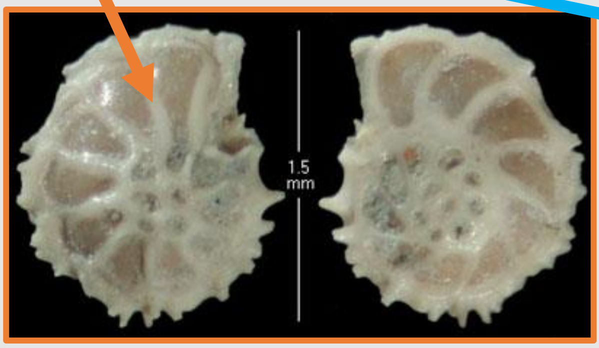
MICROFOSSILS

KEY DEFINITIONS

- **Carapace:** The hard skeleton of an ostracod
- **The CCD**: The carbon compensation depth, below which calcite becomes unstable and dissolves due to pressure.
- **Element:** describes tooth like conodonts
- **Foraminifera:** Microorganisms which are usually single-celled and have a protective test (shell). They range from 1 µm to 110mm
- **Microfauna:** are the remains of whole, small animals.
- **Microflora:** the spores or pollen, derived from larger plants.
- **Test:** the protective shell of foraminifera.

WHAT ARE MICROFOSSILS?

All fossils which are small than 4mm and commonly smaller than 1mm. The study of which requires the use of an optical (or scanning electron (SEM)) **microscope.**



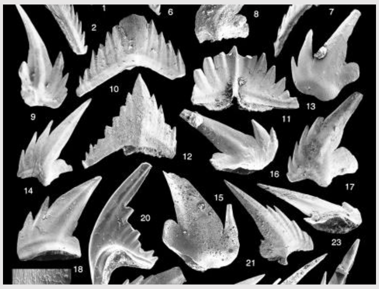
i.e. They are **too small to be studied in detail** by the human **eye** alone.

Microfossils can be found in the **chippings created when drilling boreholes**. Since microfossils are so small, thousands can be found in these chippings **undamaged.**

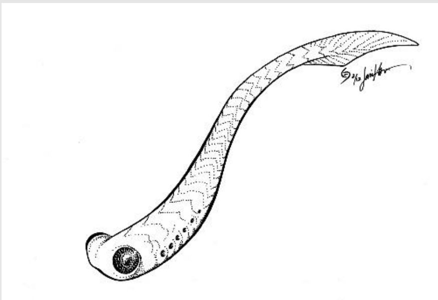
Rocks like **chalk (calcareous)** or **chert (siliceous)** are composed almost entirely of microfossil remains. Their preservation on the ocean floor sediments makes them ideal for investigating evolutionary theory.

MICROFAUNA (THE REMAINS OF WHOLE, SMALL ANIMALS)

- **Conodonts** – extinct chordates resembling eels, classified in the class Conodonta. For many years, they were known only from tooth-like microfossils found in isolation and now called **conodont elements**.



Knowledge about the soft tissue of conodonts remains relatively sparse. Other than the teeth, the creature is **soft-bodied**.



Stratigraphic use / age	They are extremely useful microfossils for stratigraphy as few other microfossils are found in such large abundance **in the Paleozoic aged** rocks.
Composition	The conodont's teeth are composed of **calcium phosphate** (like ours), **apatite** and occur in pairs known **as conodont elements**.
Size	Microfossil conodont teeth range from **200 μm to 5 mm**

- **Radiolaria** are marine, unicellular-planktonic animals, which range from 30 μm to 2 mm .

They exhibited a rich diversity of intricate silica test designs. They occupied almost all depths in the water column, from the surface to hundreds of meters down.
The delicate silica test could be **preserved even below the CCD** since **silica does not dissolve into solution in deep cold waters.** Silica is highly insoluble.

