult shrimp
Crabs
Zoea
Megalopa
Adult crab

14-1: Settling Rate

Estimated from **Stokes Law of Settling**.
This equation was derived assuming smooth, spherical particles

sinking rate = $U_S = \alpha B r^2$ (cm sec^{-1})

where:
r is a linear dimension, the equivalent spherical radius of the particle
α is a shape factor; ρ_p is the density of particles and ρ_w is the density of seawater. The density difference, or excess density, is written as $\Delta\rho$.
B is a parameter that depends on the nature of the fluid and the particulate material but not on size.

$$B = 2\ g\ (\rho_p - \rho_w)\ /\ 9\eta \quad (cm^{-1}\ sec^{-1})$$

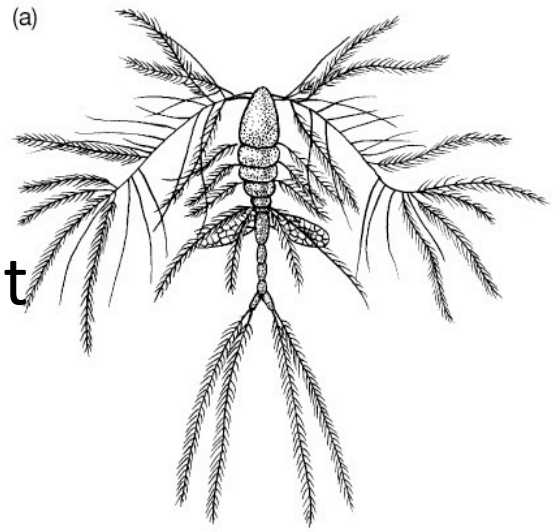
For water (at 20°C) the density of seawater is $\rho_w = 1.025$ g cm^{-3} and viscosity $\eta = 0.01$ g cm^{-1} sec^{-1}. The value of g is 980 cm sec^{-1}.

Thus: $B = 2.18 \times 10^4 (\rho_p - \rho_w)$

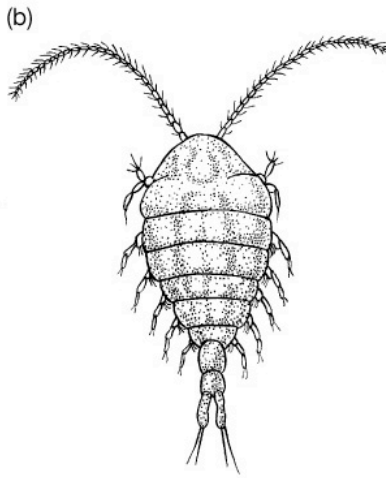
There is always substantial uncertainty in assigning the equivalent spherical radius because natural particles are rarely spherical.

Seawater's viscosity controlled by temperature

- Adaptations:
  - Many warm-water organisms have ornate appendages to say afloat
  - Many cold-water organisms are streamlined to swim more easily
  - Ability to float
  - some produce fats or oils to stay afloat



