MOLLUSCS: A MICROCOSM OF INVERTEBRA TE ZOOLOGY

AN INTRODUCTION TO THE GREAT PHYLUM MOLLUSCA

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GENERAL OVERVIEW
(Telegraphic style)

Success! More than 50,000 extant species, about 25,000 extinct.

2nd largest phylum (1/20 species in Arthropoda; 2 x species in Vertebrata).

Ubiquitous: most marine, to 10km; + freshwater, land;

Density: to 40,000/m^2

Size: 1 mm to about 16 m length!

Fossil record: Lower Cambrian to Recent. (Lower Cambrian 545 my before present)

Lower Cambrian classes: Gastropoda, Bivalvia, and Monoplacophora.

Upper Cambrian classes: Polyplacophora, Cephalopoda.

Ordovician: Scaphopoda + extinct classes.

No fossil record: Aplacophora

MOLLUSCS AND MAN

Food, money, jewellery, pests, vectors of parasites, etc.

MOLLUSCS IN SCIENCE

Basic nerve function; nerve cell networks linked to behaviour.

THREE ANATOMICAL GENERALISATIONS ABOUT MOLLUSCA

1, **Complexity** . Organ-system grade; all functional systems are well-developed; bilateral symmetry, 3 primary cell layers, coelom (small: main body cavity is hemocoel).

2, **Diversity** . No single "hallmark;" array of traits.

3, **Body plan** . Head, foot, visceral mass covered by mantle and usually a shell. (But demarcations between body regions are not always clear).

THE GENERALIZED MOLLUSC:
External morphology

Body regions: head, foot, visceral mass, mantle, and shell.

Mantle cavity: Contains gills ("ctenidia") divide mantle cavity into inhalent and exhalent chambers. Importance of cilia. Pathway of water flow in mantle cavity.

Shell: $CaCO_3$ + proteins; crystal architecture.

Internal organ systems of generalized mollusc

Digestive: Mouth, jaws, radula; alimentary tract, glands.

Nervous: Cerebral, pedal, pleural, visceral ganglia, or more, or none.

Circulatory: Heart (3 chambers) i dorsal; vessels; hemocoel; open system; relation to excretory system ("nephridia").

Coelom: Reduced. Occurs in pericardium, excretory, and reproductive systems.

Reproduction and Development: Most dioecious. Spiral, unequal, determinate cleavage. Gastrula to trochophore larva; expands along secondary axis forming visceral mass, mantle-shell, foot. Pre-oral ciliated band of trochophore, becoming the

Body axes:

Axis	Organ systems	Power source	Major functions
Primary (Somatic) (Anterior-Posterior)	head, foot	muscle	locomotion, feeding
Secondary (Visceral) (mainly Dorsal-Ventral)	visceral mass, mantle, shell	cilia	respiration, digestion, reproduction

velum of veliger larva (in some classes). Metamorphosis.

MOLLUSCAN COMPLEXITY AND DIVERSITY
Characters of 7 Classes in brief

Class APLACOPHORA
"no plates"

2nd smallest (about 150 species); no shells; no fossils. Shallow subtidal to 4000m.
Wormlike, with mantle of thickened cuticle, many $CaCO_3$ spicules.
Head poorly developed; Foot vestigial or absent; no visceral mass or 2nd axis.
Mantle cavity small, posterior; 1 pair ctenidia or several respiratory papillae; radula
Habits and diversity:

Order/Subclass/Class CAUDOFOVEATA
About 25 species, head-down infaunal deposit feeders in mud, posterior end up.

Order/Subclass/Class SOLENOGASTRES
About 125 species, ectoparasitic on Cnidaria; more distinct head than CAUDOFOVEATA.