Although they have been present since the Precambrian (so are not restricted to a narrow part of the geological column), they do make **good biostratigraphic and palaeoenvironmental tools.**

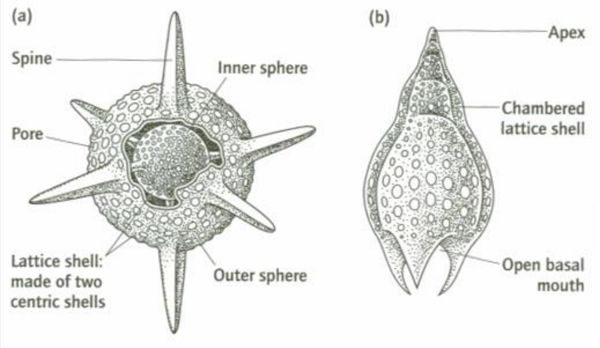
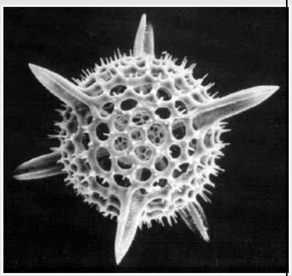


Fig. 13.6 Radiolarian morphology: (a) Spumellar (this example approximately 80 μm diameter); and (b) Nasselar (this example approximately 90 μm length).

Why they are useful in stratigraphy	▪ **Global distribution** ▪ **Present in all levels of the water column** ▪ **Rapid evolution and so huge diversity in silica tests**
Age	**Late Precambrian** to present
Size	**30 μm to 2 mm**
Composition	The intricate, delicate tests are made of **silica**



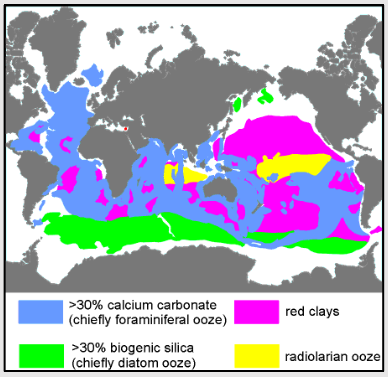
The test of Radiolaria may have **long spines** present. These are to increase drag so they **resist sinking**. Some use **spherical shapes** to resist sinking. Analysis of the distribution of fossil assemblages can be used to infer the circulation patterns of ancient ocean currents because Radiolaria have a **wide distribution** and different species are **adapted to different water masses**.

Radiolaria may be digested by other organisms and so their tests sink to the ocean floor in faecal matter or the tests may sink whole. They dominate the deposits **below the CCD (4km).** Siliceous oozes form.

Chert horizons are found interbedded with chalk. These **chert (or sometimes flint) nodules** are thought to have formed from siliceous organisms.