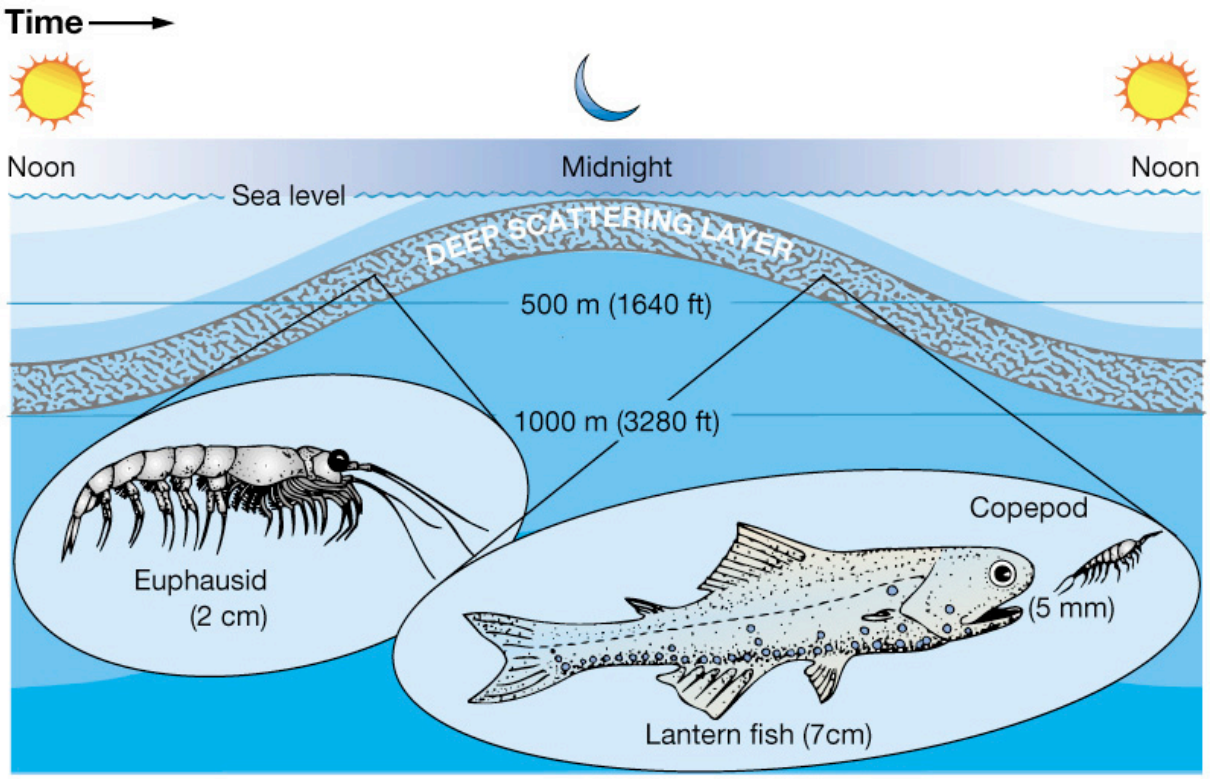
Warm-water copepod



Cold-water copepod

Diurnal vertical migration

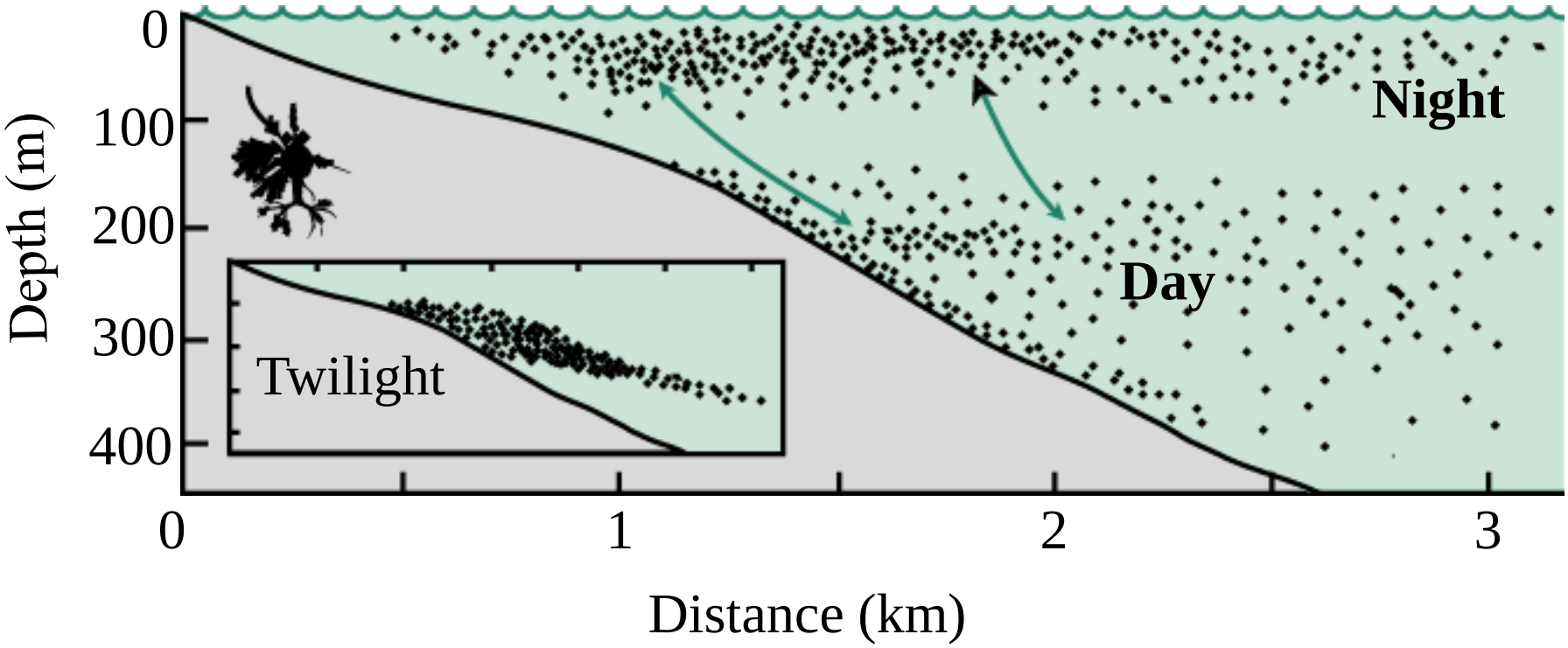
Organisms within the **deep scattering layer** undertake a daily migration to hide in deep, darker waters during daytime



