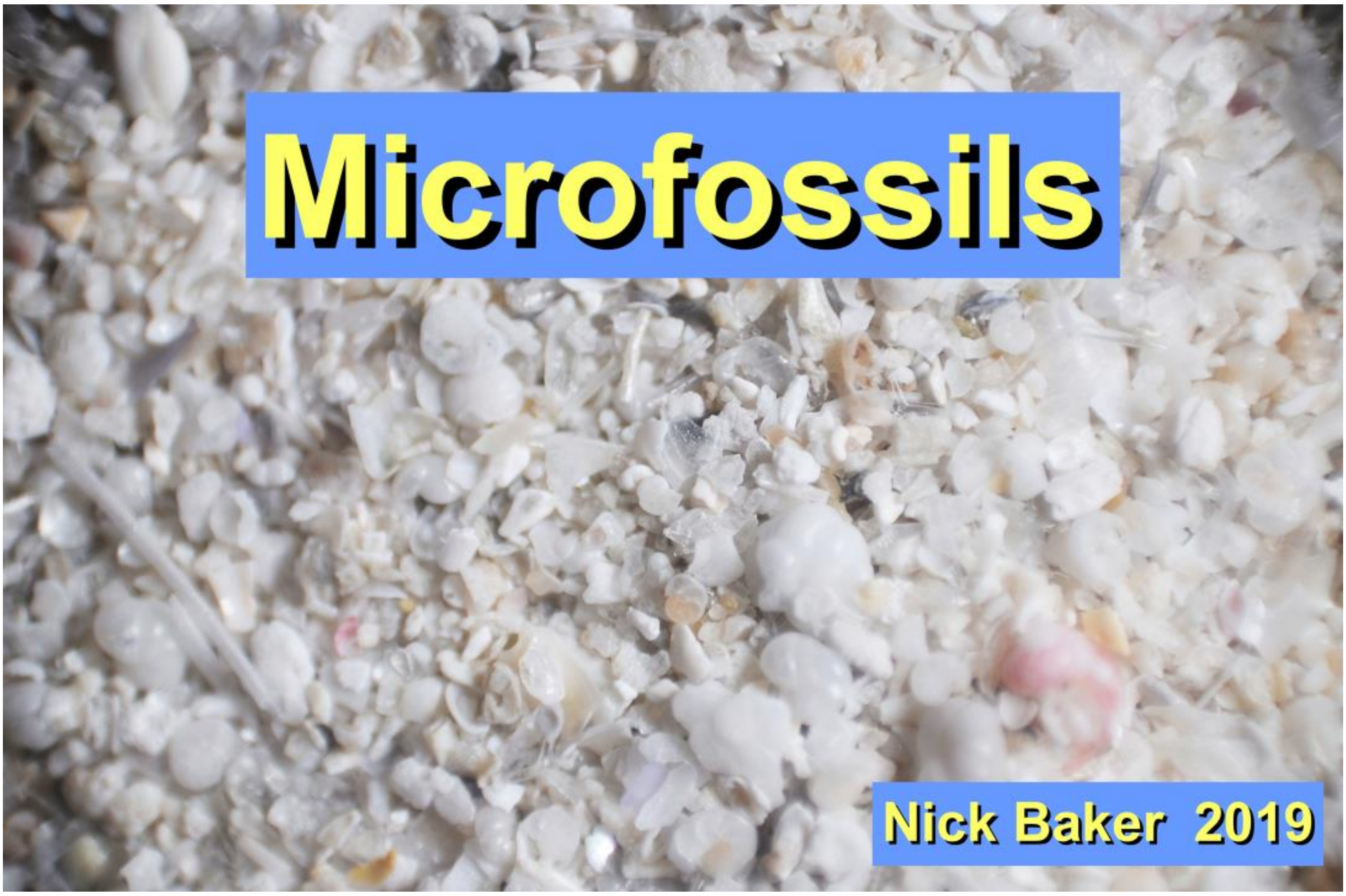
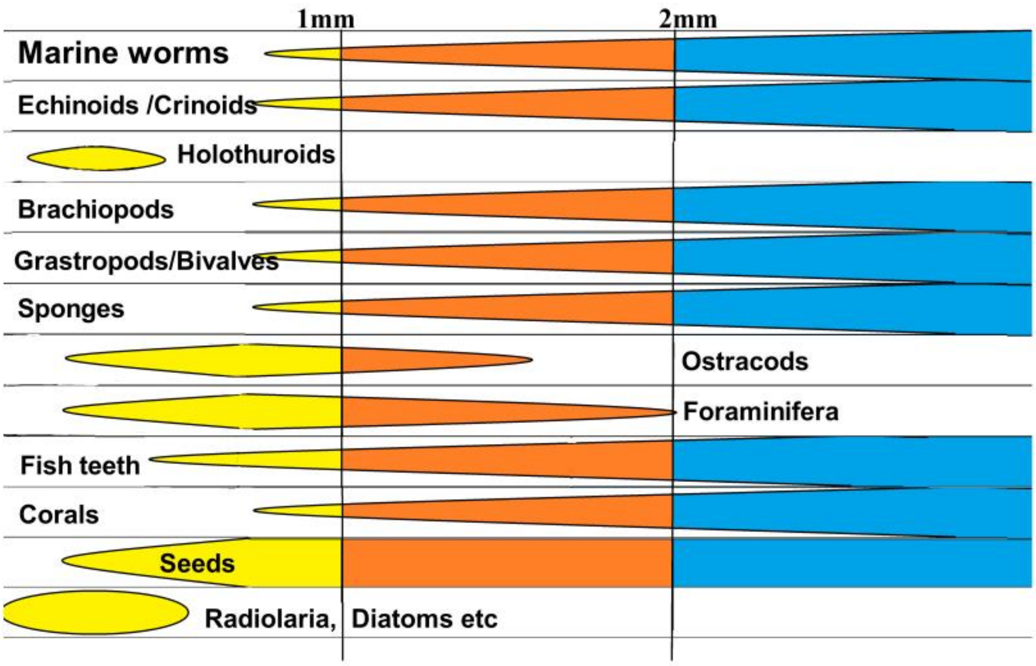


First of all, what is the definition of the term ‘microfossils’? Dr. A. J. Rundle applies this to anything below 2mm because that would include a lot of items, which would otherwise be (and often are) lost to the collector. I have included items above 2mm in the following talk, (usually I would term them as ‘miniature’, but I have included them) to illustrate the fact that a lot of them are small versions of things large. Often they are small species and not juveniles of things large. But a true definition of micro would be those things that you cannot see well with a hand lens, and a microscope is essential. But to extend it further, it would be those items that require the use of a microscope throughout the whole preparation. Very few of my collection fulfils that last definition. So, my talk covers several definitions, and I feel that is right, since it helps to bridge the gap between things large and truly micro. You are about to see examples of all. I am beginning with the simple and working onward and upwards in complexity, although I finish with examples largely beyond the optical microscope.