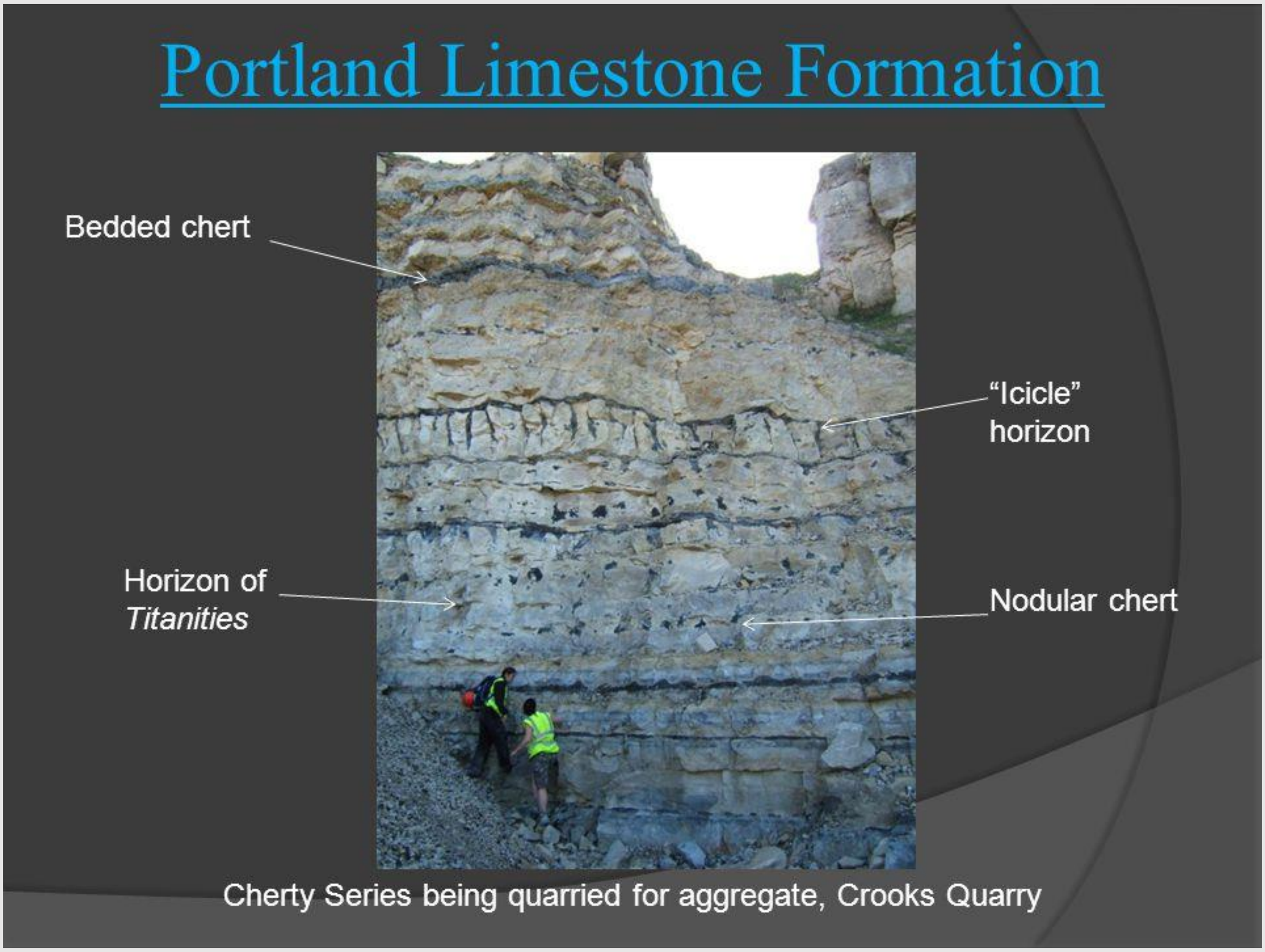
<ins>*Some AS revision on ocean basins (Calcareous / Siliceous oozes)*</ins>

*In shallow warm waters, silica is more likely to dissolve. This is the **opposite to calcite**. Calcite is less likely to dissolve in the warm, shallow seas as the ocean which are saturated in calcite and have lower pressures (above the CCD), lower CO_2 content and warmer temperatures.*

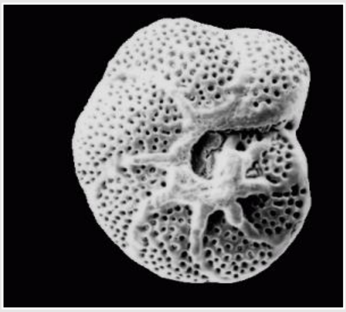


*Below the CCD, pressure is too high, CO_2 is too high and temperatures are too low so calcite is unstable and dissolves. This is why we tend to get **calcareous** deposits in shallow seas and on the continental shelf at **depths less than 4km (the CCD).***

*However, siliceous oozes will form in deposits **near to the equator and poles below the CCD**. Oozes must accumulate at a **faster rate at which they dissolve**. Silica **dissolves at a slow rate** in sea water and low energy* *waters allow for more accumulation than shallow seas. Sedimentation of silica on the **abyssal plain (3-5km depth)** is estimated at 1mm (up to 3cm) per 1000 years.*



- **Foraminifera** are microorganisms which are usually single-celled and have a protective test (shell). They range from 1 µm to 110mm



Earlier forms had tests made of **particles glued together for protection**, while more advanced forms **secrete** a huge **diversity** of tests.

Recent Foraminifera have **thread-like structures** that **extend through holes** in the test for **food capture**.

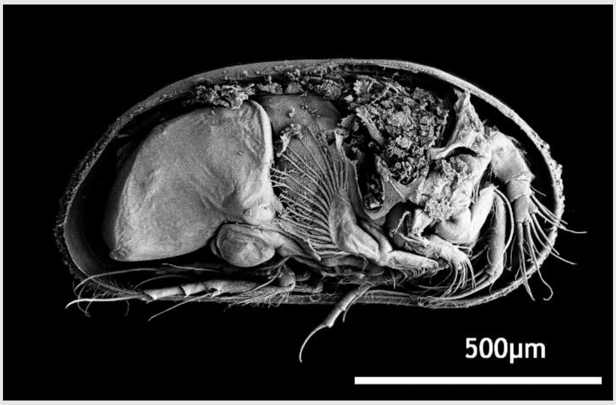
Most forms are sessile or vagrant but few, such as Globigerina, are planktonic (free floating). Most are benthonic (live in deep water).