Vertical Migration

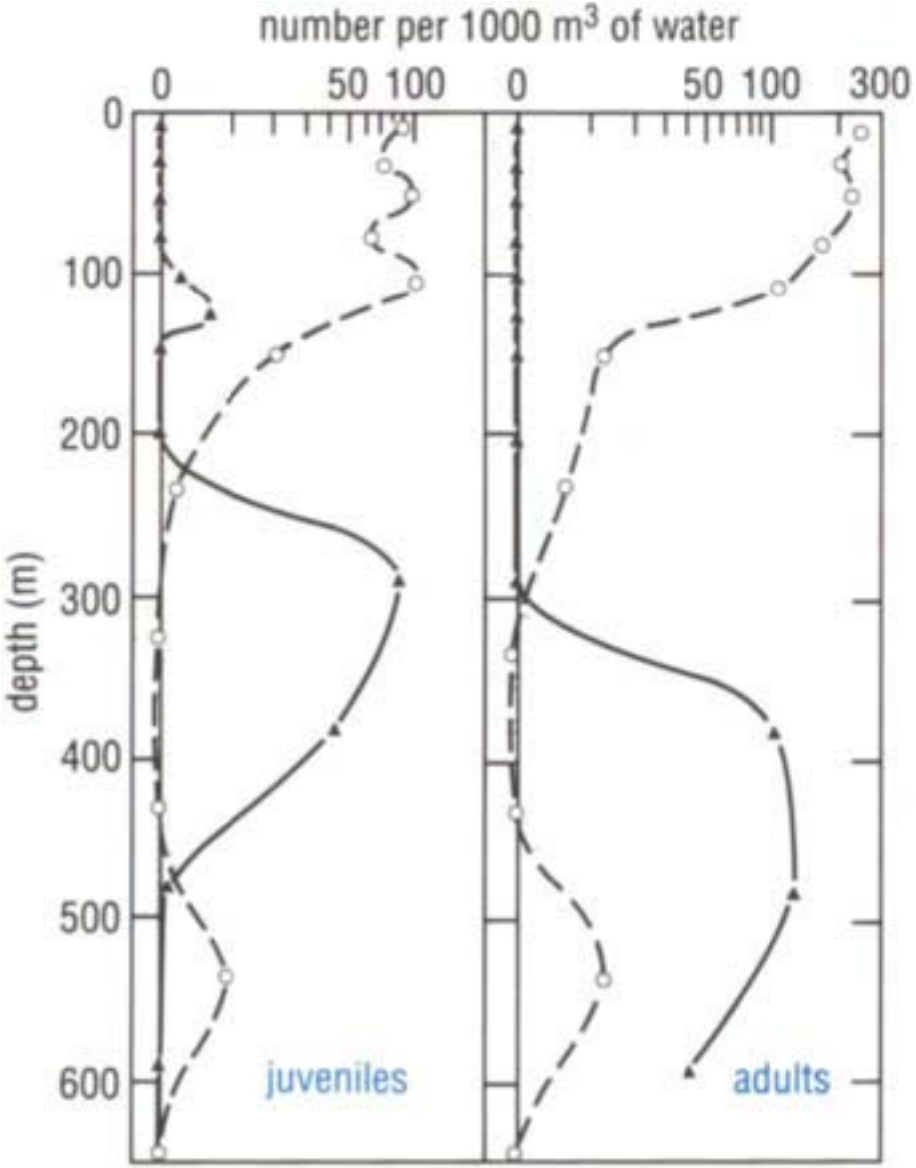
- Zooplankton rise to shallow water at night, sink to deeper water during the day
- Found in many different groups of zooplankton
- Zooplankters usually start to sink before dawn, and start to rise before dusk
- Cycle is probably an internal biological clock that must be reinforced by day-night light changes