Microfossil size distribution



Foraminifera.

Foraminifera are protozoa. They are largely marine. Mostly single cells. They do not form tissues but consist entirely of protoplasm. My first photo demonstrates the fact that their remains can constitute whole beaches of foraminifera sands.

Foraminifera Sand
Dog's Bay, Connemara, Ireland
Austin Lockwood collection

My first single example is of *Nummulites*. This from Eocene limestone at Al Jabal al Akhbar, Libya. This genus includes the largest of the Forams by a large margin if we include the *Nummulites* Limestones at Giza. The picture is of a thin section and the cut has been across the examples in those in the lower part of the picture, where the cut is along the line of the cells, while those in the upper part are cut across the specimen. The sediment appears to have been disturbed.

Nummulites?
Eocene, Al Jabal al Akhbar
Libya 1mm

The examples of *Globigerina* (below) are of a planktonic type, but are not the easiest to find, due to their smaller size. These are from the Upper Chalk at Boxley.

Globigerina
Cretaceous, Coniacian,
Decipiens zone
Cossington Fields,
Boxley, Kent
1mm

Those that are most apparent in any search are the Lenticulinids, (below) and range up to 3mm.

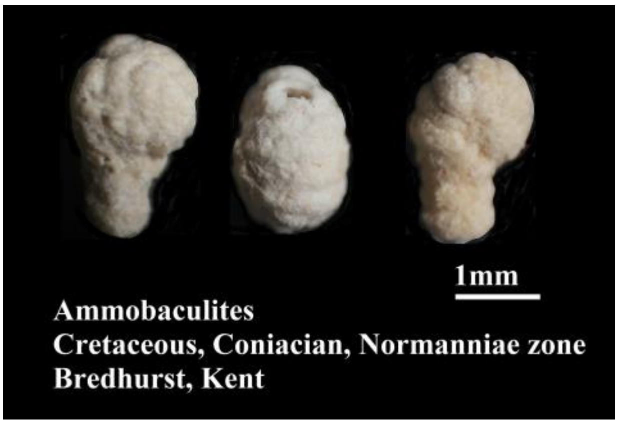
1mm
"Lenticulinids"
Cretaceous, Turonian, Planus zone
Blue Bell Hill, Kent

These are from the Upper Chalk at Blue Bell Hill.

Variations on that form are the "*Ammonia*", (right) which look like micro-ammonites, and a compartment formation can be seen. These are from the Gault Clay at Eccles, Kent.

"Ammonia"
Cretaceous, Gault Clay,
Aylesford, Kent
1mm

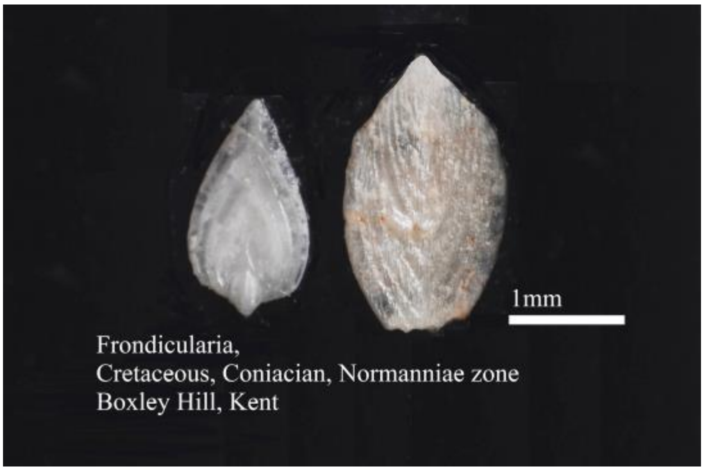
In the case of *Ammobaculites* (below) the outer shell is thick, but again shows the chambers. The shell is of compact calcite, otherwise it would not survive the preparation processes. The juvenile clump of chambers is followed by straight construction.



1mm
Ammobaculites
Cretaceous, Coniacian, Normanniae zone
Bredhurst, Kent

In *Rectobolivina* the chambers surround a central duct, while in *Frondicularia* the chambers form a plate-like construction.
See next page

Foraminifera, Rectobolivina.
Cretaceous, Santonian, Coranguinum zone
Darenth, Kent



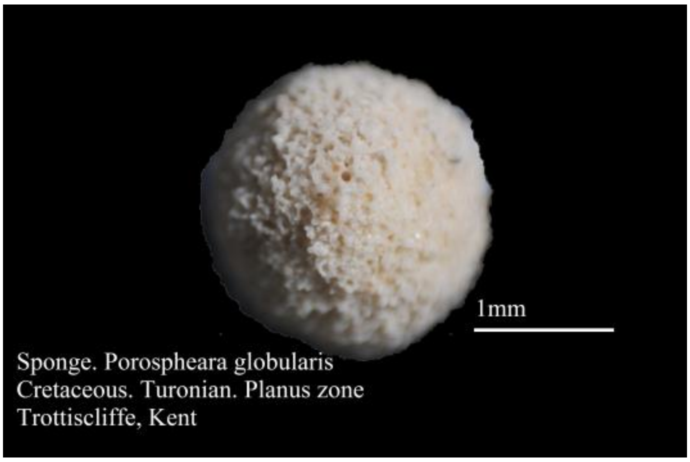
Frondicularia,
Cretaceous, Coniacian, Normanniae zone
Boxley Hill, Kent

Sponges

Sponges are normally found as large fossils, and in smaller form are included in what I would class as 'miniature', as in the example shown to the right, (so far not identified) from the Upper Chalk at Cuxton.