Class MONOPLACOPHORA
"one plate"

Lower Cambrian to Devonian (until 1957 when *Neopilina* was discovered!)
Smallest class: about 20 extant species. All marine, on hard substrate in 180-4000 m.
Head anterior, ventral, like chitons; Foot flat, circular, weak; Visceral mass conical; Mantle, shell limpet-like; Mantle cavity a lateral groove.
Neopilina: 5-8 pairs muscle scars; bilateral symmetry; limpet-like (cap-shaped shell).
Nervous system ladder-like: 2 pairs longitudinal nerves, 10 pairs connectives, no ganglia. Cf. Polyplacophora.

Class POLYPLACOPHORA
"many plates"
The chitons

About 600 species; Morphologically most uniform class.
Adapted to hard substratum, shallow water, but to 7,000 m!
Head: definite but reduced; visceral mass: depressed; foot: large, flat;
Mantle: girdle, 8-piece shell, with thin outer cuticle; shape of shell plates.
Shell: Outer shell layer $CaCO_3$ but more or less soft, pigmented, perforated: with sense organs. Inner shell layer extends under valve in front yielding flexibility, strength.
Feeding and digestion: Most chitons herbivorous, with typically molluscan system.

Class GASTROPODA
"stomach foot"
The snails, nudibranchs, etc.

The largest molluscan class: About 35,000 Recent species, most varied habitats.
"Definition": Molluscs that have undergone torsion.
Primitive members retain broad flat foot; head well developed.
Visceral mass: much enlarged along 2nd axis, coiled.
Mantle-shell: enlarged, coiled, specifically conispiral; mantle cavity typically anterior.
Torsion: 180° twist of visceral mass on head-foot.

Class BIVALVIA
"two-valved shells"
Clams, mussels, scallops, oysters, etc.

About 10,000 species; marine + freshwater; Lower Cambrian-present. Mainly Mesozoic-present.
Secondary axis important; Head absent; compressed, usually large, digging, may attach by byssal threads, sucker.
Visceral mass extensive D-V.

Mantle-Shell usually encloses entire body; decalcified dorsally, of 2 valves with hinge, teeth. Ligament: C-spring or resilium: resilin (protein similar to rubber). Antagonises adductor muscle(s). Mantle cavity large, down and forward.
Ctenidia: long (D-V), enlarged (A-P), lamellae/filaments, main food collecting organs; ciliary pumping and ciliary-mucus feeding.
Mantle assumes head, gill functions; mantle fusion, siphons. U-shaped water flow pattern, inhalent, exhalent chambers in mantle cavity.
Siphon types related to suspension and deposit feeding.

Class SCAPHOPODA
"spade-footed"
Tusk shells

About 300 species; morphologically conservative; all marine in soft sediment, from intertidal to
more than 3,000 m. Size up to 15 cm length.
Active subsurface predators, mainly on foraminiferans.
Secondary axis emphasised; Head a buccal tube with two groups of many long and thin tentacles ("captacula").
Buccal mass with very large radula.
Foot very large, piston-like, digging.
Visceral mass elongate;
Mantle in tubular shell, with mantle cavity open at both ends; water circulation in + out posterior opening.
No ctenidia.

CLASS CEPHALOPODA
"They Bear Their Feet on Their Heads"
Squids, Octopus

Muscle molluscs: Biggest (16 m), smartest, fastest marine invertebrates; inventors of submarine, smoke screen, jet propulsion.
All marine, ca. 600 species, 7,000 fossil species; Upper Cambrian origin; most members of class Mesozoic, most extinct at end-Cretaceous mass extinction.
Secondary body axis predominates, primary axis reduced.
Head highly developed.
Foot much modified, into arms + siphon (=funnel).
Visceral mass elongate, coiled in 1 subclass.
Shell usually reduced or absent; Mantle muscular (as is 2nd axis!).
Orientation of body: functional vs. morphological.
The cephalopod personality
(In contrast to other molluscs): Adaptations for active lifestyle: rapid muscular movement, large size complex body plan; importance of head: sense organs: vision important; centralised nervous system; behaviour: increased dependence on prior experience. Skeletal and circulatory systems. Muscular hydrostats.