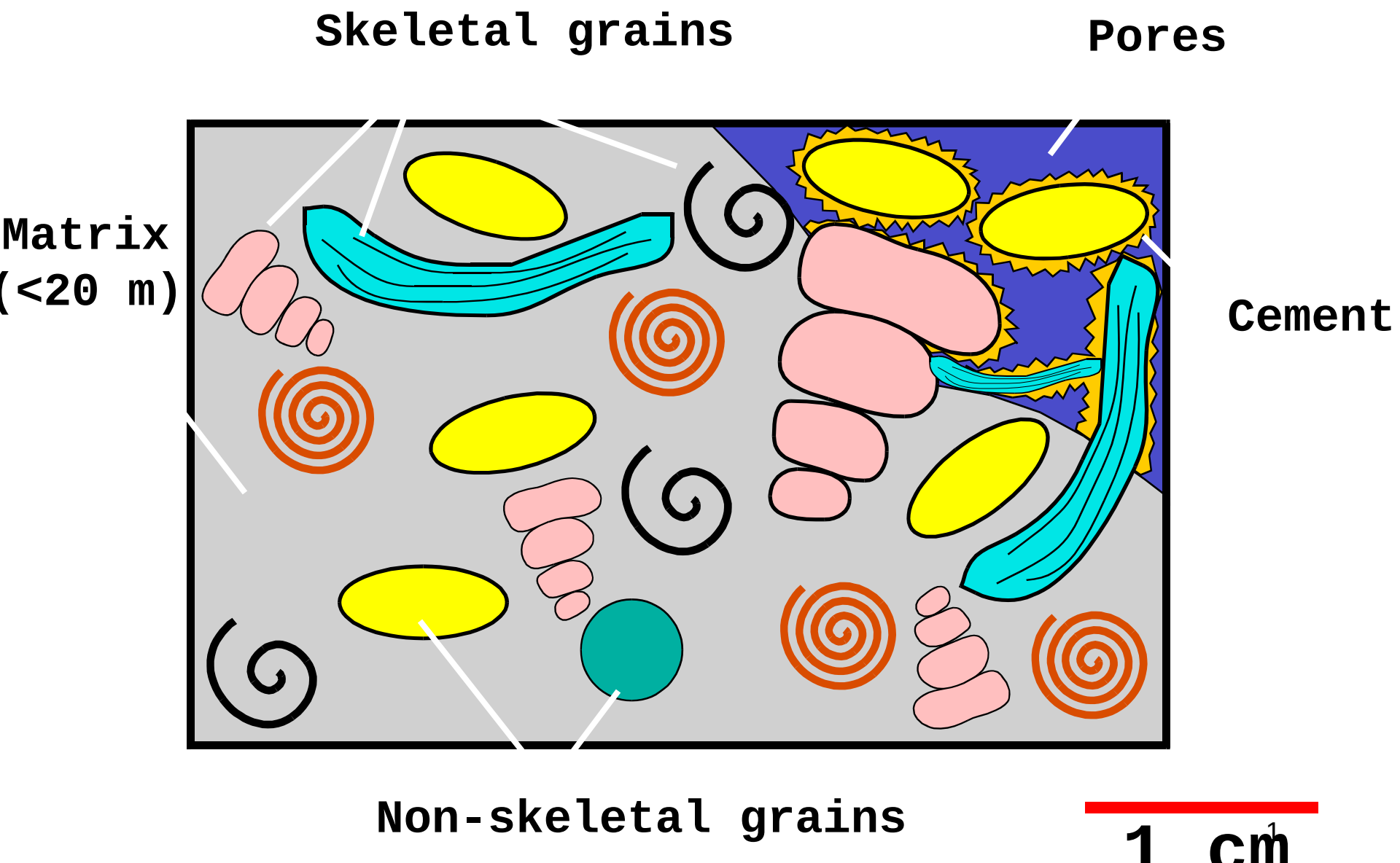
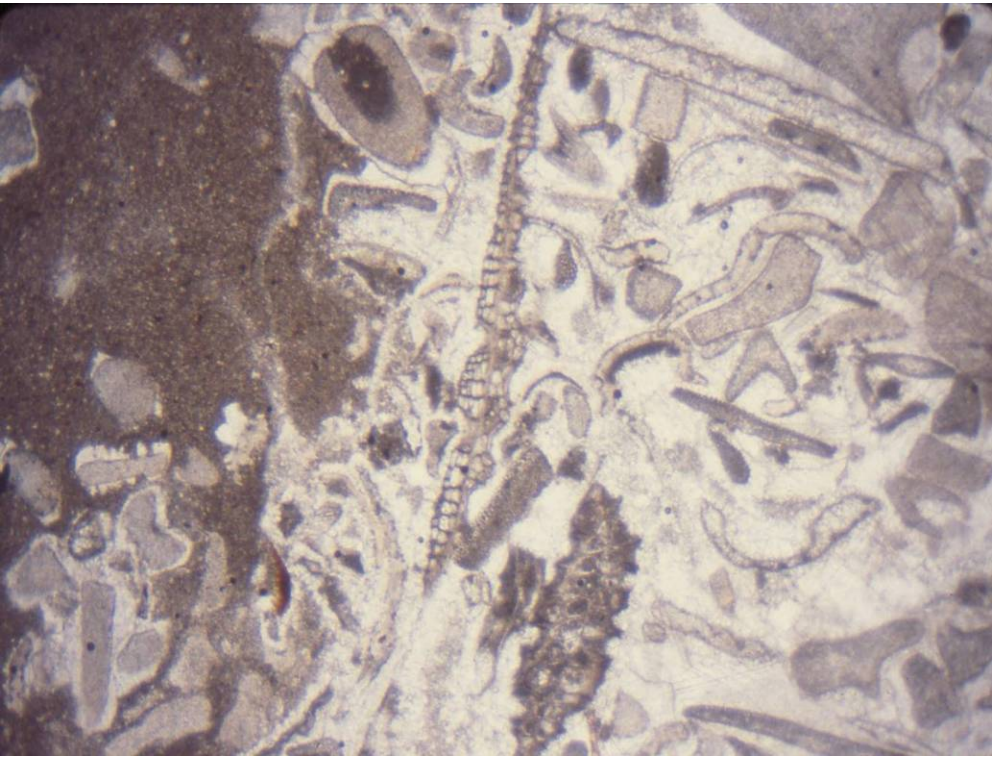
Components of a Carbonate rock