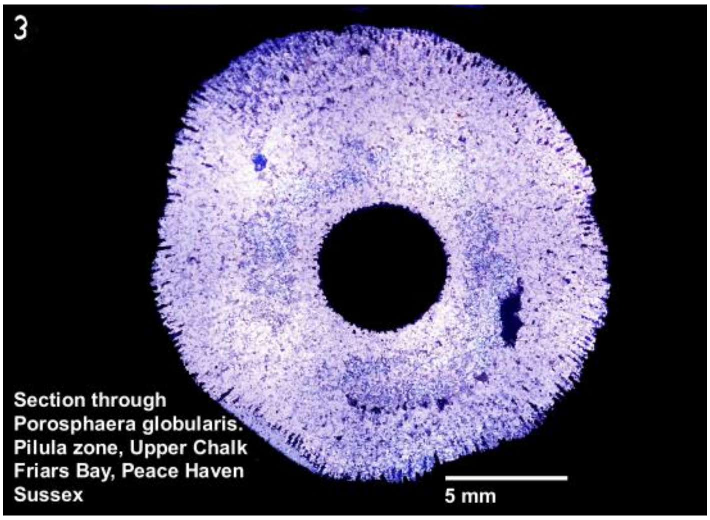
Sponge
Cretaceous, Turonian, Planus zone
Cuxton, Kent

Porosphaera are common in the Upper Chalk and range up to 2cm in diameter. Large, hand-size flint nodules are not *Porosphaera* but are hand-size flint nodules.



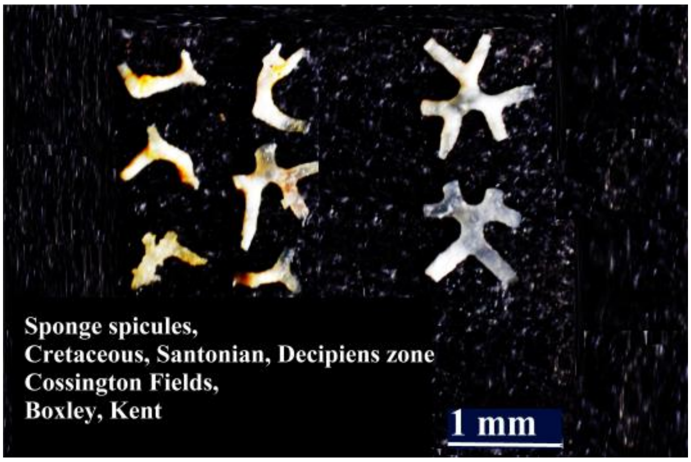
Sponge. Porospheara globularis
Cretaceous. Turonian. Planus zone
Trottiscliffe, Kent

Porosphaera are calcareous and do not metabolize silica. In thin section (below), the tubular structure is clearly shown in the calcite construction. Flint cores can be mis-taken for *Porosphaera* but usually show a maze-like chal-cedony in section. Also, flint cores have a rough surface, while *Porosphaera* shows evenly-spaced micro-pores and have a duct leading to the interior. *Porosphaera* can be converted to silica on burial but will still show some of the original structure. *Porosphaera* can range down to 1mm diameter,



Section through
Porosphaera globularis.
Pilula zone, Upper Chalk
Friars Bay, Peace Haven
Sussex
5 mm

Sponge spicules are generally found inside nodular flints. I have never found them in Chalk samples. The slightly raised pH in the Chalk environment may render small silica structures soluble. The lower pH in the decay environment in the flint (burial chamber) might prevent this. The spicules are often tubules, forming the circulatory system, as well as support in the sponge structure. The type of spicule is often indicative of the genus to which the deceased belonged.

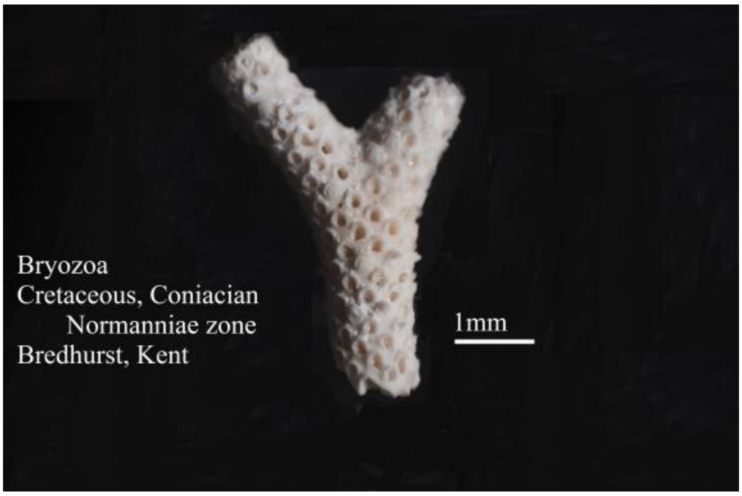


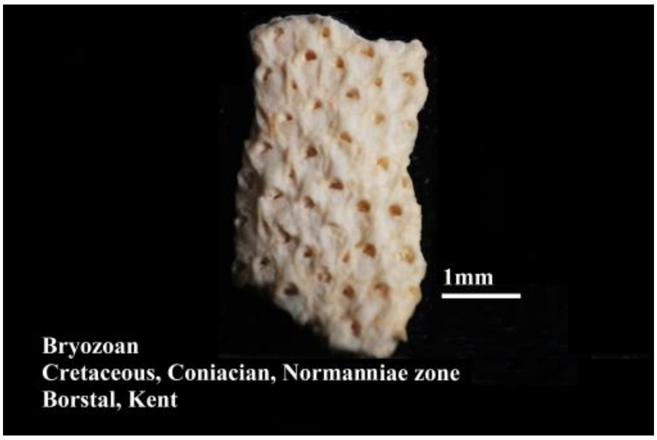
Sponge spicules,
Cretaceous, Santonian, Decipiens zone
Cossington Fields,
Boxley, Kent
1 mm

Bryozoa

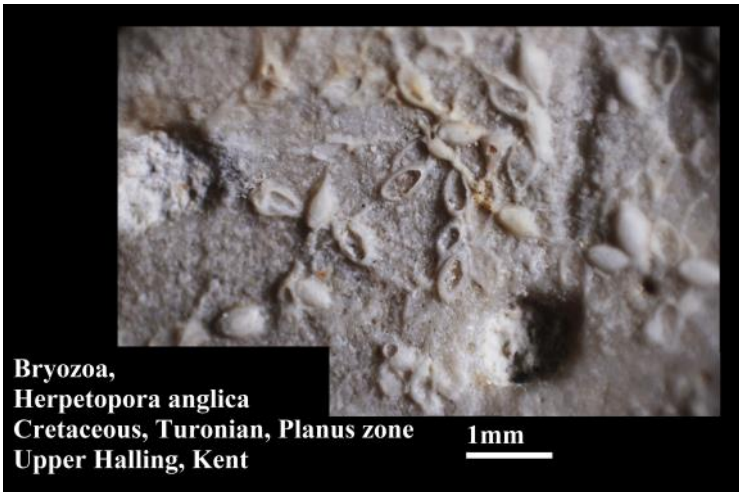
Bryozoa are colonial animals, (almost all marine) each of the apertures indicating the position of an individual animal. They appear first in the Ordovician, although all the Palaeozoic forms are now extinct. The Mesozoic survivors reached their ‘high noon’ in the Upper Cretaceous. The term Bryozoa (branched-life) covers several orders and sub-orders. In some thin beds of the Upper Chalk they comprise a large percentage of the chalk, almost comprising a ‘reef’.