Vertical migration of planktonic shrimp *Sergia lucens*



Vertical distribution

Day (solid lines) and night (dashed lines) distributions of the juveniles and adults of *Euphausia hemigibba* at one station in the California Current.



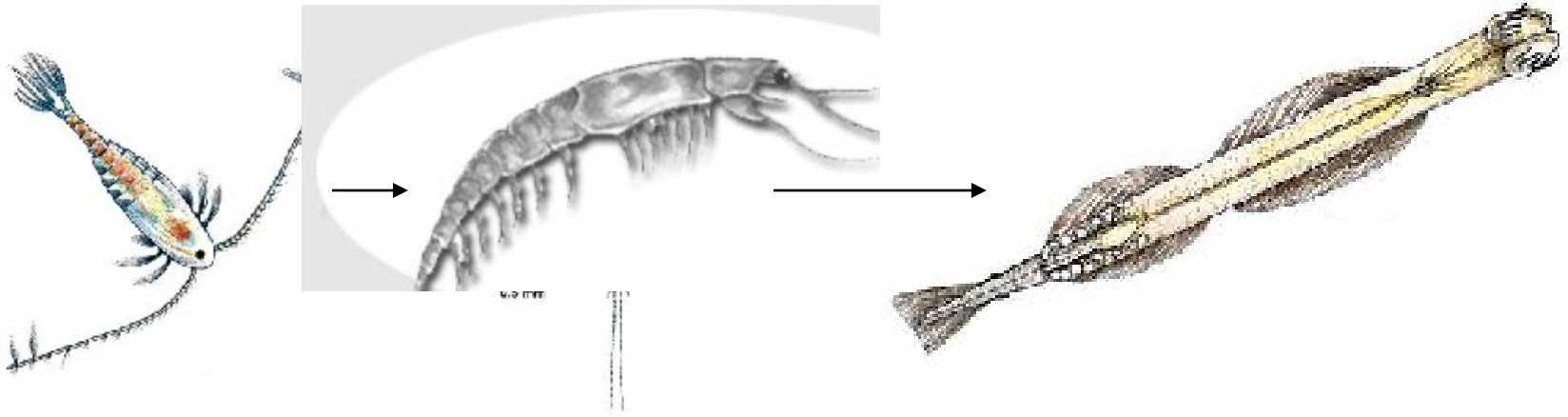
Diurnal Vertical Migration

Each species has its own preferred day and night depth range, which may vary with lifecycle.