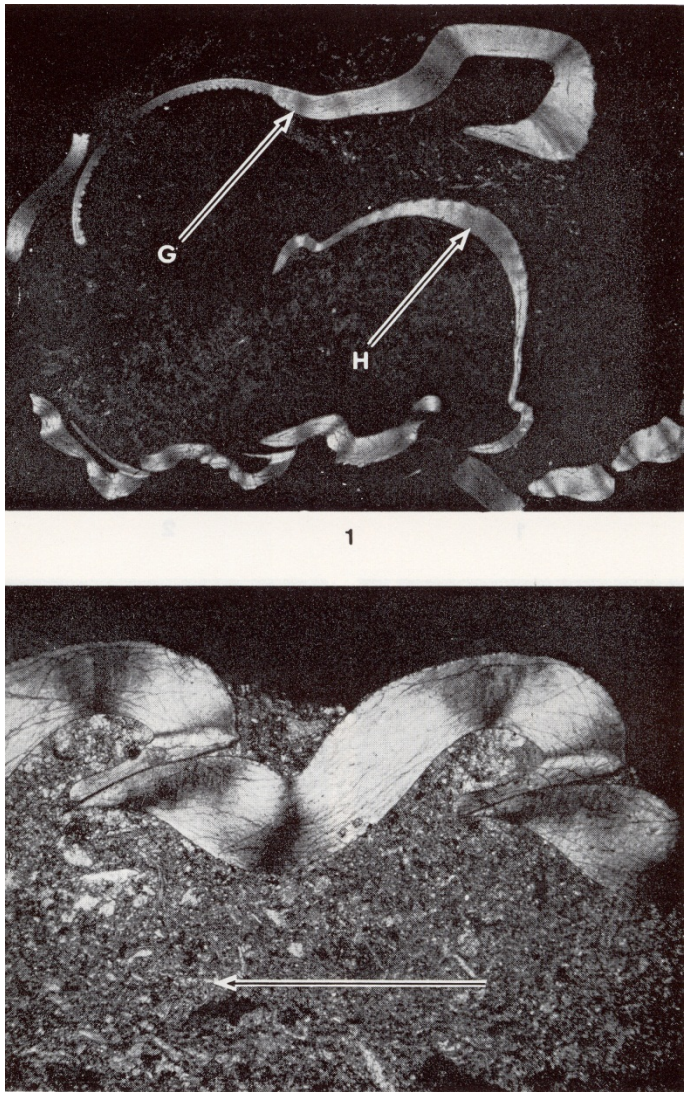
Differentiation of Fossil Allochems



- Morphology
- Size
- Skeletal microstructure
- Mineralogy

Morphology

Trilobites

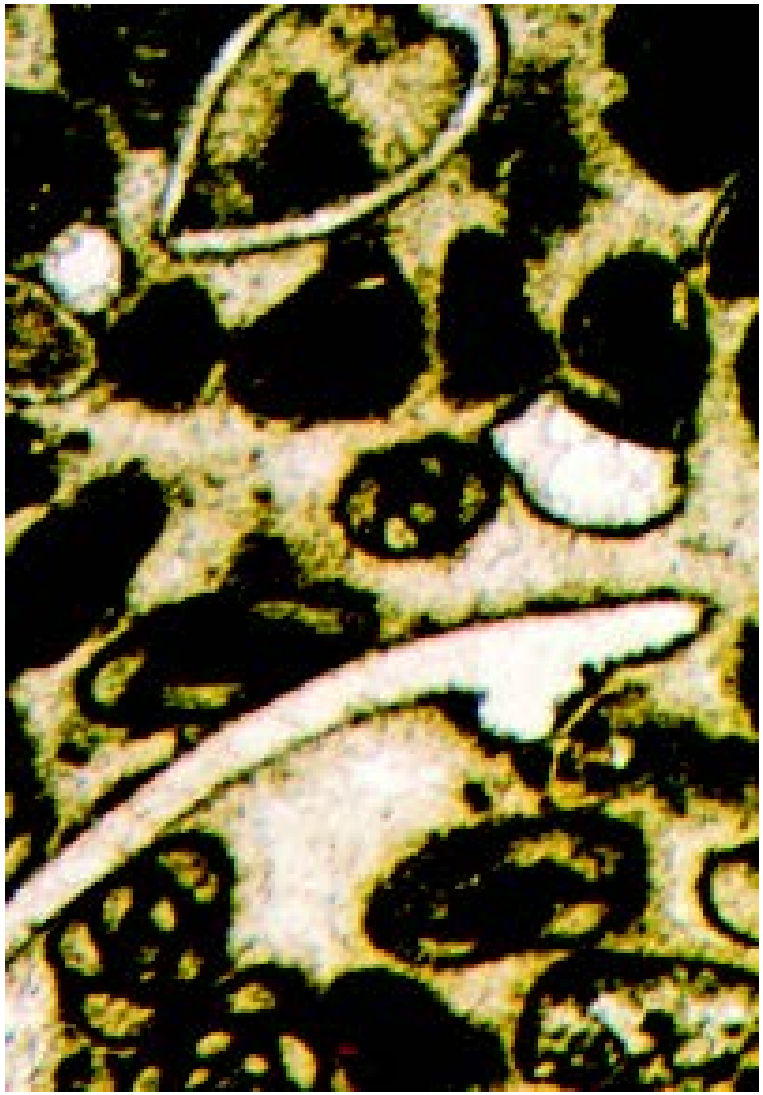


Gastropods

Size

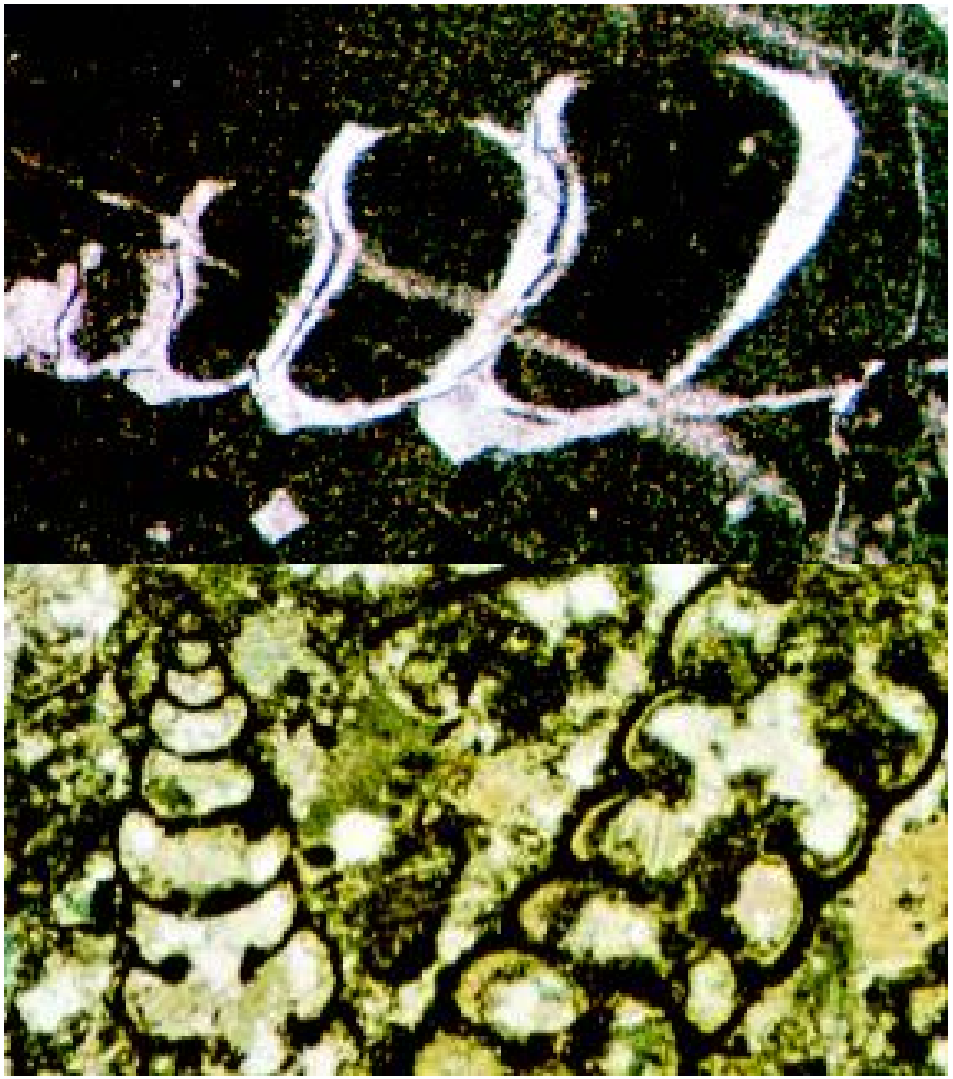
Bivalves & Ostracodes

~1 cm



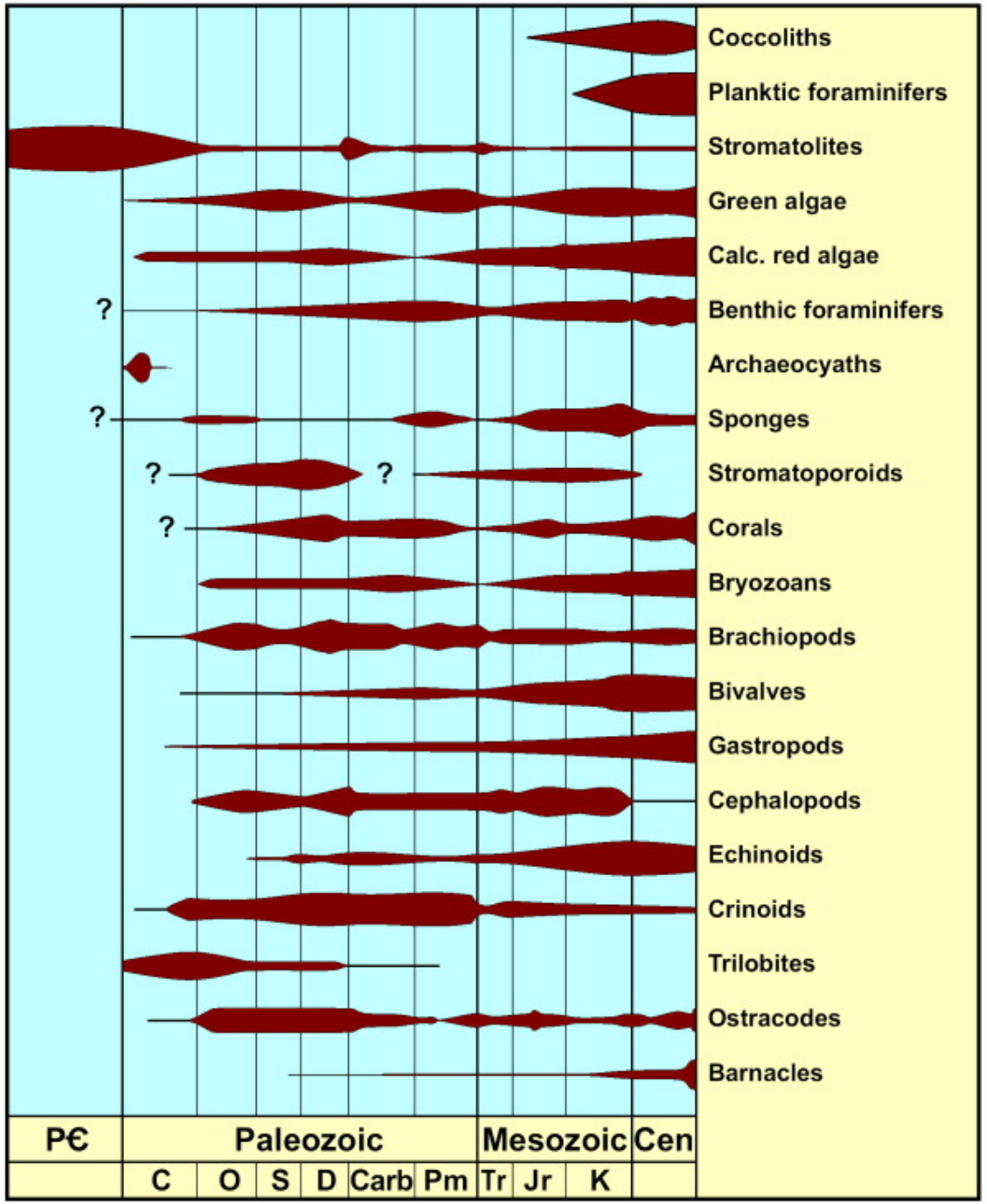
Gastropods & Forams

1 cm



1 mm

Temporal Distribution of Major Faunal Groups



Temporal Distribution of Major Faunal Groups

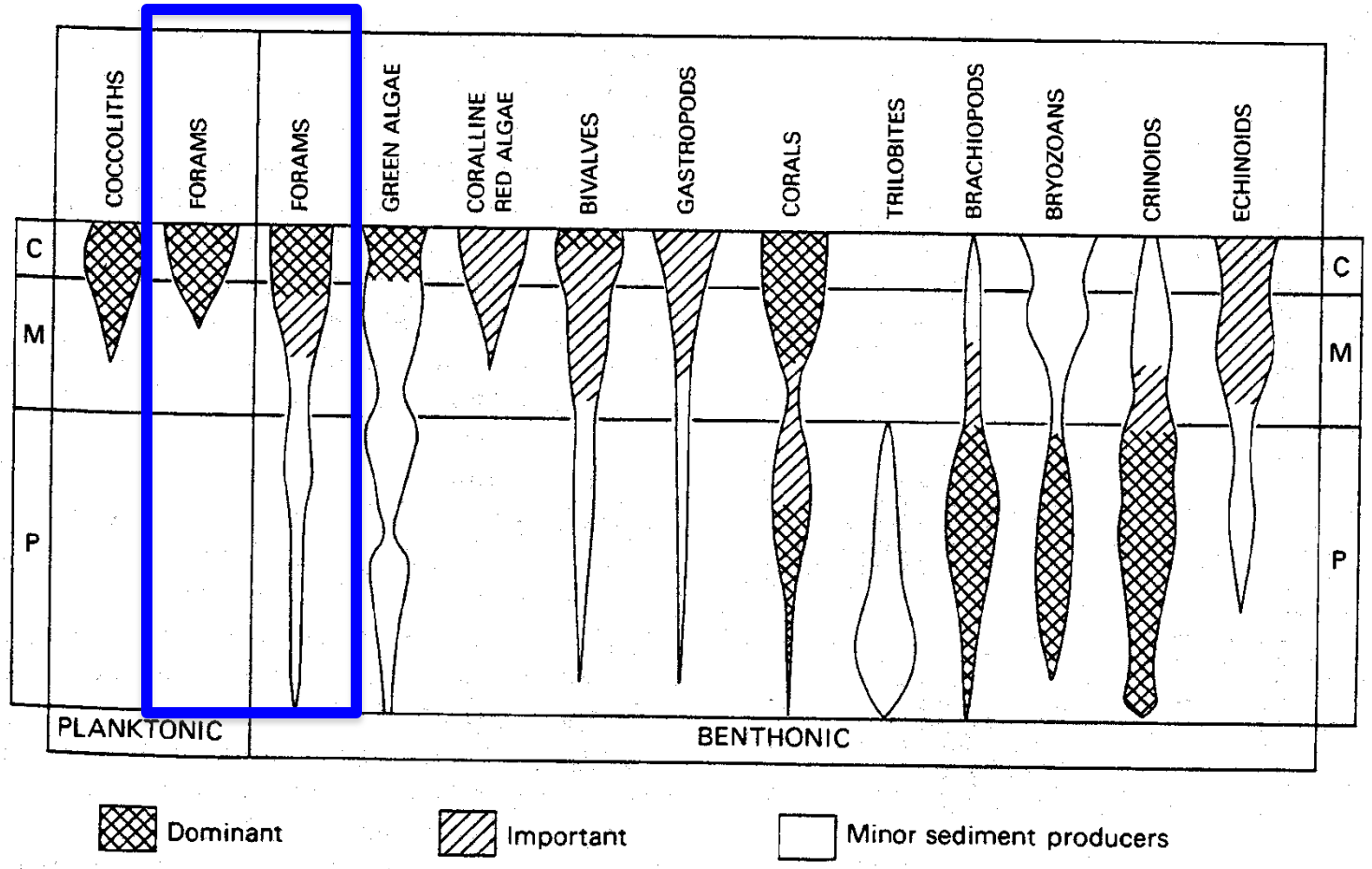


Figure 4.1 Diversity, abundance and relative importance of various calcareous marine organisms as sediment producers. After Wilkinson (1979).

Carbonate Producers: Foraminiferida

- Protists (unicellular organisms) that secrete or agglutinate a mineralized covering
- Larger benthic foraminifera dominate shallow waters (< 400m)
- Significant forms in the fossil record
  - Fusilinids; Devonian to end of the Paleozoic
  - Miliolids; early Carboniferous to Recent
  - Nummulites; Eocene (Pyramids!)

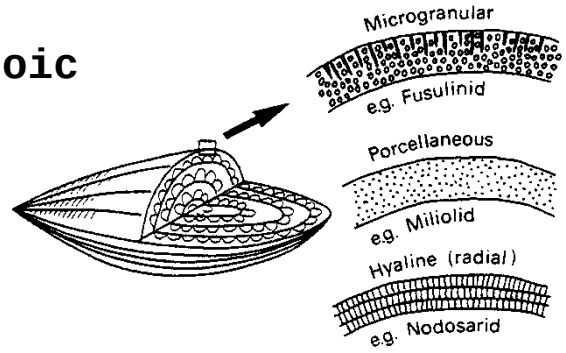
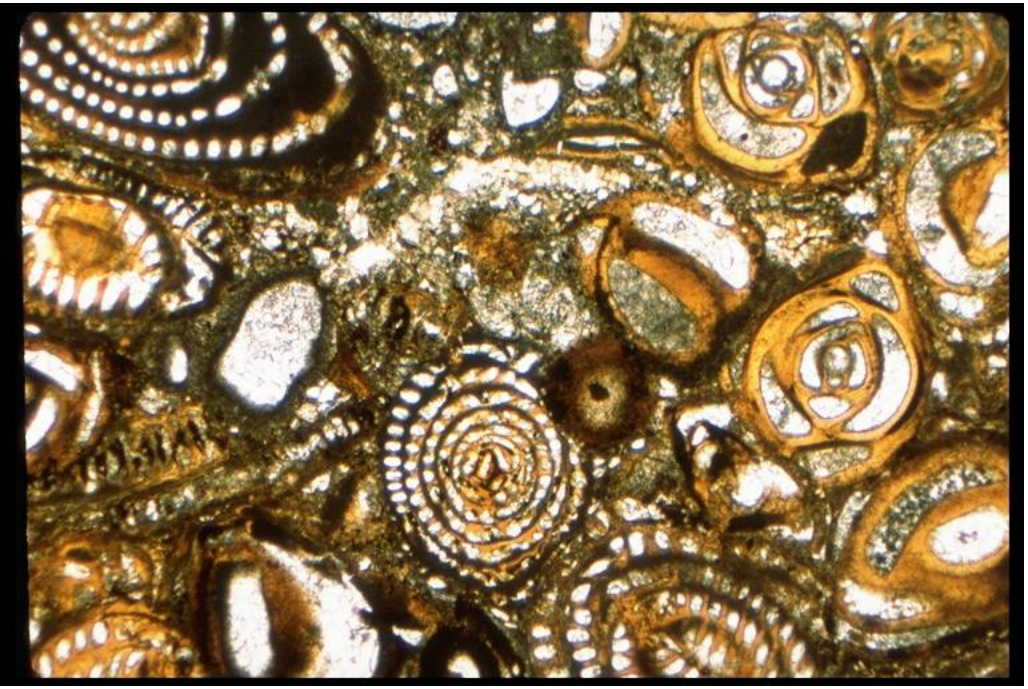


Figure 4.2 Varieties of wall structure of skeletal foraminiferans



Temporal Distribution of Major Faunal Groups

Mollusca

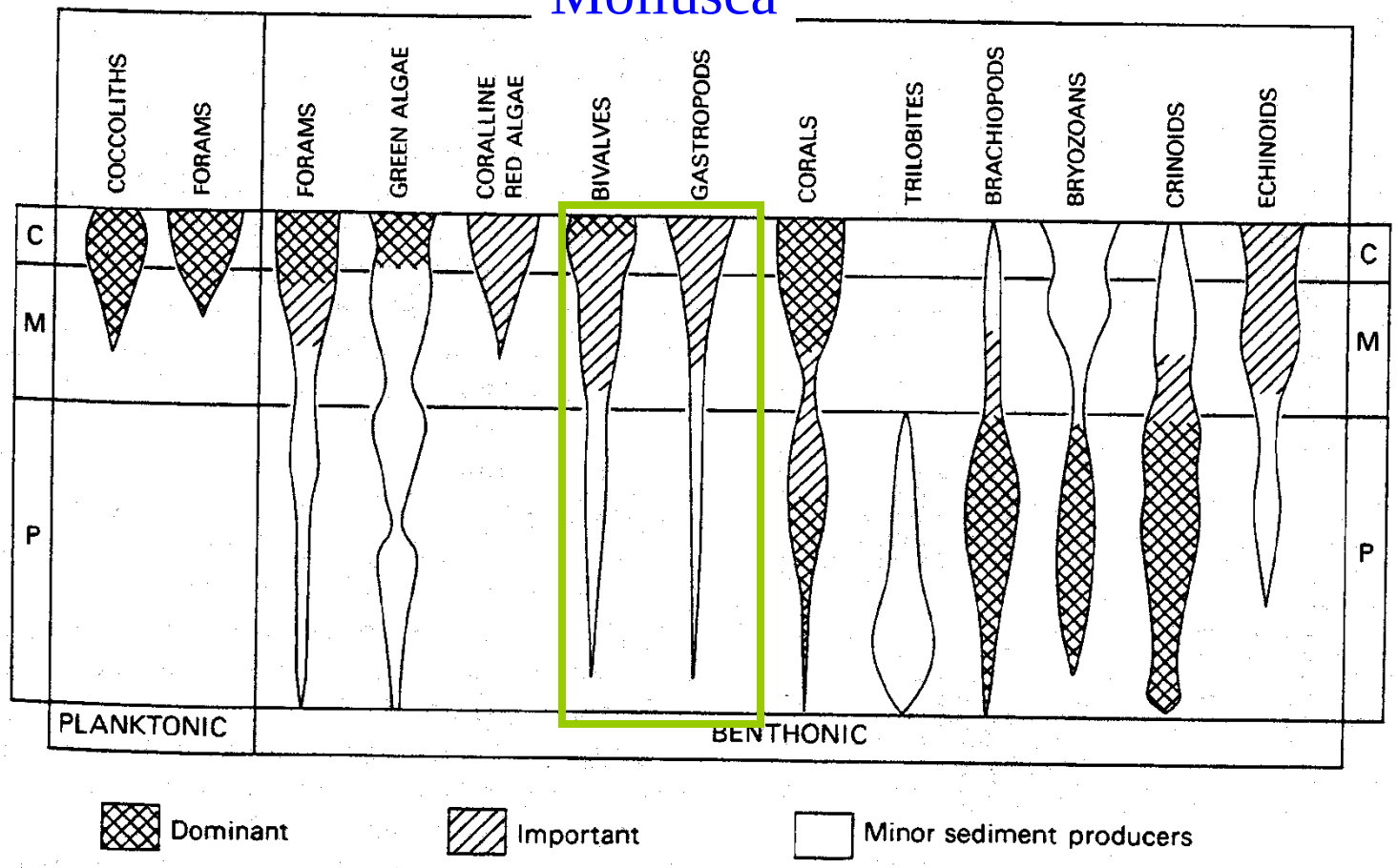


Figure 4.1 Diversity, abundance and relative importance of various calcareous marine organisms as sediment producers. After Wilkinson (1979).