Most are branch-like but they are often found as flat plates, sometimes covering other organisms, earning them the name of ‘sea-mats’


Bryozoa
Cretaceous, Coniacian
Normanniae zone
Bredhurst, Kent
1mm


1mm
Bryozoan
Cretaceous, Coniacian, Normanniae zone
Borstal, Kent

This encrustation can been seen here. *Herpetopora anglica*


Bryozoa,
Herpetopora anglica
Cretaceous, Turonian, Planus zone
Upper Halling, Kent
1mm

can be seen encrusting a bivalve fragment, in the Upper Chalk at Upper Halling, Kent
I mentioned the term ‘reef’. This is certainly the case in the Upper Permian, Magnesian Limestone. This is a thin section through a sample from the reef base in the Tunstall Hills, County Durham. One is reminded that the term Coralline Crag of the Pliocene of Suffolk, refers to Bryozoa and not Corals.


Bryozoan Reef
Permian, Magnesian Limestone
Tunstall Hills, Co Durham
1mm

Corals

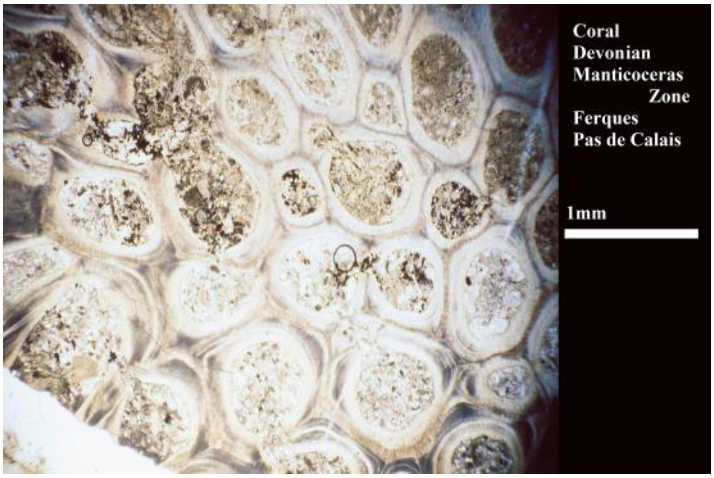
Corals do not often occur as microfossils – save perhaps fragments in coralline sands. But here I want to refer to the smallest I have found. As a hand-sample,

Micrabacia coronula
Cretaceous,
Cenomanian,
Rhotomagense zone
Blue Bell Hill, Kent
1mm

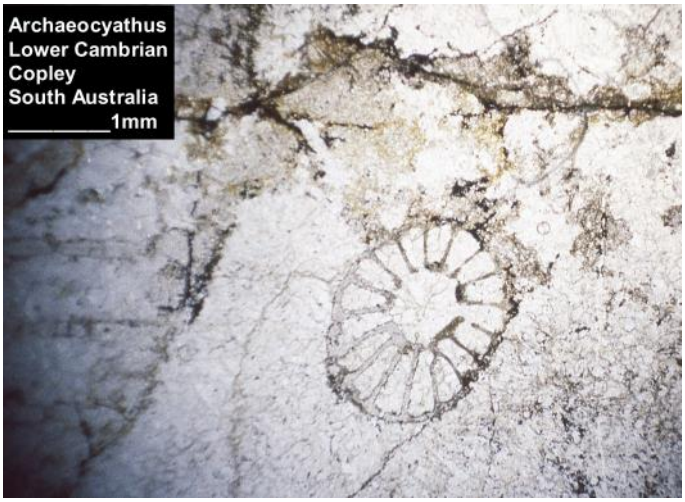

Micrabacia coronula
Cretaceous
Cenomanian Limestone
Mantelli Zone
Seaton
Devon
1mm

Micrabacia coronula is not uncommon in the Lower Chalk and range up in size to 10mm. Here (above) is an example from Blue Bell Hill. In South Devon, the Lower Chalk is represented by a few metres of hard Cenomanian Limestone. The Hooken Limestone Division below Seaton Cliffs gave the (2mm) example of *Micrabacia coronula* (left).

Next is a thin section (right) through Devonian limestone, from the stone quarry at Ferques, in the Pas de Calais. Here the coral colonies are well shown, the cells being infilled with calcite. I have not been able to name the species.