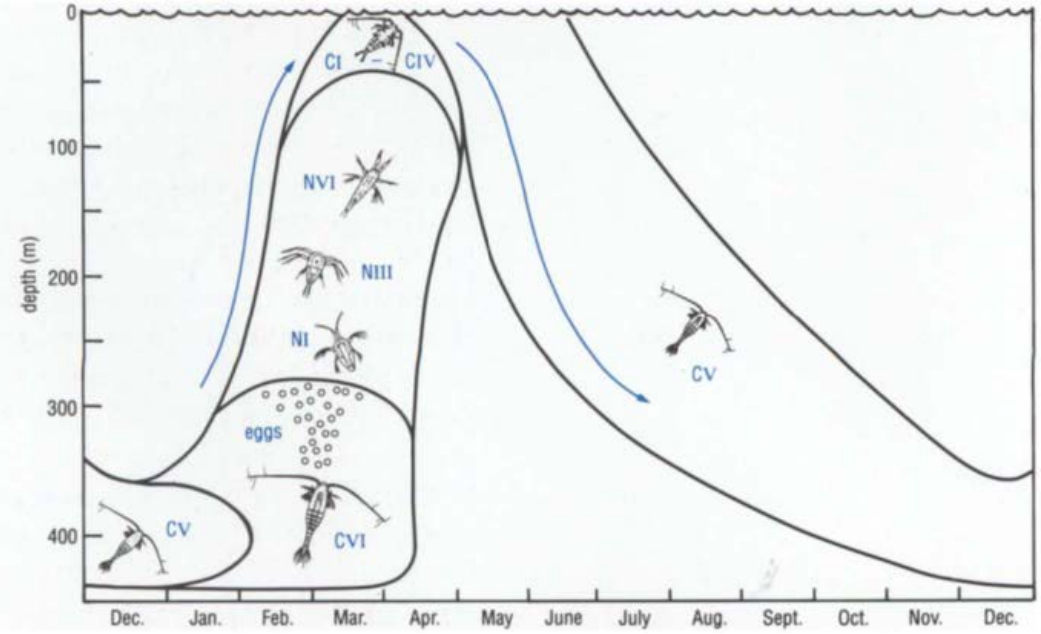
1. Nocturnal Migration
   - single daily ascent near sunset
2. Twilight migration (crepuscular period)
   - two ascents and two descents
3. Reverse migration
   - rise during day and descend at night

Advantages for Diurnal vertical migration

1. An antipredator strategy; less visual to predators
2. 2. Zooplankton migrate to the surface at night and below during the day to the mesopelagic zone.
3. Copepods avoid euphasiids which avoid chaetognaths.
4. Energy conservation
5. Encounter new feeding areas
6. Get genetic mixing of populationsHastens transfer of organic material produced in the euphotic zone to the deep sea



Ontogenic (seasonal) migration

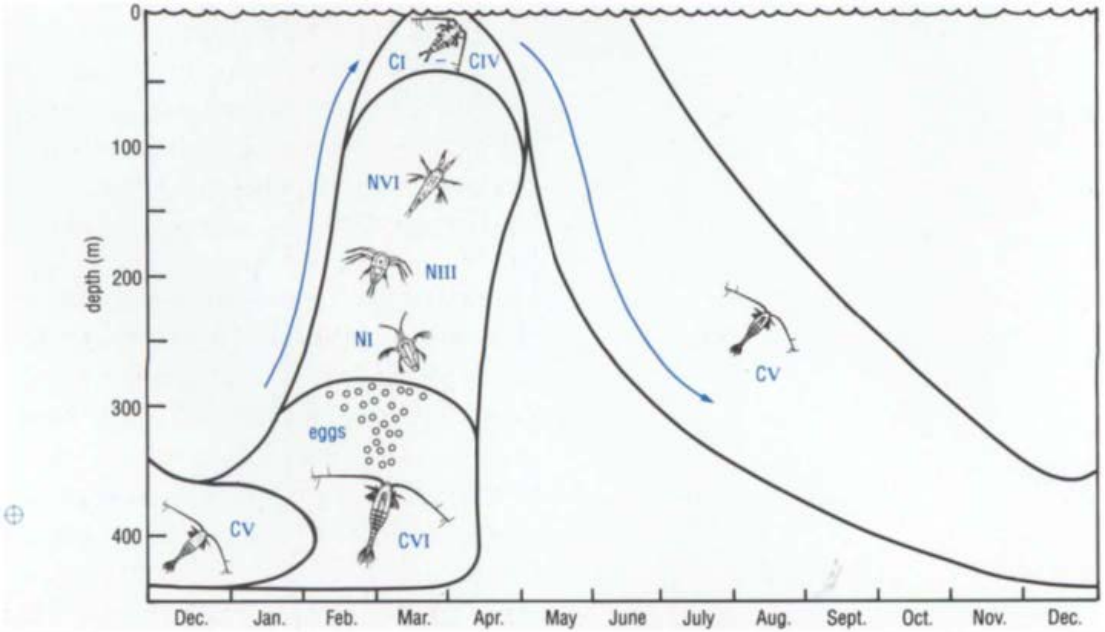


Neocalanus plumchrus adults do not feed, and they overwinter at about 300-450 m depth where the eggs are laid between December and April (Figure 4.18).