Carbonate Producers
Mollusc - Bivalves

- Bivalve shell structure
- Important sediment contributors, especially since the cenozoic and the decline of the brachiopods
- Life modes vary from
  - infaunal (w/I sediment)
  - epifaunal (on substrate)
  - vagile (crawlers)
  - nektonic (free swimming)
  - planktonic (free floating)
- Commin Bimineralic shell
  - Aragonite & calcite

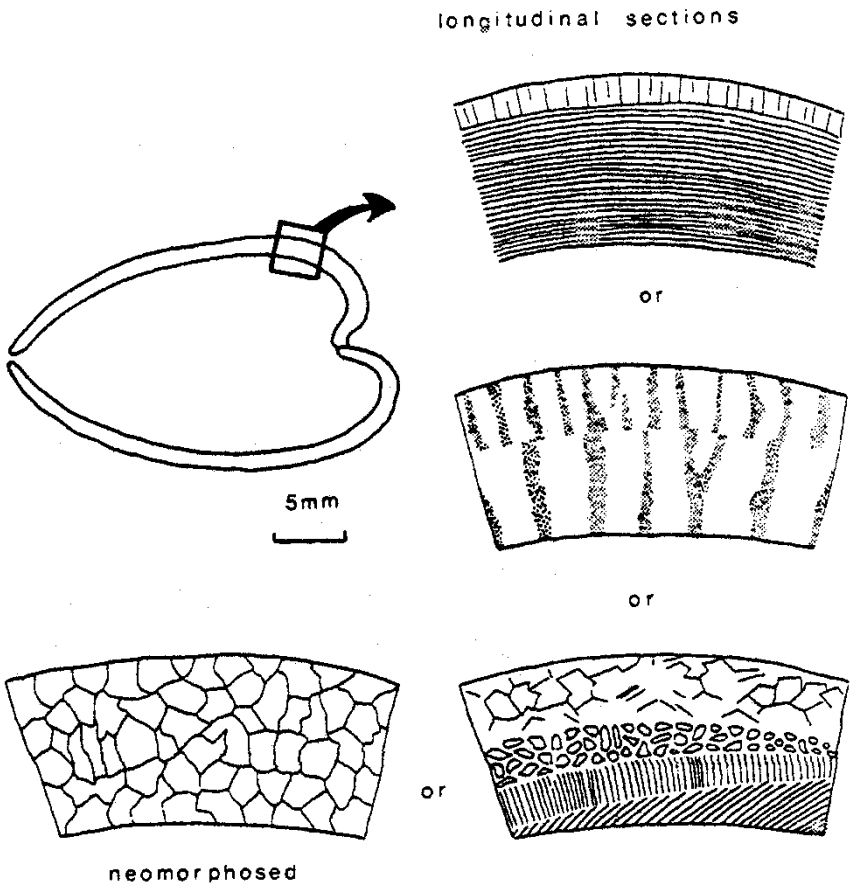
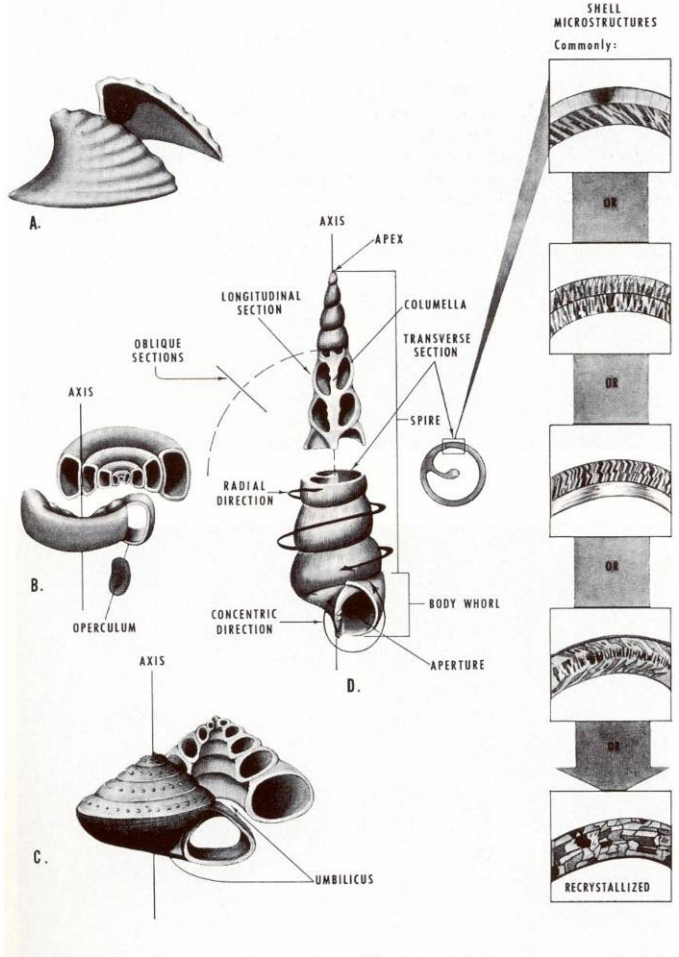


Figure. 4.10 Bivalve skeletal structure

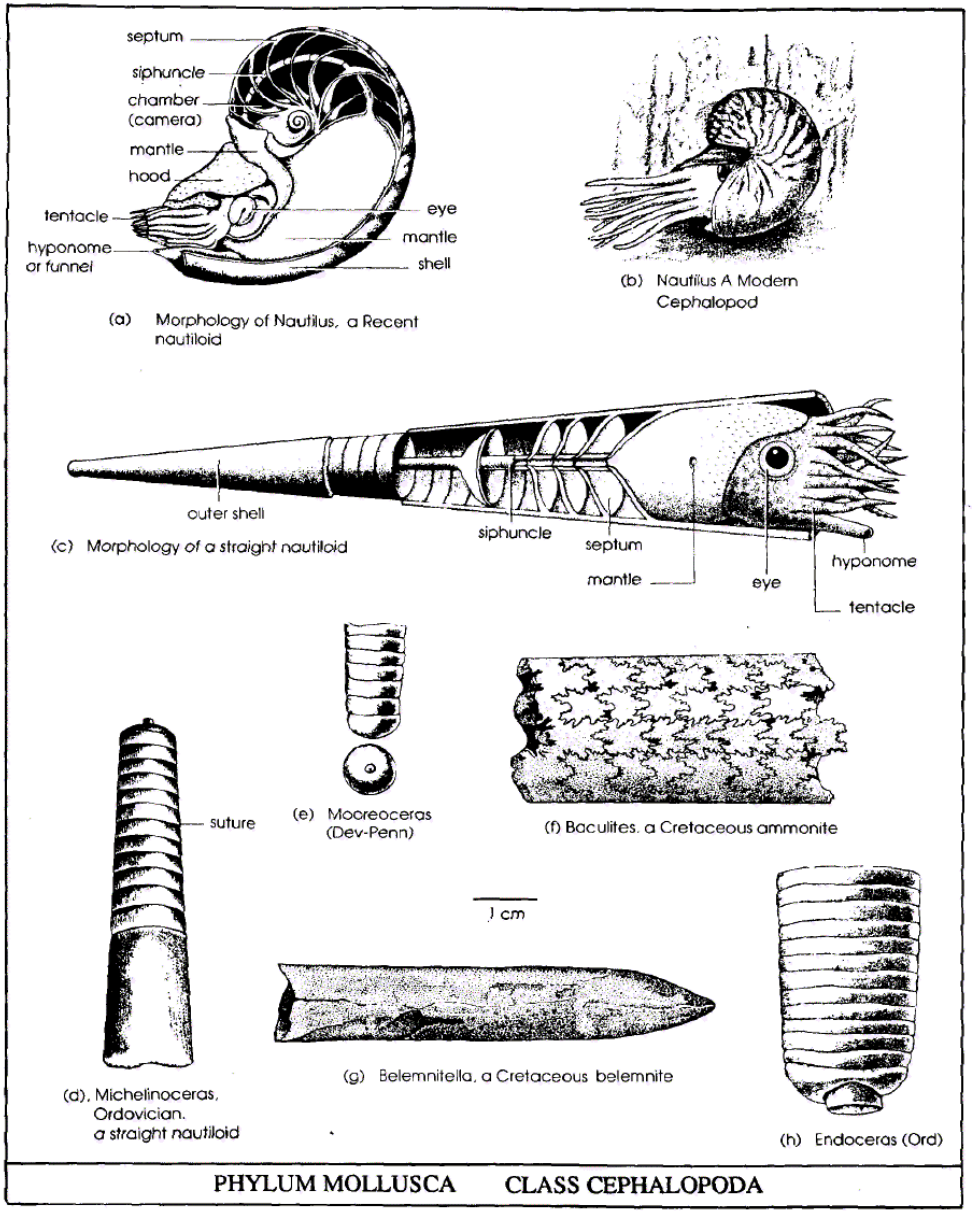
Carbonate Producers
Mollusc - Gastropods

- Univalves having an unchambered coiled shape
- Most are aragonitic
- extreme environmental tolerance (salinity & Temperature)
- Herbivores, many graze on algal mats
- Ordovician to Recent

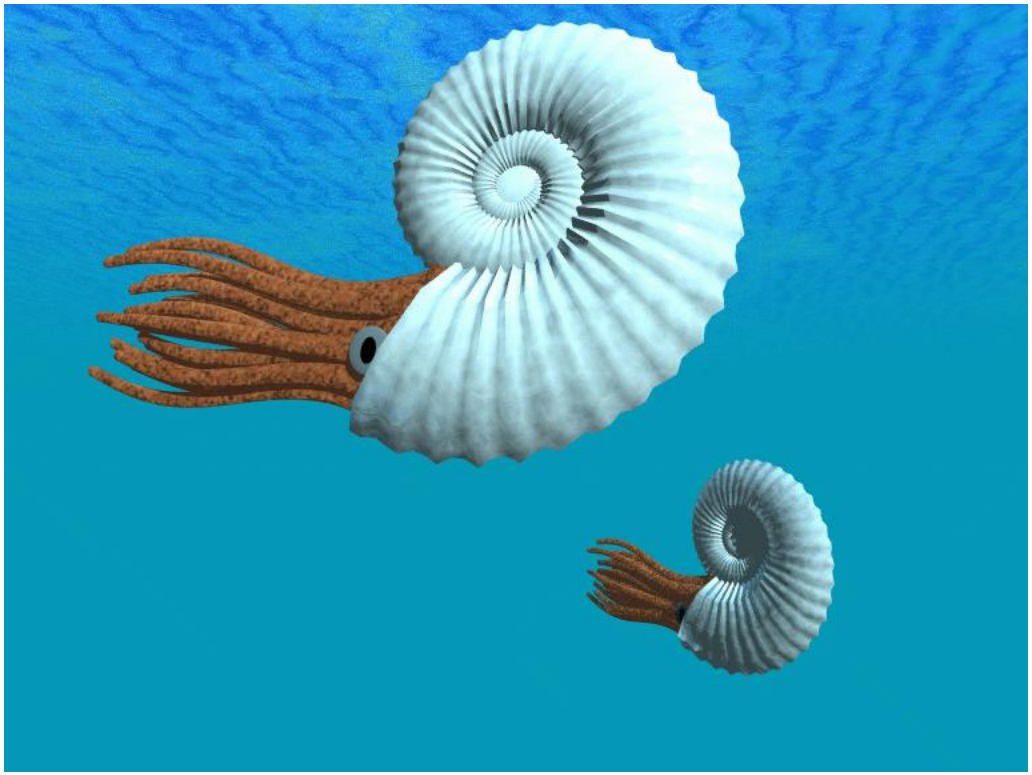


Carbonate Producers
Mollusc - Cephalopods

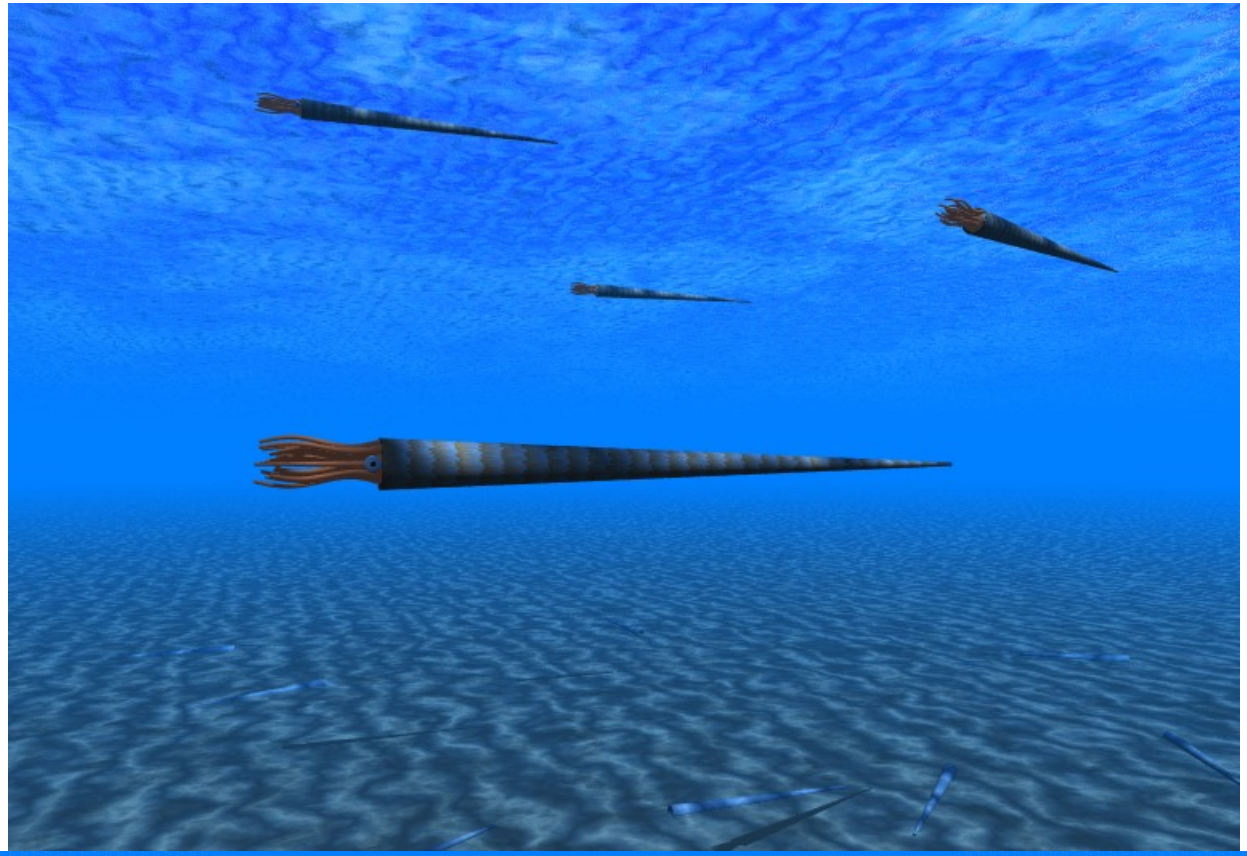
- Univalve shell that is wholly or partially chambered
- Most are aragonitic
- Nektonic (Free swimming)
- Common index fossils nautiloids, ammonoites, and belemnites
- Cambrian to Recent, most abundant in paleozoic