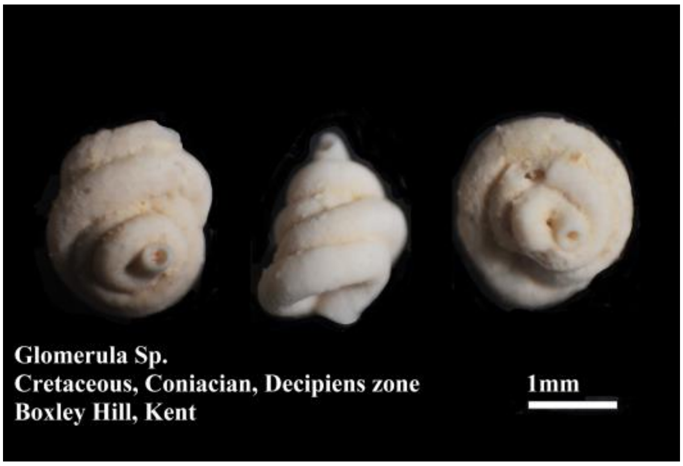


Archaeocyathus



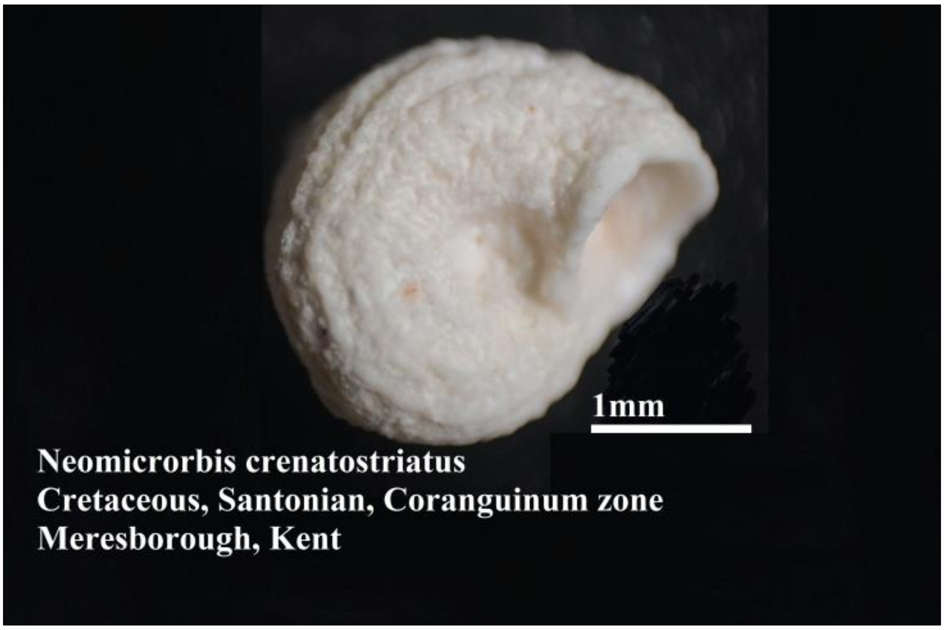
I include *Archaeocyathus* (Ancient Cups) because it is considered to represent the extinction of possibly a whole class. They appear to have been colonial but they differ from Corals, or Bryozoa. They appear in the Lower Cambrian and are extinct by the Mid Cambrian. This is a thin section through an example from Copley, South Australia.

Worms



Worms are relatively rare in processed samples, due to the fact that they do not always produce shells. At some levels in the Chalk they are quite abundant as marine worms. Some are organised and ornamented. Some are unornamented and apparently disorganised in their growth, with *Glomerulus* as a good example of the latter in the Upper Chalk. They have been likened in appearance to squirts of polyfiller. There are two examples shown here

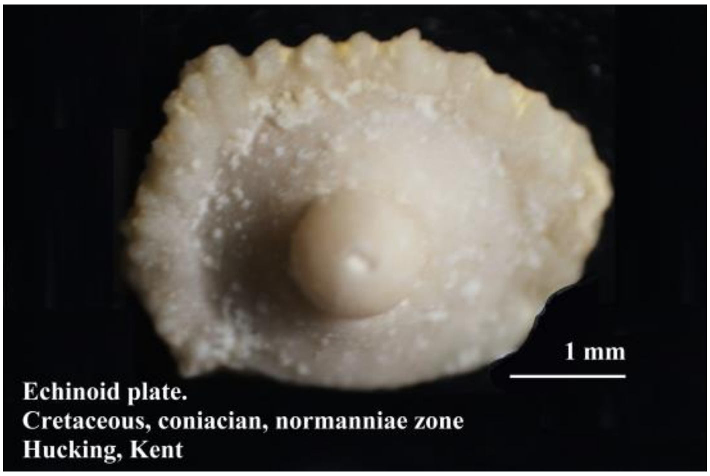
Others, such as Neomimicrorbis have strong ornamentation. What the environmental advantages are in these two situations is difficult to say. This specimen is from the Upper Chalk at Meresborough, near Rainham, in Kent



Echinoids

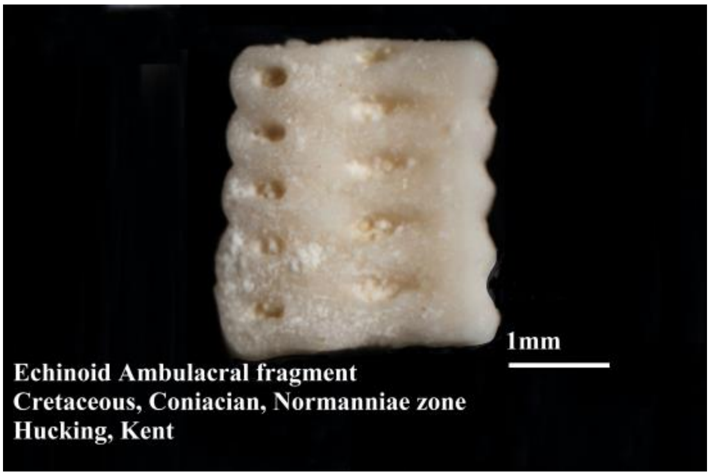
We are now going to look at Echinoderms, which comprise Echinoids, Crinoids, Asteroids, and Holothuroids. So for Echinoids, in the Chalk, the most common remains are the plates or fragments of the test. By some referred to as the rivets (right)

And here is a close-up (below) of one such, probably from a Cidarid .



Echinoid plate.
Cretaceous, coniacian, normanniae zone
Hucking, Kent

And also fragments of the ambulacra, part of the respire - tory system. (below).



Echinoid Ambulacral fragment
Cretaceous, Coniacian, Normanniae zone
Hucking, Kent

Echinoid, Cidarid (juv)
Cretaceous, Coniacian, Normanniae zone
Boxley Hill, Kent

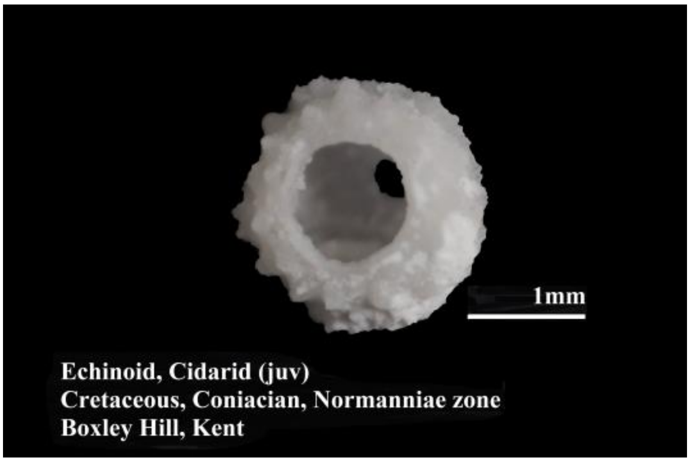
Other items to be found are the ‘lanterns’ (right). These form part of the ‘teeth’ in the mouth, largely used for rasping, rather than biting. The area is quite complex but goes back to the earliest stages of Echinoid evolution in the Ordovician.