The eggs float toward the surface, and nauplii (see Section 4.2) hatch and develop at intermediate depths.

Nauplii are present in near-surface waters from February to April, and the population matures to the copepodite V stage during March to June when primary productivity is highest.

Ontogenic (seasonal) migration

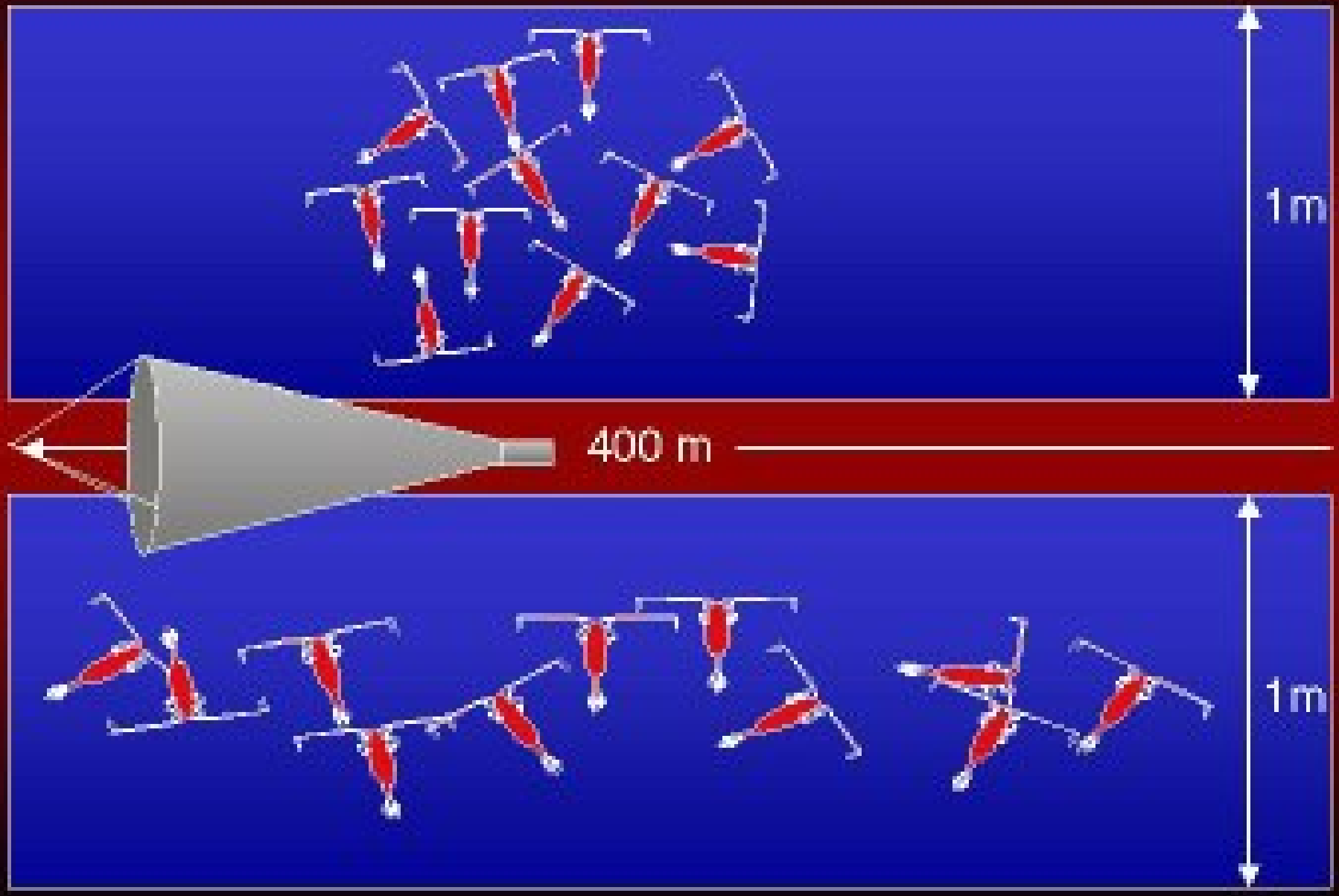


By early June, stage V individuals contain large amounts of lipids accumulated from feeding on phytoplankton, and they begin to migrate to deeper waters where they will subsist on this stored fat reserve. There they mature to the adult stage VI, mate, and lay eggs during the winter.

Patchiness of the Plankton

- Plankton rarely distributed homogeneously in the water column
- Plankton occur in spatially discontinuous patches, sometimes distinct aggregations
- Difficult to detect with plankton nets
- - Nets “average” the catch over the length of the tow
- May explain enormous variability in catches from net tows at close distances apart