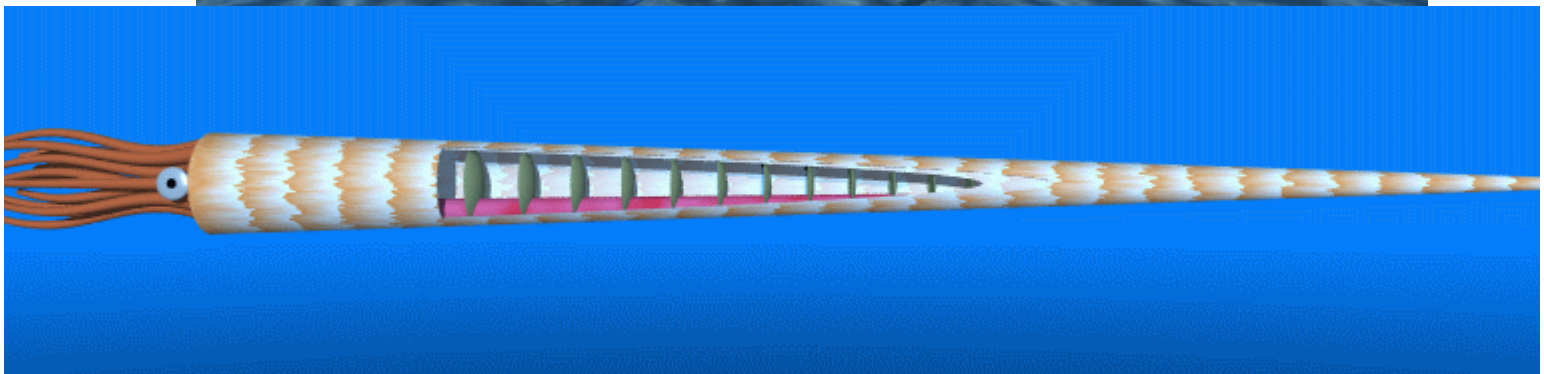


Ammonites



Nautiloids





Temporal Distribution of Major Faunal Groups

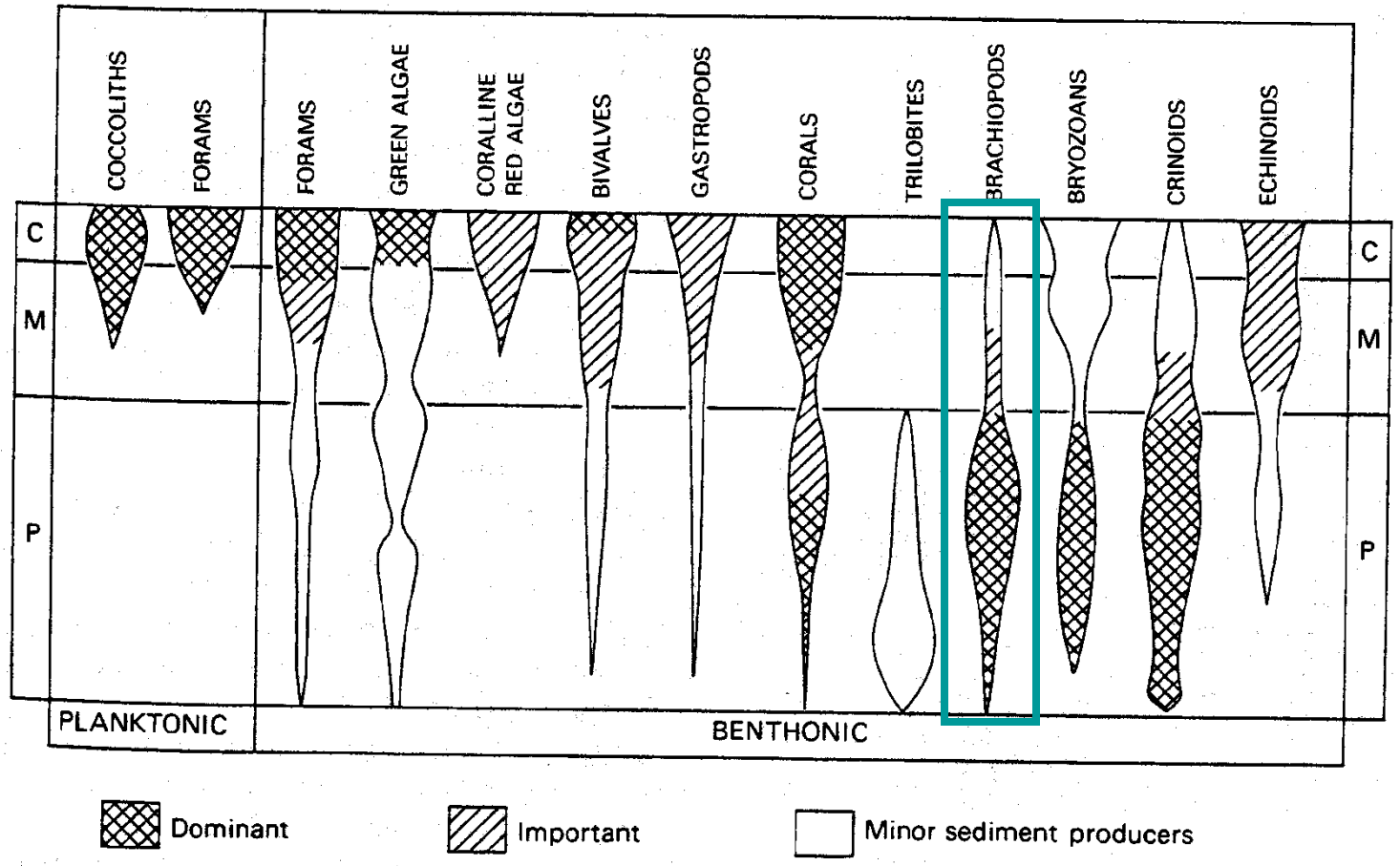
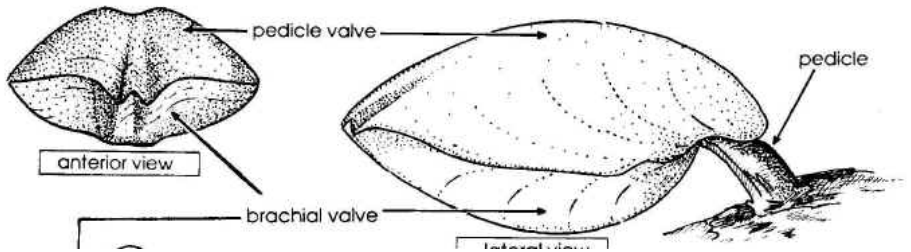


Figure 4.1 Diversity, abundance and relative importance of various calcareous marine organisms as sediment producers. After Wilkinson (1979).

Carbonate Producers: Brachiopods

- Largely benthic, sessile organism; a few species are infaunal
- Low-Mg calcite
- superficially look like clams, but that are quite different in their anatomy
- Common in Paleozoic & Mesozoic shallow-marine limestones when they occupied diverse ecologic niches including reefs
- decimated in the worst mass extinction of all time, the Permo-Triassic event
- rare today overall, but they are fairly common in cold water, either in polar regions or at great depths
- Brachiopods have two shells
- Plane of symmetry bisects each shell



Temporal Distribution of Major Faunal Groups

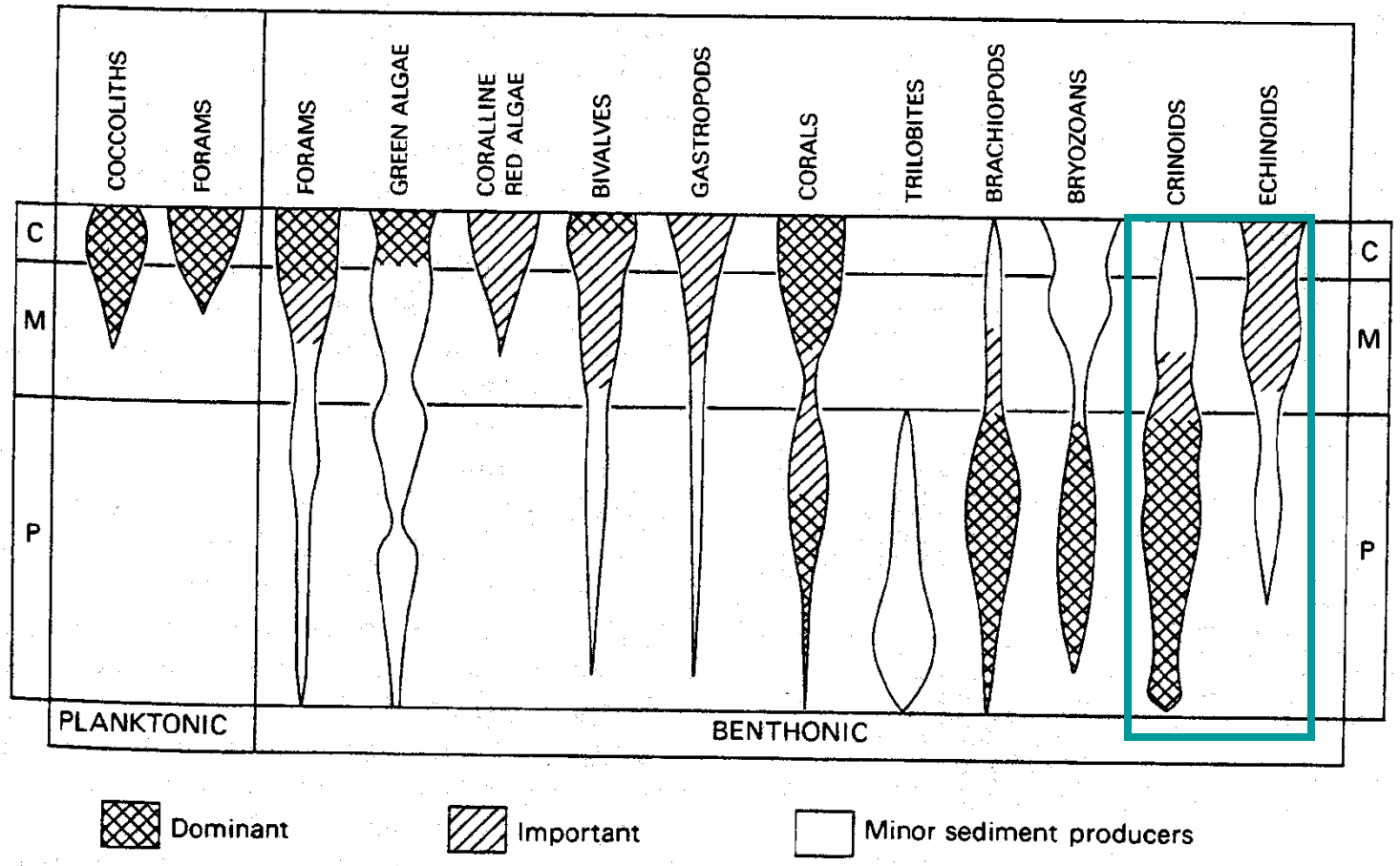
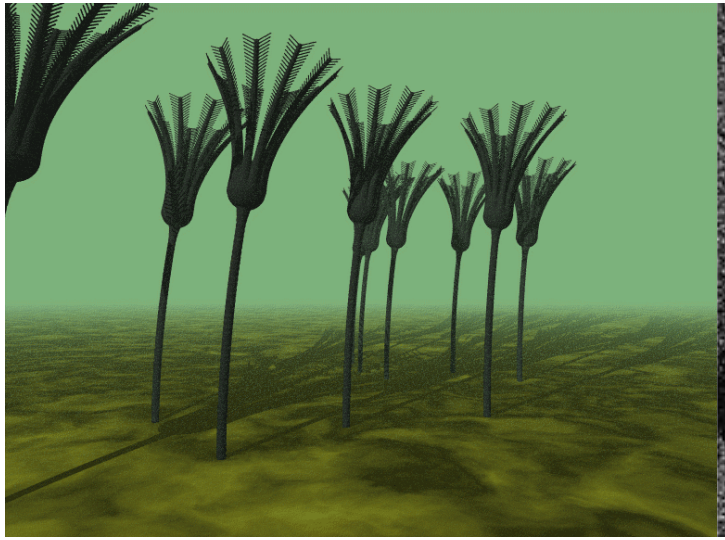


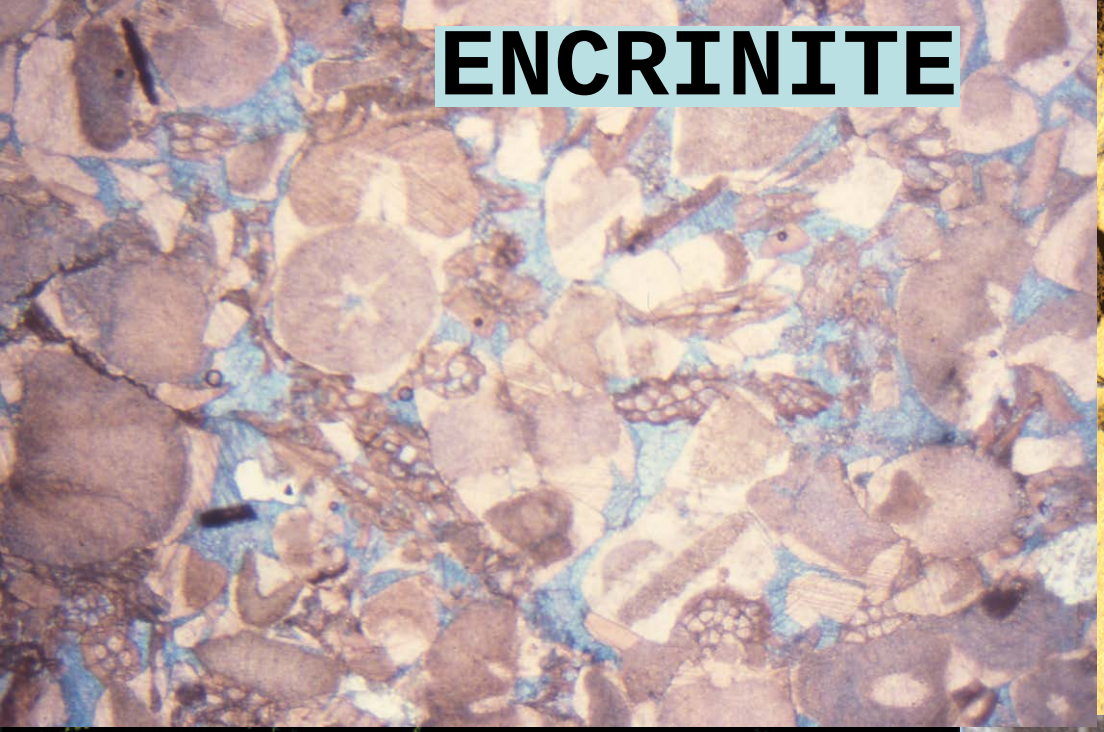
Figure 4.1 Diversity, abundance and relative importance of various calcareous marine organisms as sediment producers. After Wilkinson (1979).