Echinoderms
1. Echinoids

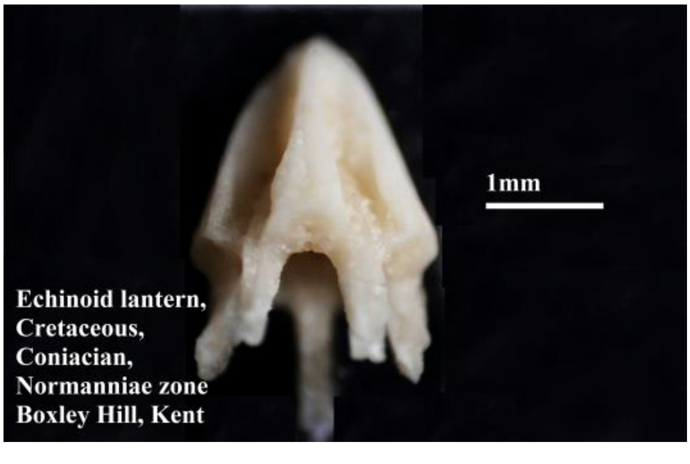
Other common fragments are the spines.

Echinoid spine
Cretaceous, Coniacian, Normanniae zone
Hucking, Kent

Very occasionally it is possible to find juvenile examples of Echinoids, mainly Cidarids. And here are two examples of such. It has been pointed out the five-fold structure is not possible to see in these. The answer is that such development may become apparent only in the adults. The infant state of an Echinoid is also very short compared with the rest of its life-span



Echinoid, Cidarid (juv)
Cretaceous, Coniacian, Normanniae zone
Boxley Hill, Kent

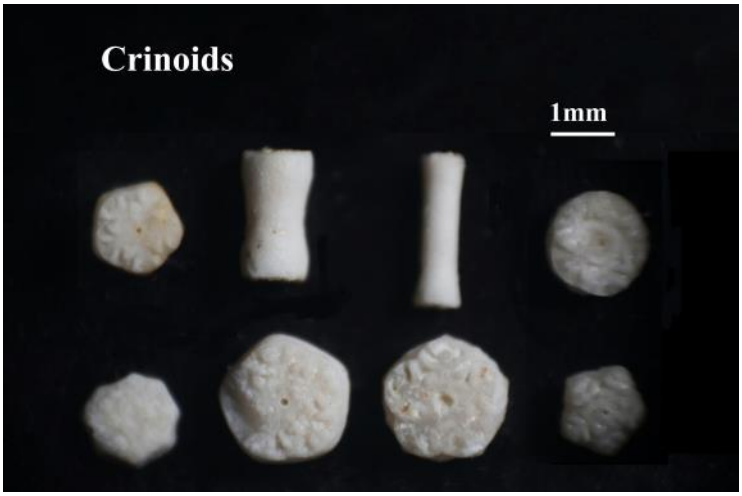


Echinoid lantern,
Cretaceous,
Coniacian,
Normanniae zone
Boxley Hill, Kent

Cidarids

At the small level the most common remains of Crinoids are stem fragments. Here is a selection.

And an example (below) from the Lower Chalk at Blue Bell Hill. It is possible that fragments of calyx may be common but may be less easily noticed.



Crinoid stem fragment,
Cretaceous, Cenomanian, Rhotomagense zone
Blue Bell Hill, Kent

Holothuroids

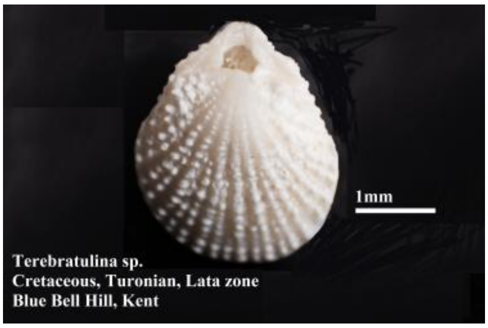
Holothuroids (see below) include sea-cucumbers. The wheel-like structures here, consist of part of the supporting 'skeleton' which is here about 250 microns across, and were found in the Jurassic Oxford Clay, near Weymouth, Dorset.

Holothuroidea, Chirodata sp.
Jurassic, Oxford Clay, Weymouth, Dorset.

Brachiopods

Brachiopods were the most common in the Palaeozoic, but retained their abundance in the Mesozoic. They are much depleted in the Tertiary, giving way to more modern bivalves. In the Middle Chalk small Rhychonelids are abundant, especially *Terebratulina* of which we see several here. One can see why they are sometimes referred to as 'lamp-shells'. But of special note, I want to illustrate *Iso-Crania*, (below) from the Upper Chalk, where the posterior adductor muscles are located well towards the centre of the valves. Likewise with the exterior ridges. The effect is to award the name of 'chicken face'. One is not usually rewarded with a view of the interior. The ornamented surface tends to accommodate 'resistant' chalk and cleaning small fossils is difficult and risky.