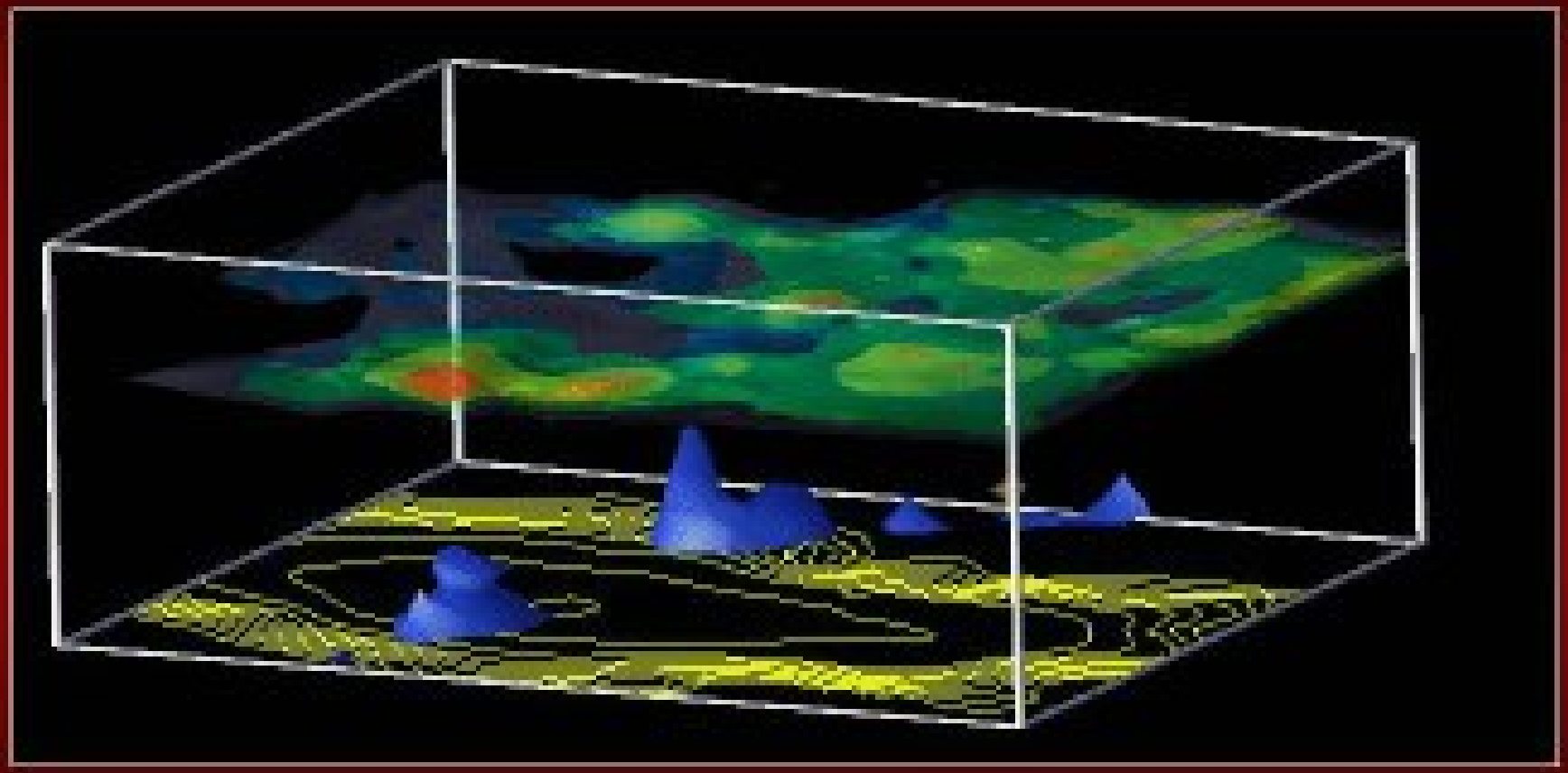
Problems Detecting Patches with Nets



Causes of Patchiness

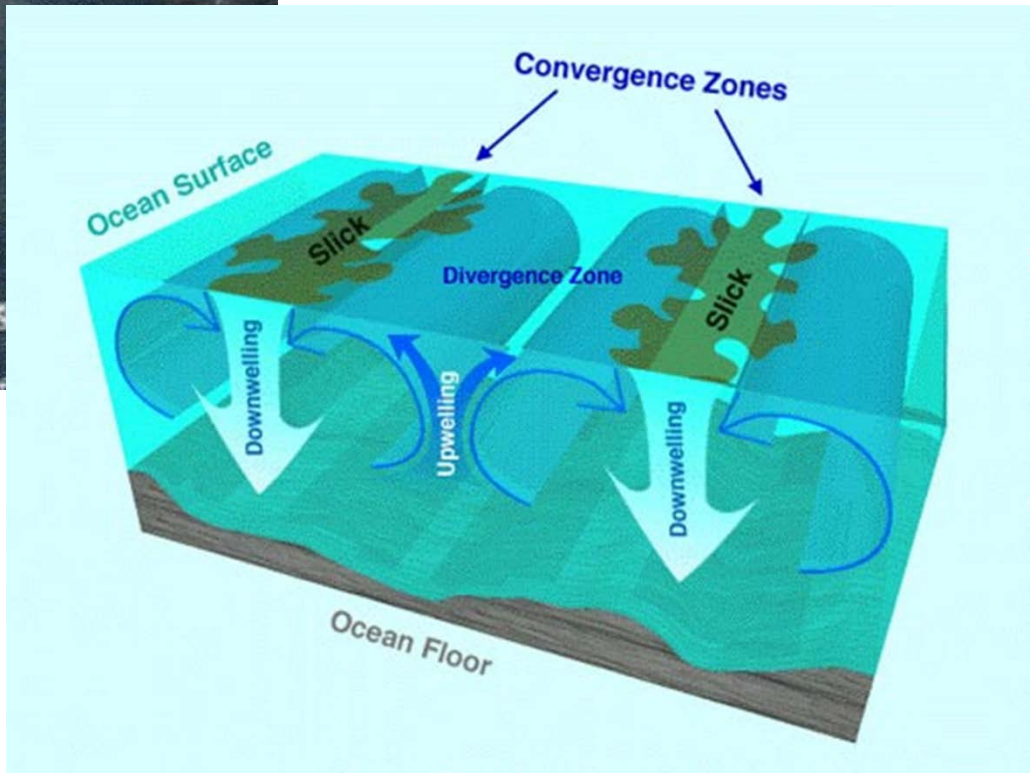
- Aggregations around phytoplankton
  - If phytoplankton occurs in patches, grazers will be drawn to food
  - Similar process that led to phytoplankton patches will form zooplankton patches
- Grazing “holes”
- Physical process
  - Langmuir Cells
  - Internal waves

Grazing Holes



Langmuir Cells

Buoyant particles and upward-swimming zooplankton will accumulate over downwelling zones



Deep sea scattering layer:

- Composite echogram of hydroacoustic data showing a distinct krill scattering layer.
- Black line represents surface tracking of a blue whale feeding