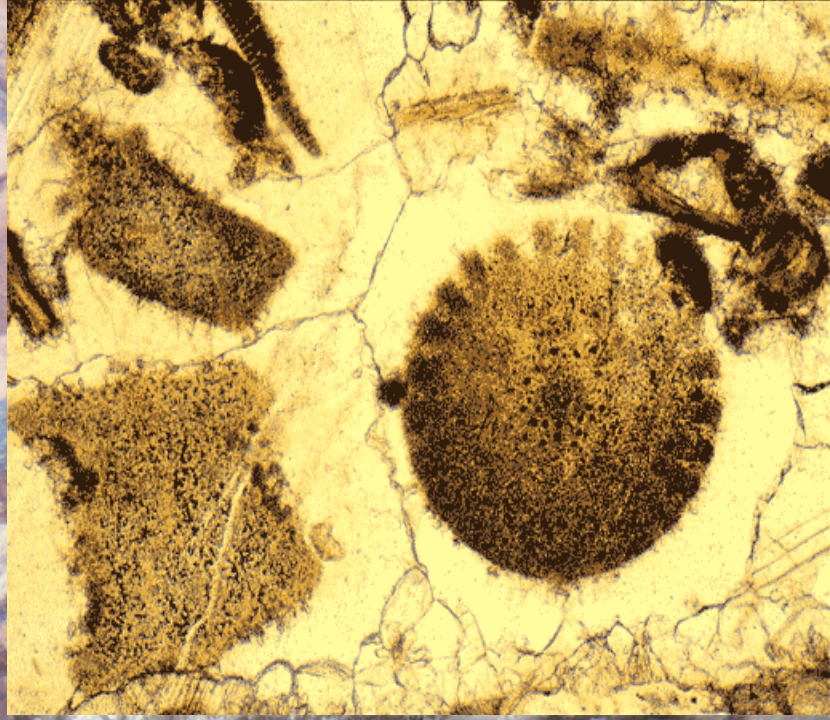
Carbonate Producers: Echinodermata

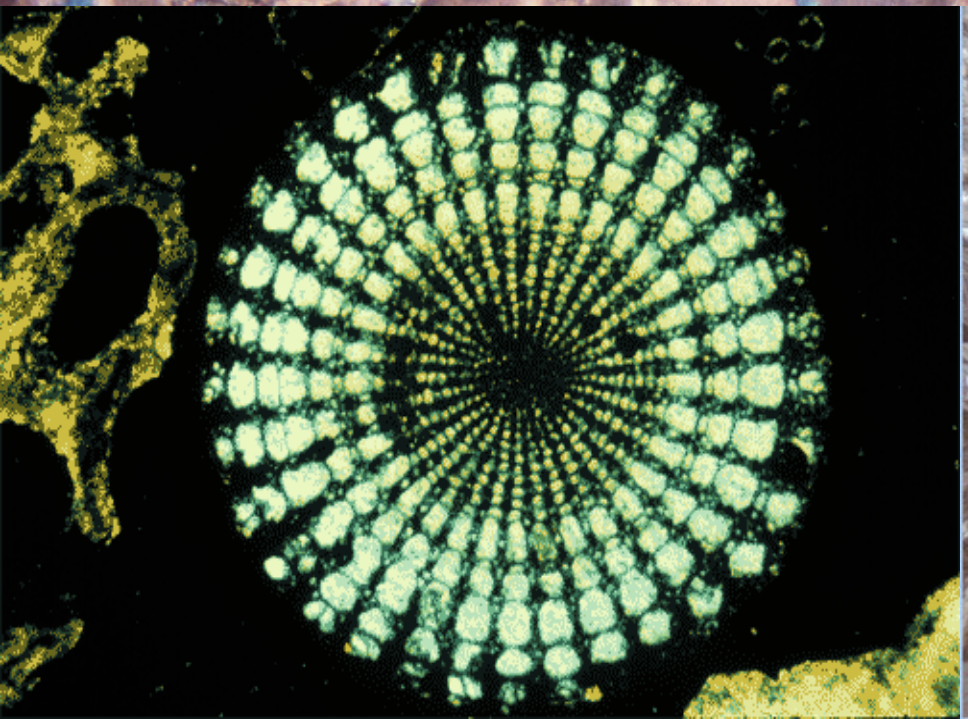
- Marine organisms, include echinoids & crinoids
- echinoids & crinoids are calcitic, modern forms are HMC
- Modern ocean echinoids inhabit reefal environments & crinoids are restricted to deeper waters
- Echinoids include starfish, sea cucumbers, sea urchins and sand dollars
- Exhibit 5-fold symmetry
- Crinoids are major Paleozoic fauna

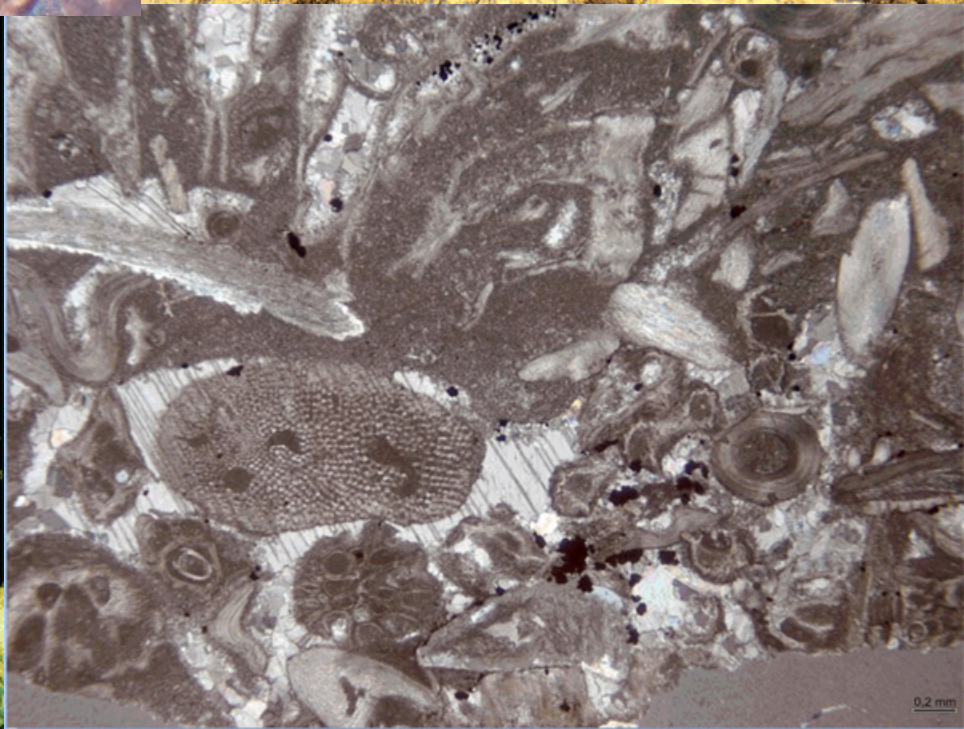


ENCRINITE









Temporal Distribution of Major Faunal Groups

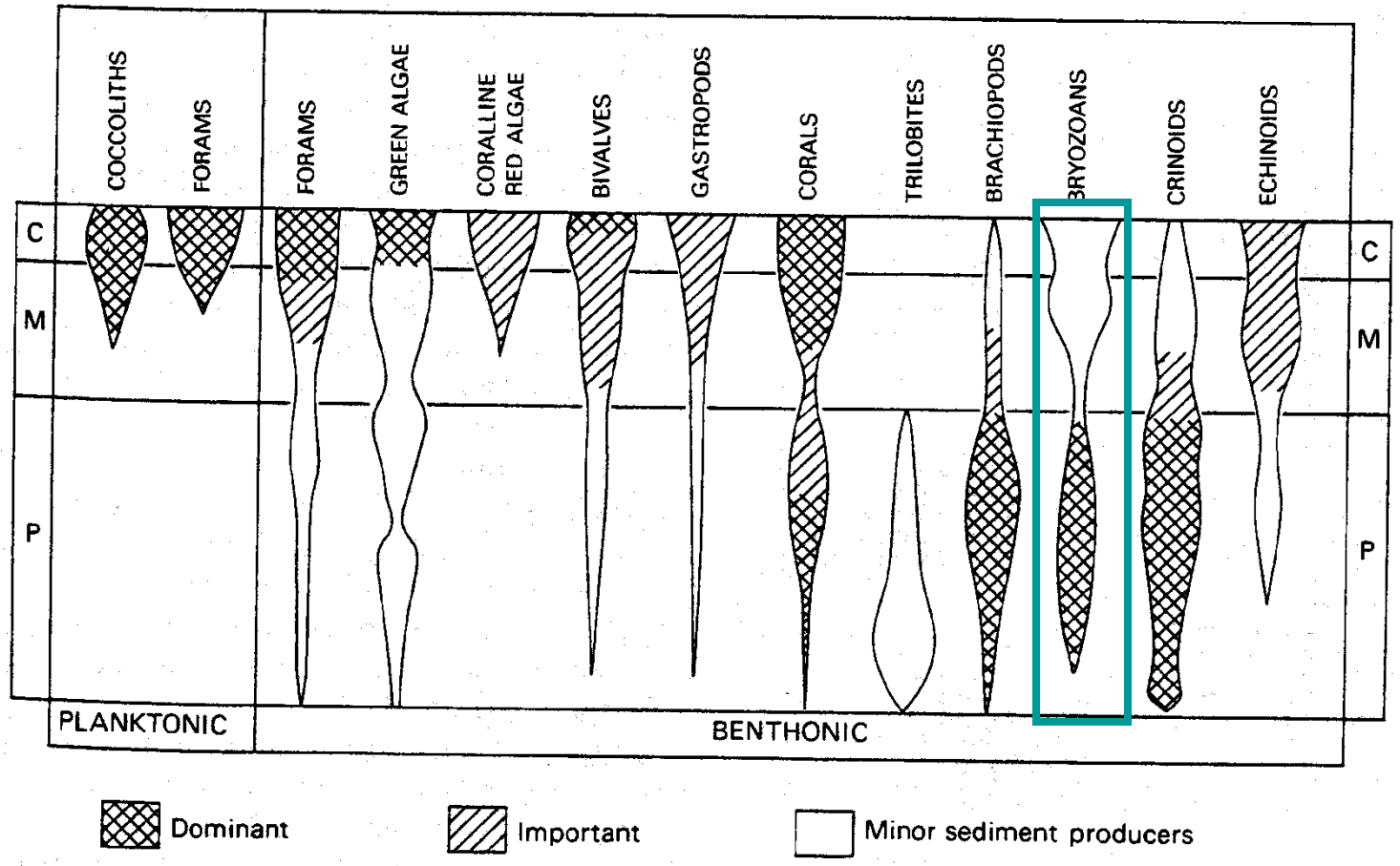
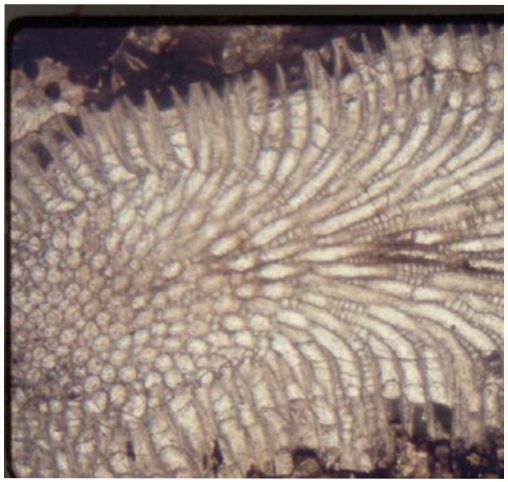
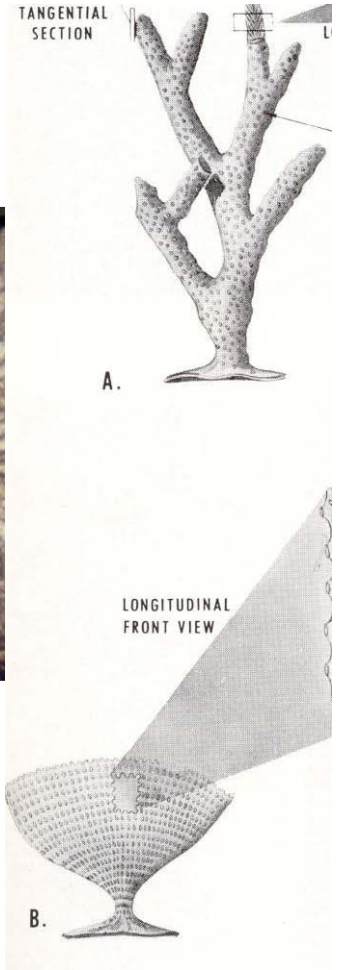


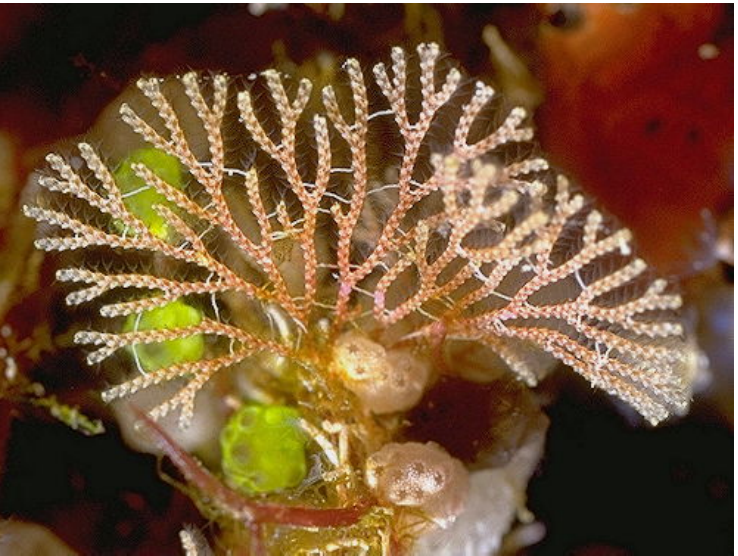
Figure 4.1 Diversity, abundance and relative importance of various calcareous marine organisms as sediment producers. After Wilkinson (1979).

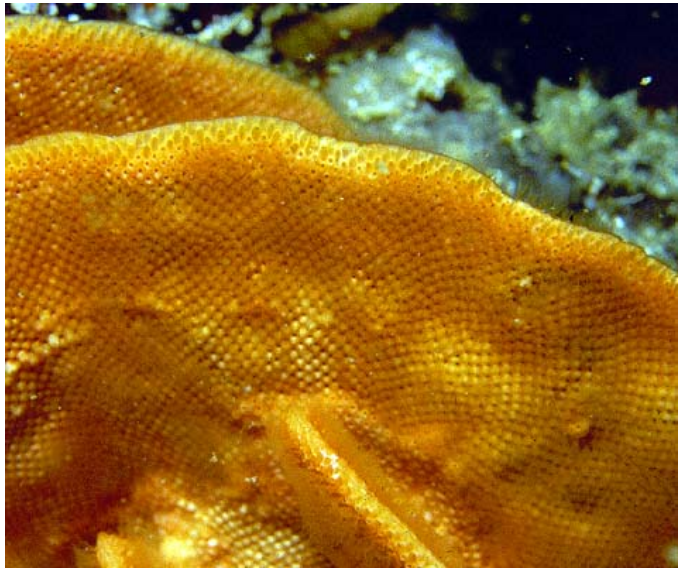
Carbonate Producers: Bryozoa

- Two main forms
  - Ramose (stick-like)
  - Fenestrate (fan-like)
- Small, colonial, sessile, benthic marine organisms that played an important role in Paleozoic limestone formation
- Modern bryozoans are aragonite or HMC or some combination
- Major constituent in modern Cool-water carbonate factory