Terebratulina sp.
Cretaceous, Turonian, Lata zone
Blue Bell Hill, Kent

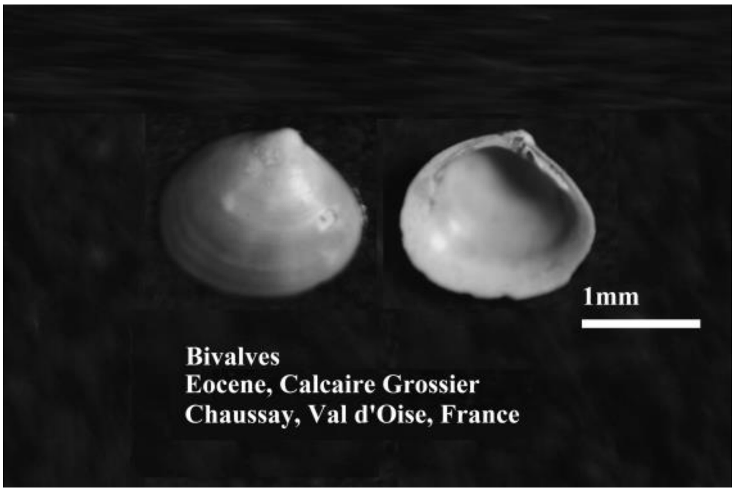


Terebratulina sp.
Cretaceous, Turonian, Lata zone
Blue Bell Hill, Kent

Isocrania paucicostata.
Cretaceous, Coniacian, Normanniae zone
Boxley Hill, Kent

Bivalves and Gastropods

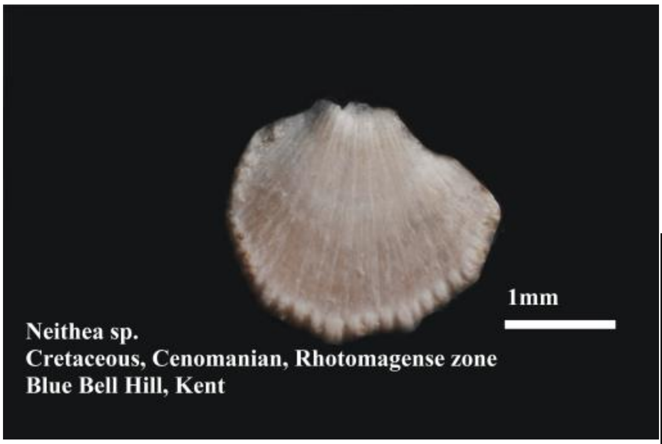
In the Tertiary, with the decline of the Brachiopods, their place was taken by the Bivalves and Gastropods. In Northern France the Calcaire Grossier is equivalent in age to the Bracklesham and had a remarkable fauna. One problem with here and elsewhere in the Eocene is the number of small adult forms (right), sometimes mistaken for juveniles. The number of whorls in the gastropods suggest otherwise.



1mm

Bivalves
Eocene, Calcaire Grossier
Chaussay, Val d'Oise, France

Likewise, very small versions of *Neithea* can be found in the Lower Chalk (see below)



1mm

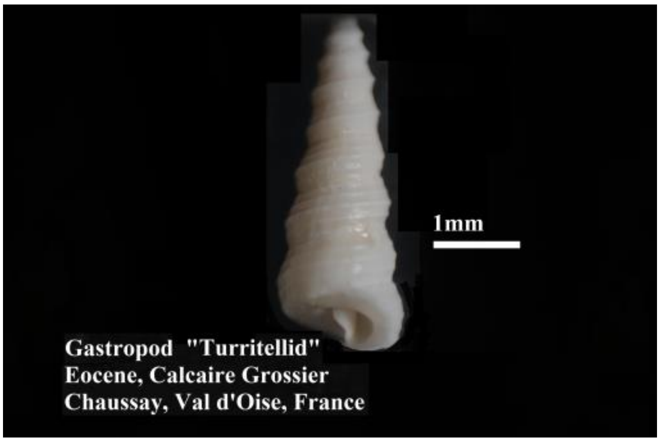
Neithea sp.
Cretaceous, Cenomanian, Rhotomagense zone
Blue Bell Hill, Kent

And with the Gastropods (see below) you might think that these were *Bonellitia*, but true *Bonellitia* is often much larger. Nor are they the juvenile form.

1mm

Gastropods.
Eocene, Calcaire Grossier
Chaussay, Val d'Oise, France

Likewise with this "*Turritella*". They may be small species, but not a juvenile. Doubtless, the juveniles will be present but may be difficult to find among the debris, and being less attractive than the adults, will tend to be ignored. This is where the micro-Palaeontologist will need to take on a specialist study.

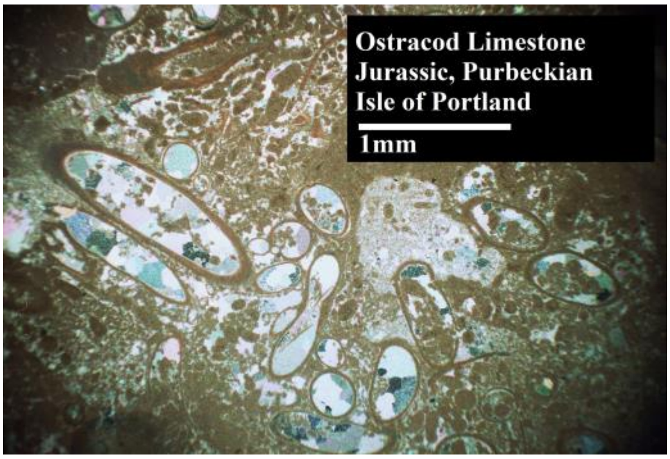


1mm

Gastropod "Turritellid"
Eocene, Calcaire Grossier
Chaussay, Val d'Oise, France

Ostracods

One may wonder why in "British Fossils" these are always placed towards the end, near the vertebrates. These are in fact Crustacea. It is remarkable that, with the Forams, blobs of protoplasm produces many ornate and varied forms of 'shell', while these Crustacea make do with slight variations of two valves, with or without spines. That is all you have to identify them in the fossil record. The animal inhabits the shells almost permanently, opening them with rear legs. The concentration on the Wealden forms in British Mesozoic Fossils also propagates the idea that there are only fresh water forms. This is fake, as you are about to see.



Ostracod Limestone
Jurassic, Purbeckian
Isle of Portland
1mm

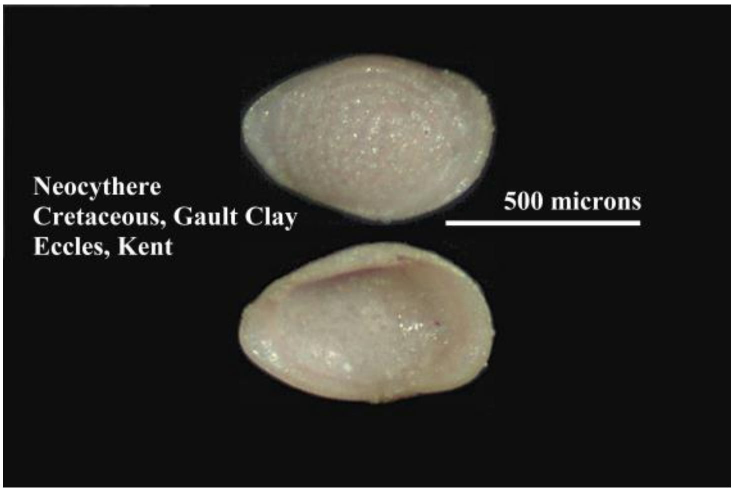
But, first of all we can see some freshwater forms in this thin section through Purbeck Limestone from the Isle of Portland. They are quite visible, to the naked eye, on the surface of the limestone.


Cythere and Bairdia
Cretaceous, Turonian, Lata zone
Blue Bell Hill, Kent
1mm

While *Homocythere*, (below) from the Gault at Eccles is definitely a marine genus.