They range from the **Cambrian to the present** day (extant), although the **planktonic forms** were **not common until the Mesozoic.**

Foraminifera have proved to be **excellent biostratigraphic tools** used extensively in the **oil industry**. This also provides us with evidence of how **evolutionary change occurs**.

Age	**Cambrian to present** **Planktonic forms became common in Mesozoic (~Jurassic)**
Size	**1 µm to 110 mm**
Composition	**Calcite** (some earlier forms had **agglutinated tests** which were many parts of other particles glued together)

- **Ostracods** are complex crustaceans, related to trilobites and crabs.



They have **two halves**, **a hinge** with **teeth and sockets** and **adductor muscles** to close them (similar to bivalves). They are usually **less than 2cm long**. The shell is composed of calcium carbonate and fibrous organics, this composition is commonly called **chitin**.
The skeleton is called the **carapace** and is the hard part of an ostracod.
Ostracods range from the **Cambrian to the present day**.
Earliest groups are no extinct. Due to their lo**ng stratigraphic range** and mainly **benthonic mode of life**, their use for dating rocks is limited.
They do make good **palaeo-environmental indicators** as different forms have **evolved to survive** in **waters different salinities**.

Age	**Cambrian to present**
Size	**< 2mm long**
Composition	**Chitin or calcium carbonate** They have two valves, a hinge with teeth/sockets and adductor muscles.
Environment	**Pelagic** (live at surface of water) in marine environments**. Benthonic** (living at the bottom of water) in both marine and fresh waters.

MICROFLORA (REMAINS OF SPORES/POLLEN DERIVED FROM LARGER PLANTS)

Spores and pollen were produced on plants that either **lived on land in a marginal shallow water environment**. Either way, the light particles could be **drifted out to sea or found in sediments elsewhere** as they're carried by wind and waters.

Source	Spores are produced from plants such as **mosses and ferns**. Pollen is the product of **seed-bearing** plants.   
Size	**10 to 200 µm** diameter (**Note that 1 micron = 1 µm**)
Composition	**Terrestrial vascular plant spores and pollen** are composed of **sporopollenin** as they are designed to be tough.
Age range	Still found to the present day but earlier groups have become extinct. While he earliest found terrestrial plant preservation dates to the Late Silurian, **spores** have been found which date from the **Ordovician**. The earliest plants **producing pollen** were from the **late Devonian** but they **diversified mainly in the Cretaceous.**

The surface may be pitted or ornamented with rod-like projections for protection. Analysis of pollen content in layer sediments like glacial varves shows the regional change in vegetation through time. Pollen from **oaks indicates a temperate** climate but **pollen from pine indicates colder** climates.

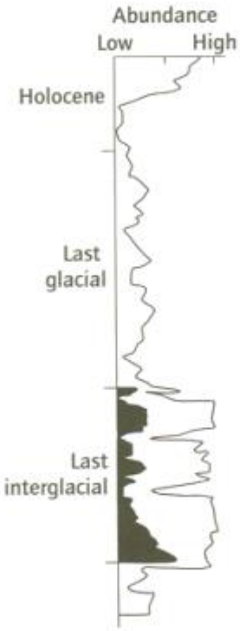


Fig. 13.15 Pollen record from Grand Pile, France. The white area represents the relative abundance of tree pollen, and the black bars show oak pollen (*Quercus*). The presence of oak pollen identifies the last interglacial period.

Why are microfossils so good at being zone fossils?

They are more abundant than macrofossils, being found on a **global distribution**. The fact that most are planktonic/nektonic and are small-bodied means when they die **they sink and float to be deposited in a variety of sediments.**
They show **rapid evolutionary** changes making good **zone fossils** and **palaeoenvironmental** indicators. They are quick to appear and disappear form the **stratigraphic record**.
They can be relatively **easily identified** using a microscope.
They are abundant in many rocks as their small tests are **well preserved** unlike the large skeletons of macrofossils which have a higher chance of disarticulation.