Temporal Distribution of Major Faunal Groups

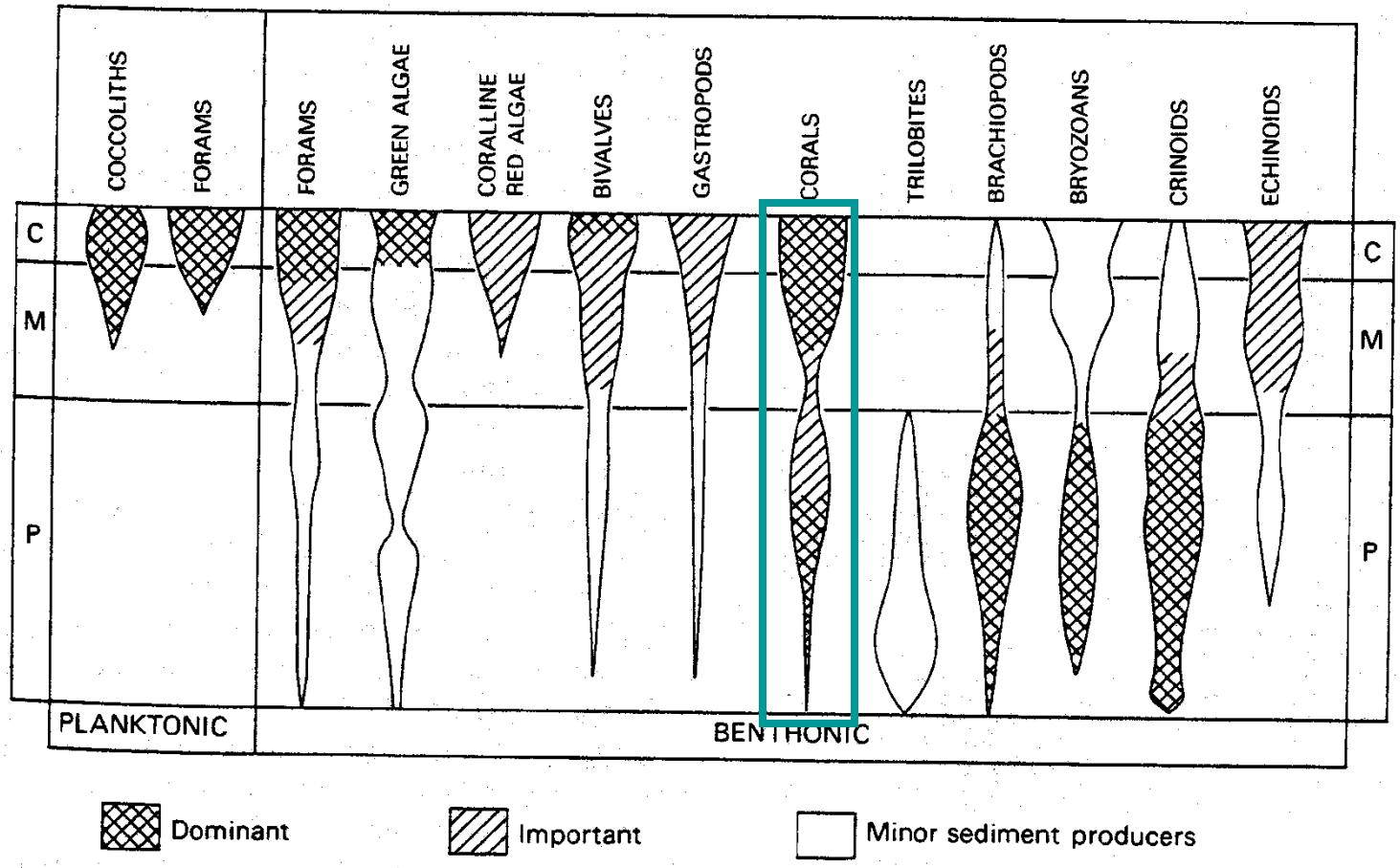
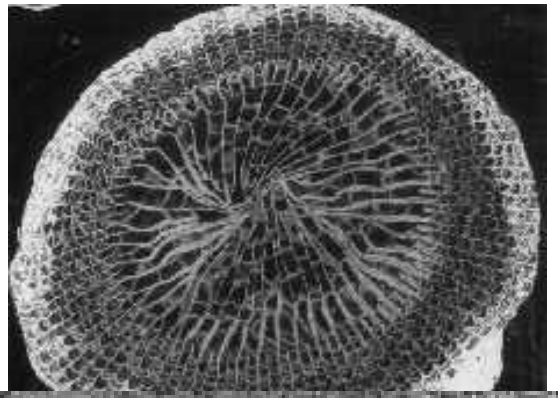


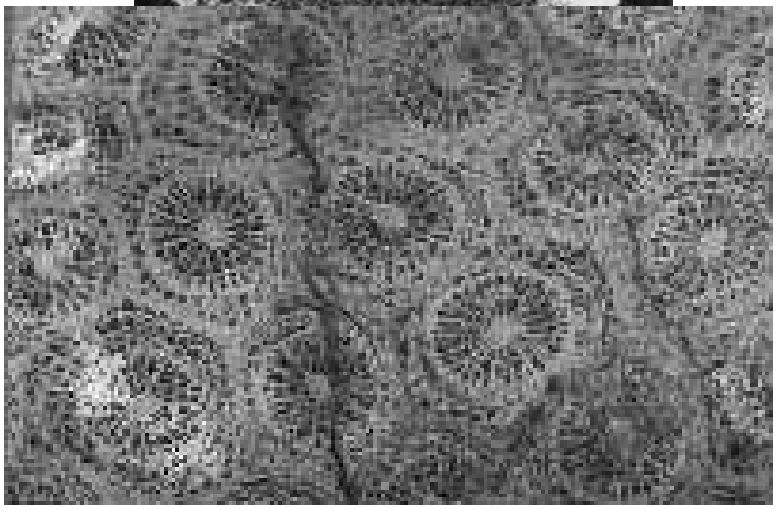
Figure 4.1 Diversity, abundance and relative importance of various calcareous marine organisms as sediment producers. After Wilkinson (1979).

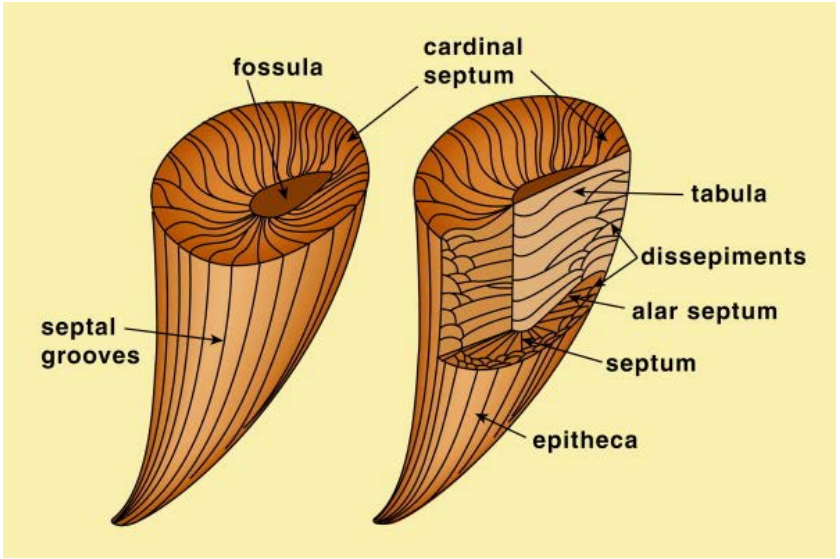
Carbonate Producers: CNIDARIA

- Incredible diversity in form
- Anthozoa are Geologically Significant
- Mineralized hard parts of corals become significant part of the record in the Ordovician

Rugose Corals:
Ordovician-Permian

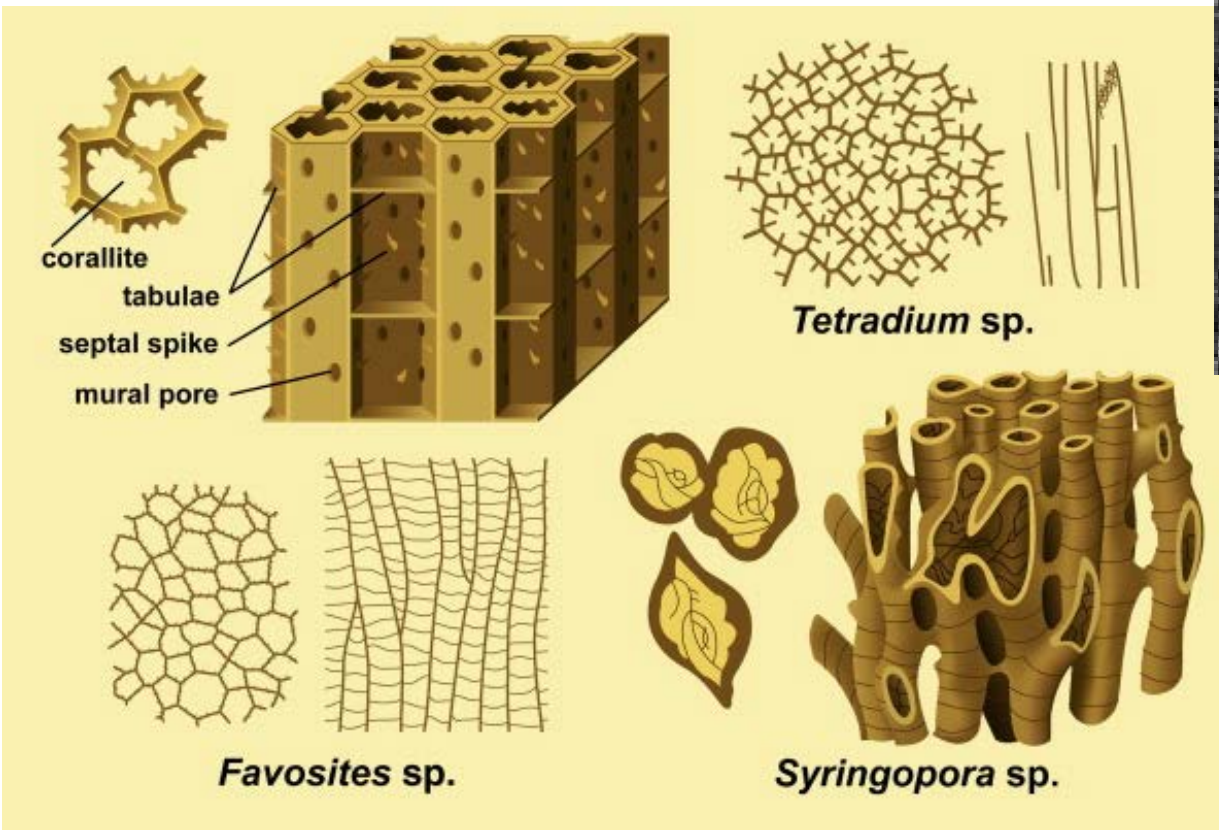


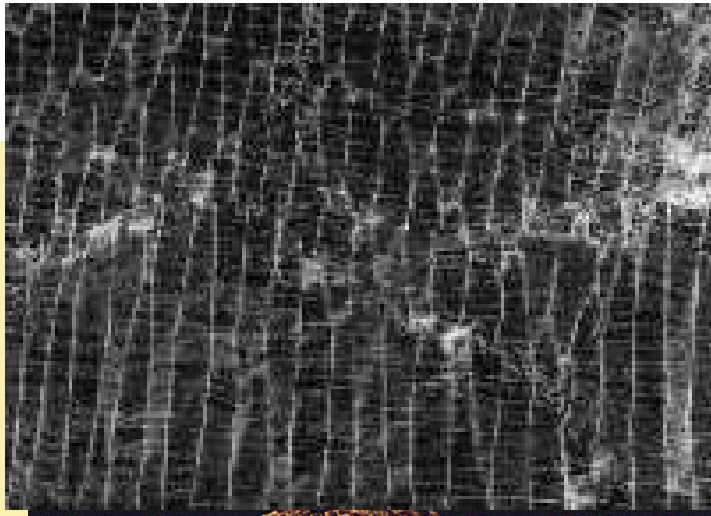


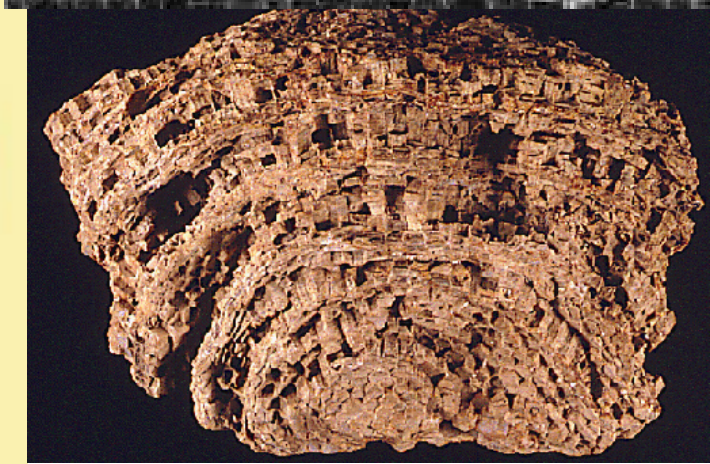


Carbonate Producers: Tabulate Corals

- receive their name from horizontal internal partitions known as tabulae
- Most tabulates were colonial, with some forming substantial reefs.
- Calcitic
- Ordovician to Permian

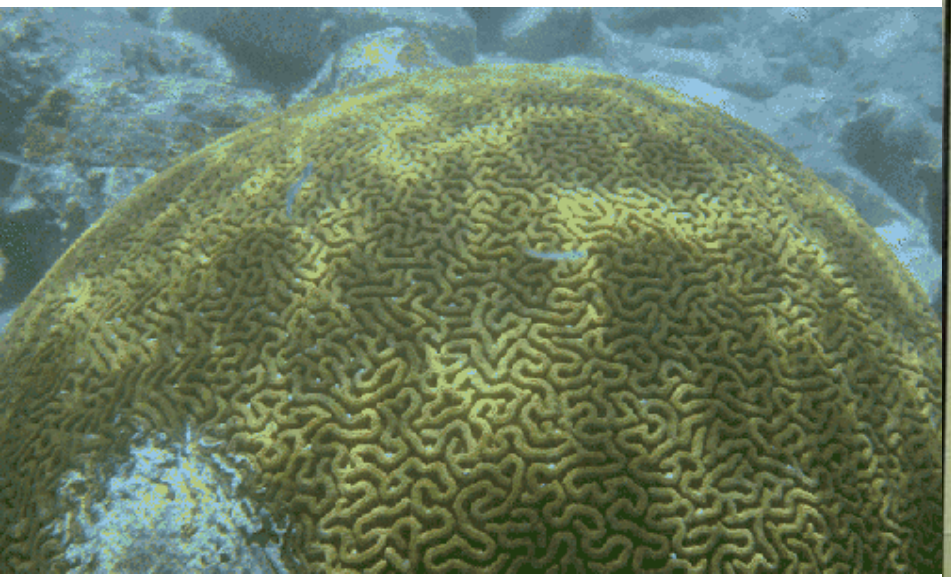






Carbonate Producers: CNIDARIA Scleractinian Corals

- Refilled ecological niche once held by tabulates and rugosans
- Colonial scleractinians from modern tropical seas now form world's reefs
- Aragonitic
- Mesozoic and Cenozoic



Temporal Distribution of Major Faunal Groups

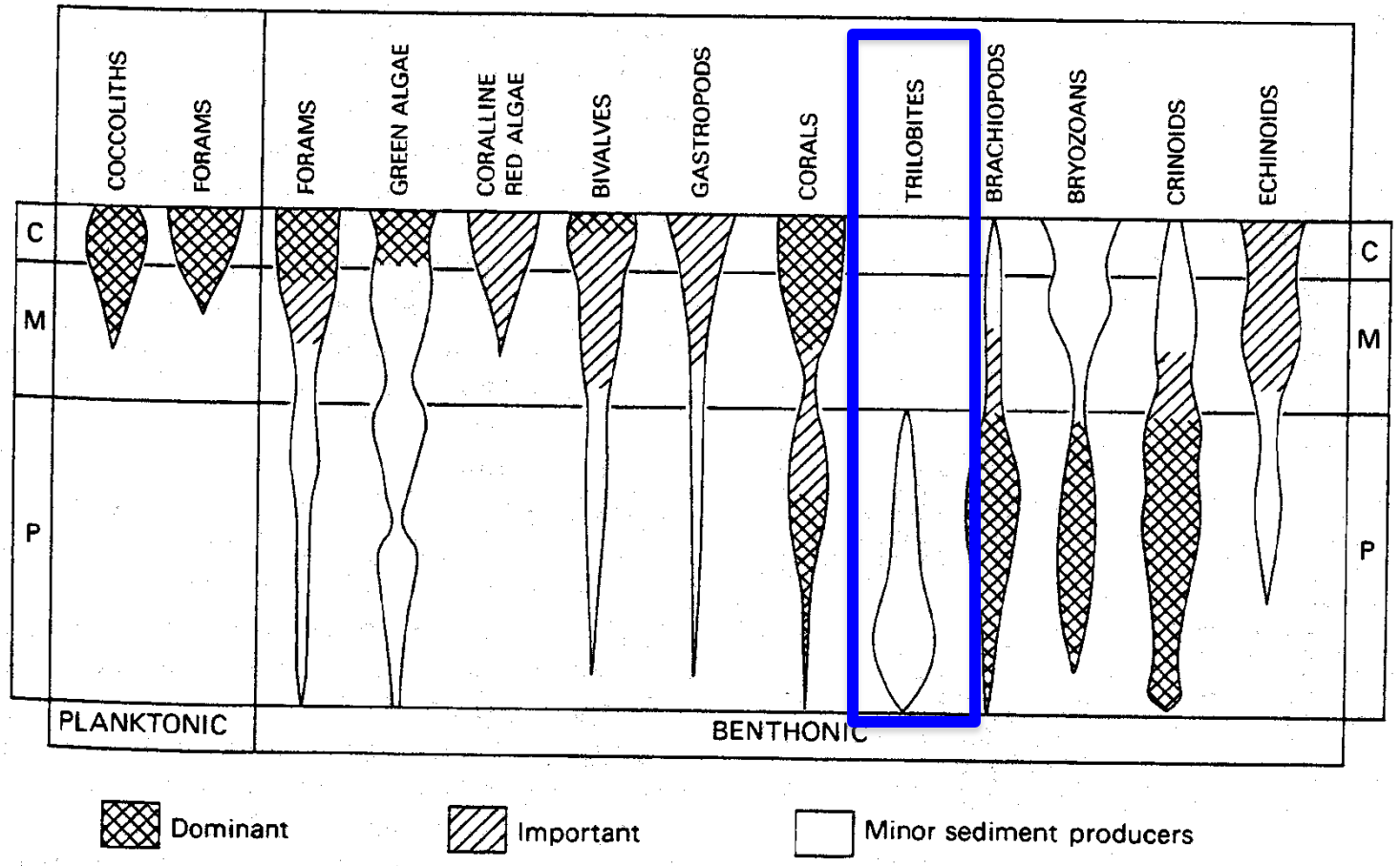
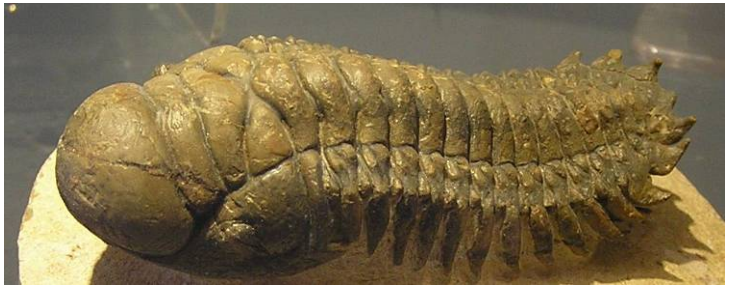


Figure 4.1 Diversity, abundance and relative importance of various calcareous marine organisms as sediment producers. After Wilkinson (1979).

Carbonate Producers: Crustacea Trilobites

- Extinct marine Arthropods
- Most bottom dwellers, some swam, some planktonic
- Filled diverse ecological niches
- Cambrian to end Permian Extinction
- Shell fragments have distinctive “shepherd’s crook” shape



Trilobites

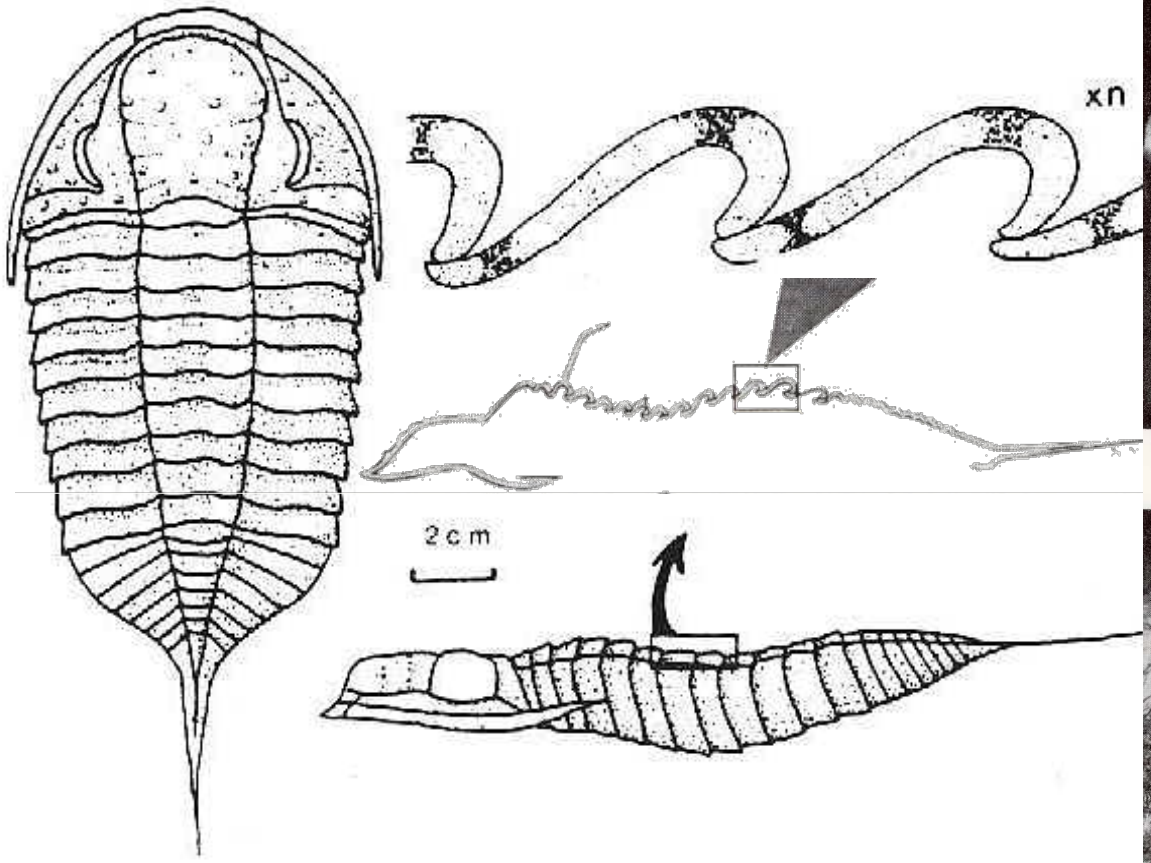
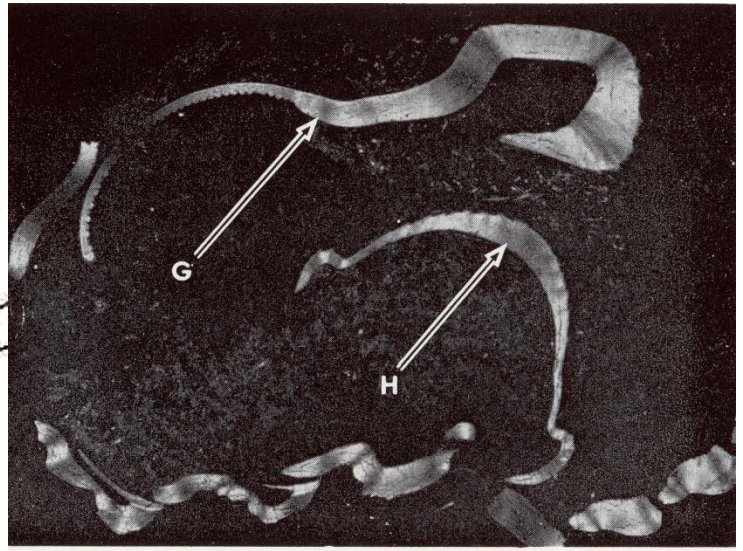


Figure 4.40 Trilobite skeletal structure



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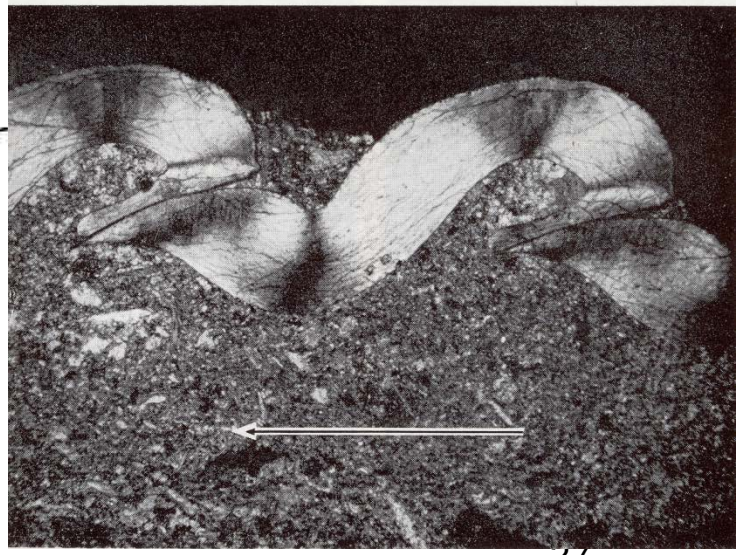


Temporal Distribution of Major Faunal Groups

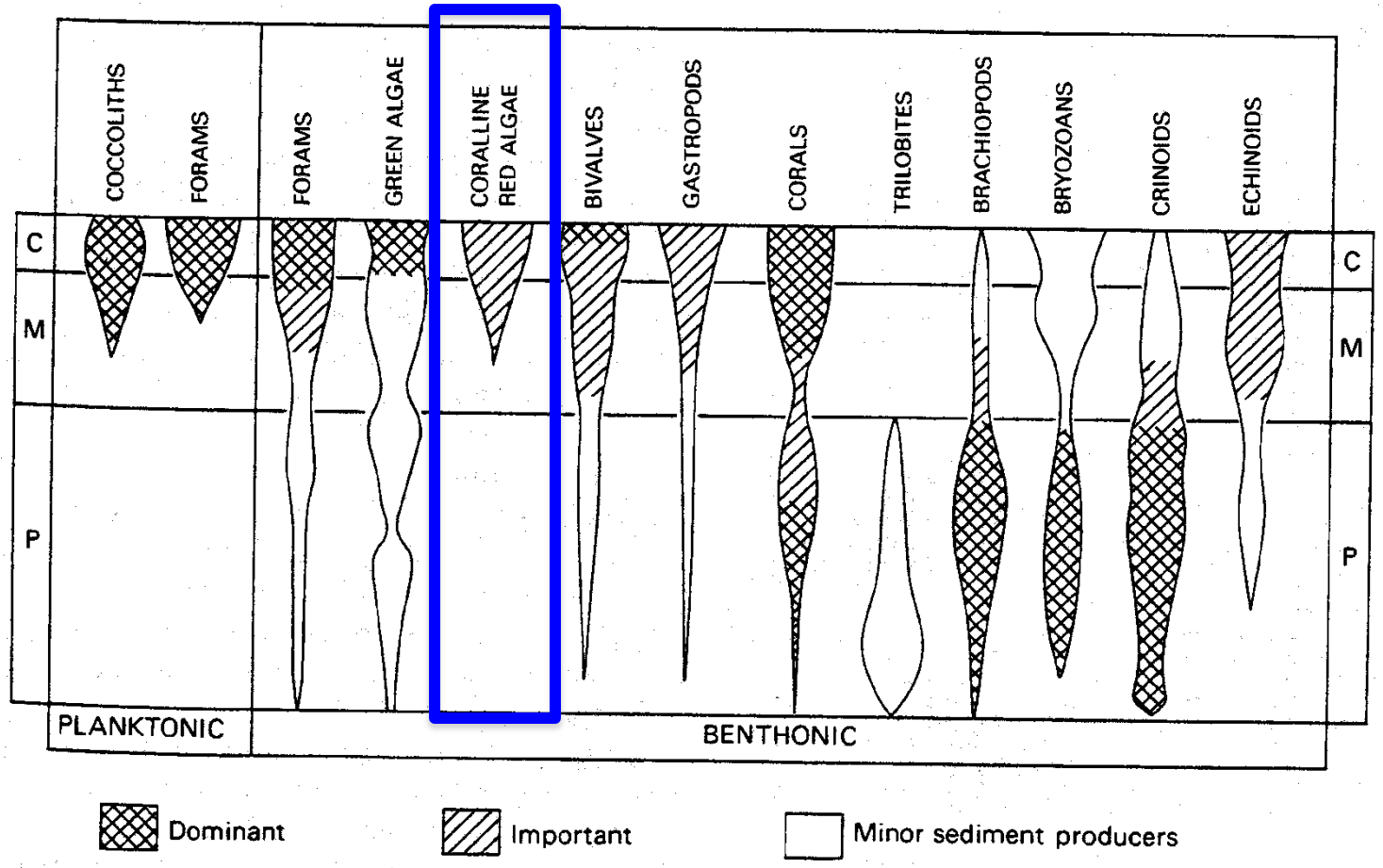
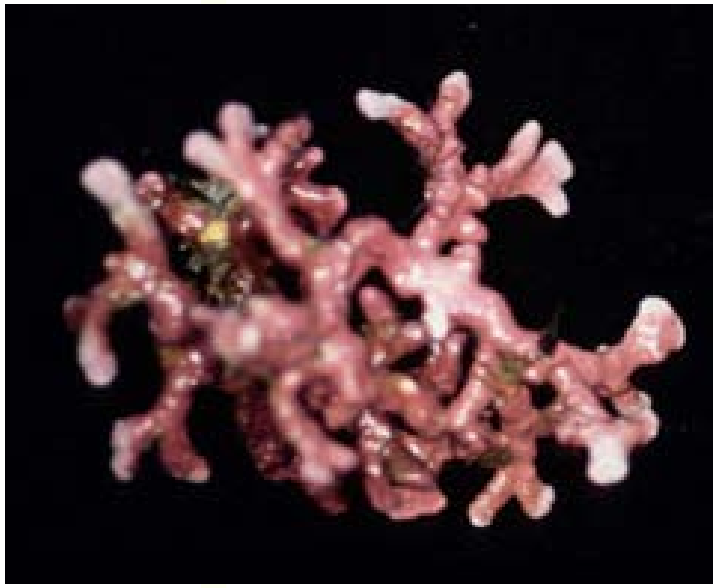
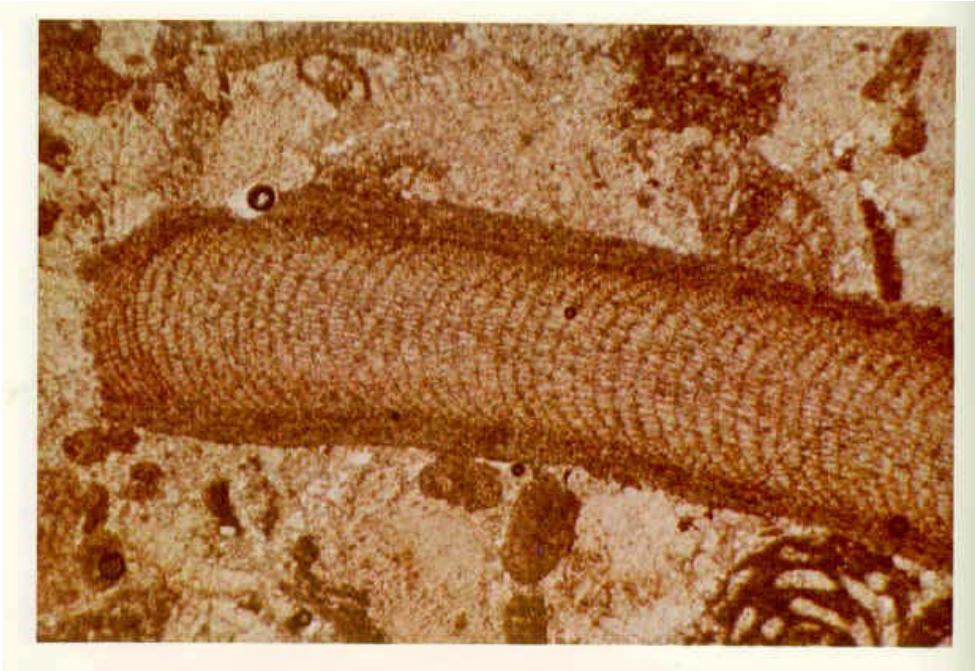


Figure 4.1 Diversity, abundance and relative importance of various calcareous marine organisms as sediment producers. After Wilkinson (1979).

Carbonate Producers: Rhodophyta
Calcareous Red Algae – Jurassic to Present

- Red color is due to a pigment, which permit red algae to inhabit deeper waters than green algae
- usually precipitate calcium carbonate (HMC) within & between cell walls, hence cellular microstructures are often preserved in the fossil record





Temporal Distribution of Major Faunal Groups

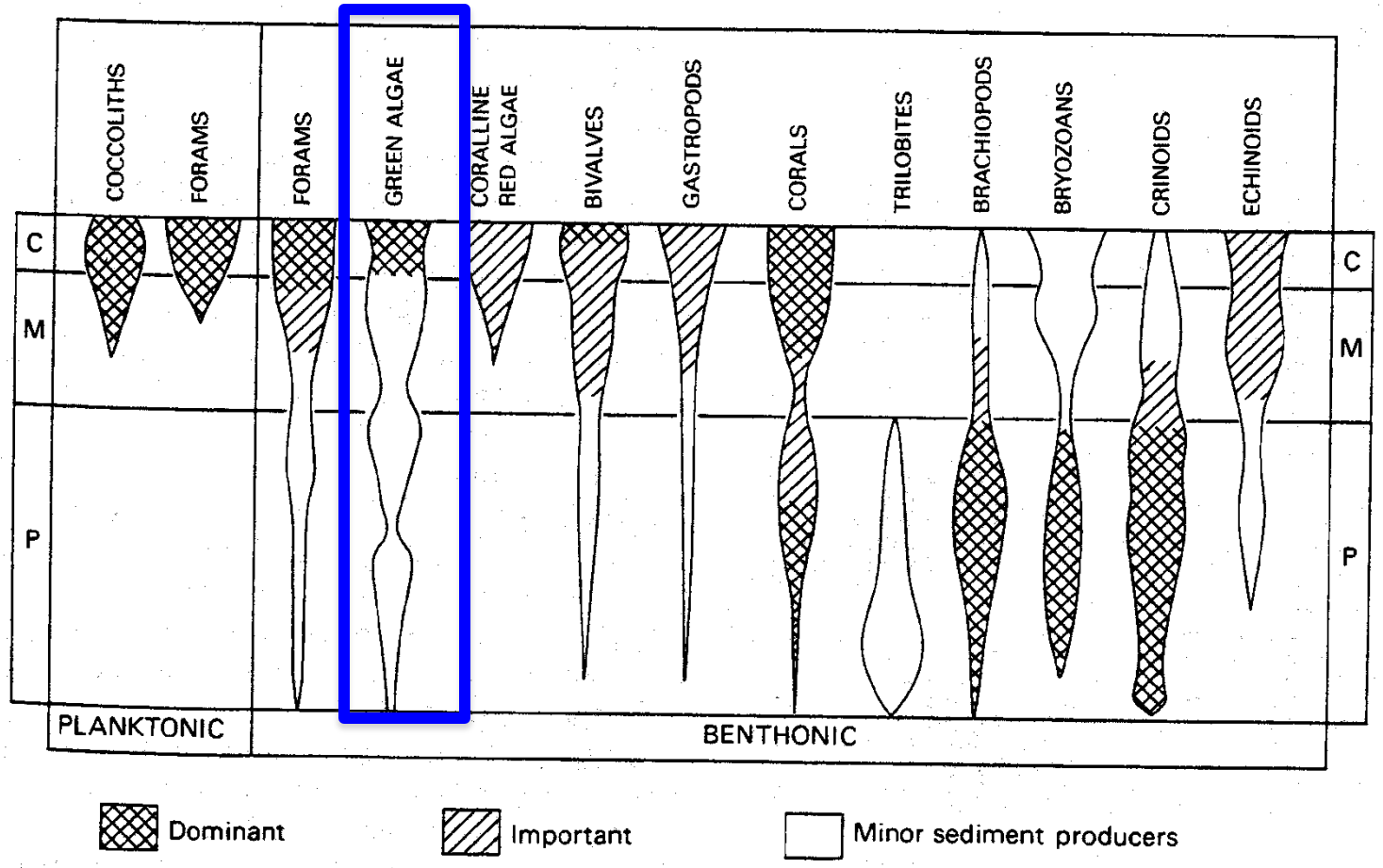
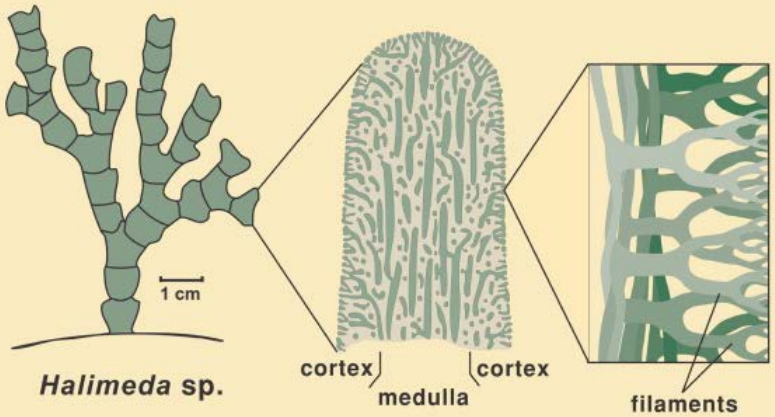


Figure 4.1 Diversity, abundance and relative importance of various calcareous marine organisms as sediment producers. After Wilkinson (1979).

Carbonate Producers: Calcareous Green Algae Codiaceans - Ordovician to Recent

- Segmented & branching erect plants w/internal structure of tubular filaments
- lagoonal & back-reef environments in the tropics
- Significant Sediment producers upon death in the modern - Aragonitic
  - Halimeda -



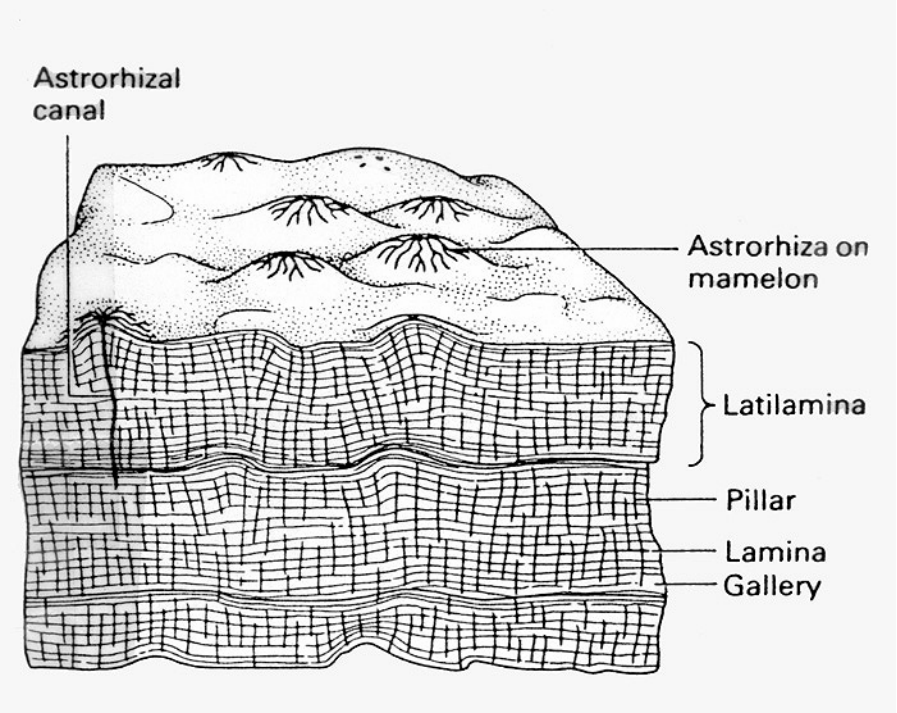
Permian Laborcita Formation
Sacramento Mountains, NM

Carbonate Producers: Porifera (Sponges)

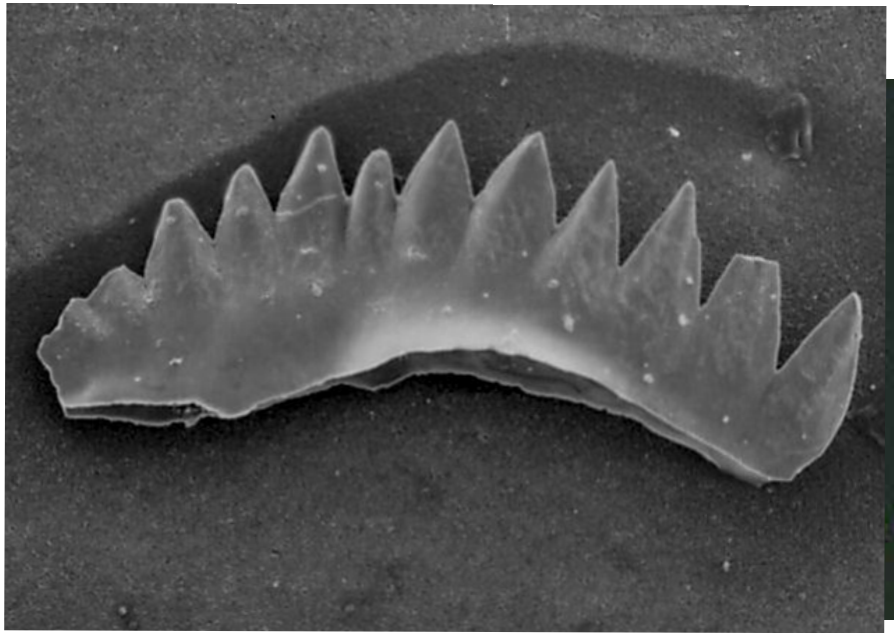
- Simple, many celled colonial, sessile organisms
- Precambrain to Recent
- Spicules, siliceous or calcareous, help support the body and upon death of

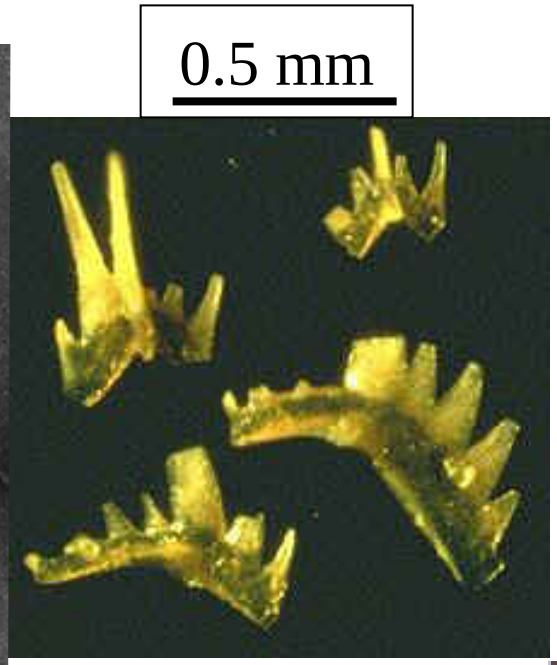
Stromatoporoidea:

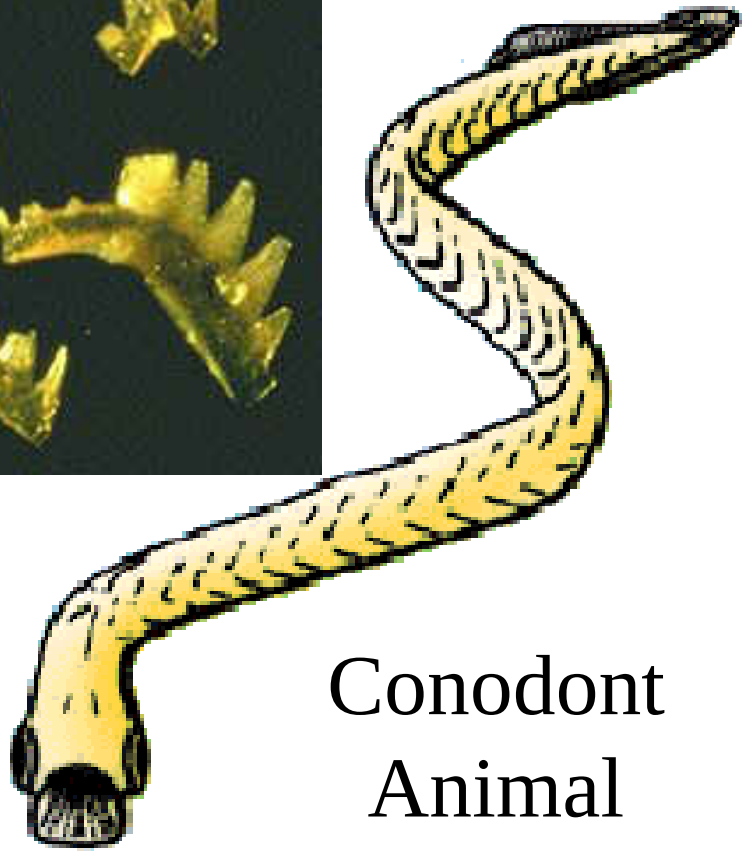
Cambrian-Permian



Conodonts
Cambrian-Triassic







Index Fossil
Mineralogy: $Ca_3(PO_4)_2$

Conodont Animal (?)

Carbonate Producers: cyanobacteria

Stromatolites

- Living fossils, abundant in Precambrian in diverse environments w/i photic zone
- Carbonate precipitated over growing mat of bacteria
- Prokaryotes, Photosynthetic bacteria w/chlorophyll
- Fossil traces of cyanobacteria ~3.8 bya
- Modern forms mostly found in hypersaline lakes & marine lagoons (occasionally in open marine settings)

Key Points

- **Geologically important calcareous organisms vary with geological time**
- **Mineralogy of calcareous organisms varies with time.**
- **Carbonate producers have distinct & diagnostic skeletal features that aid in their identification.**
- **Much carbonate precipitated is biologically mediated**