Homocythere
Gault Clay, Eccles, Kent
1mm

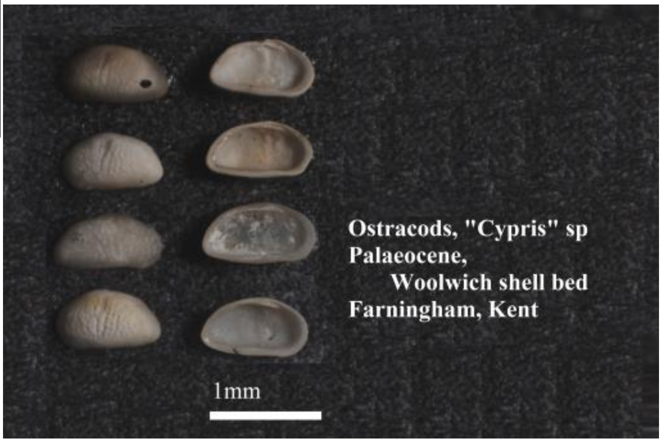
Finally, we have *Neocythere*, which is one of the smallest of the Gault fauna. (below)


Neocythere
Cretaceous, Gault Clay
Eccles, Kent
500 microns

Fish teeth can arrive by two routes in the sampling, either as extraction from hard rock such as bone bed or from softer sediments. In the first instance, here are some from the Rhaetic Bone Bed (Upper Triassic) at Blue Anchor Bay, Somerset. (right)

Low down in the Chalk, *Cythere* and like forms tend to be predominant. These comprise the three specimens on the left of the picture. while in the Upper Chalk there is an increasing proportion of the triangulate *Bairdia*. These are, of course, marine and their numbers in the Chalk are vast.

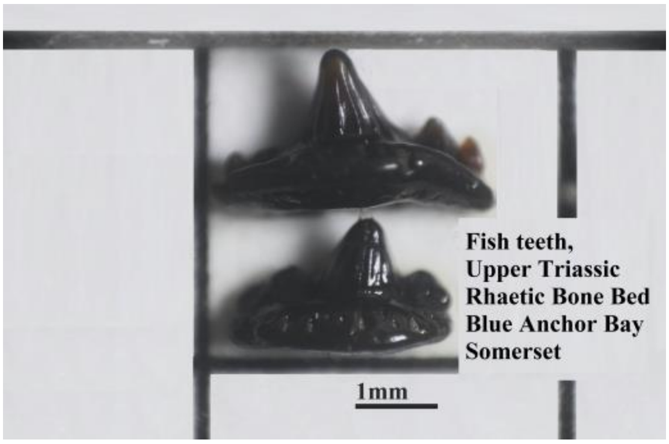
Those shown here from the Woolwich Shell Bed may be of brackish water. The bivalves in the Shell Bed tend to show both marine and freshwater affinities.


Ostracods, "Cypris" sp
Palaeocene,
Woolwich shell bed
Farningham, Kent
1mm

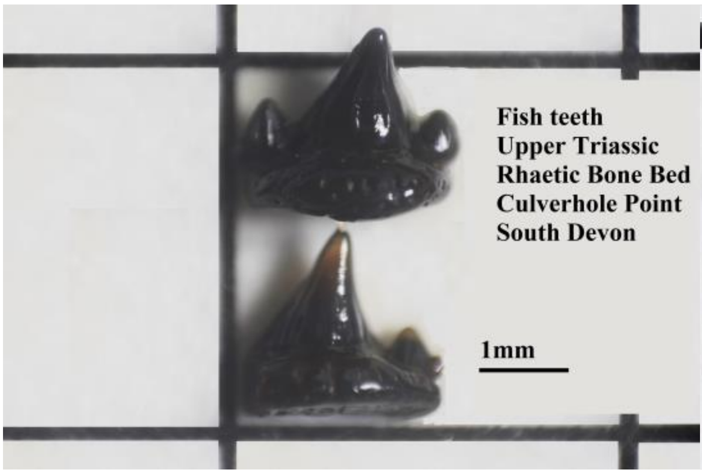
This is also the case (below) with these two 'Punks' – *Cythereis*. The Punks tend to be common in the Gault but tend to give way to the 'Smooths' in the Chalk. Not sure why this change but might be due to sea bed conditions.

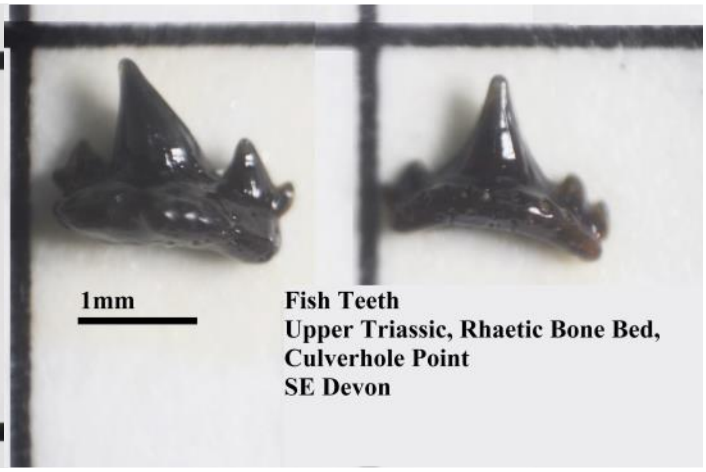

Cythereis
Cretaceous, Gault Clay
Eccles, Kent
1mm

Fish


Fish teeth,
Upper Triassic
Rhaetic Bone Bed
Blue Anchor Bay
Somerset
1mm

The Rhaetic Bone Bed occurs at three locations—Aust Cliff, Blue Anchor Bay (Both in Somerset) and Culverhole Point in South Devon. Because the last mentioned is the least known, I offer you two pictures of teeth from that location. (below)

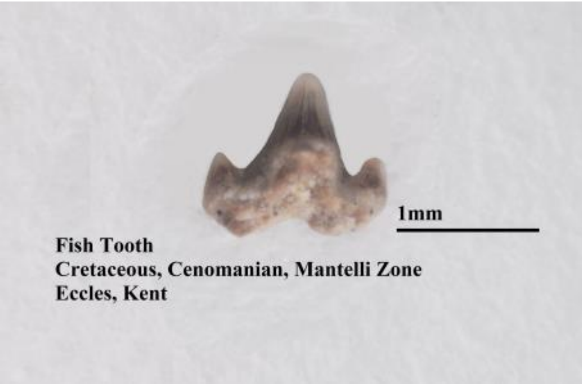




The bone bed at Culverhole is subject to long periods of burial under shingle

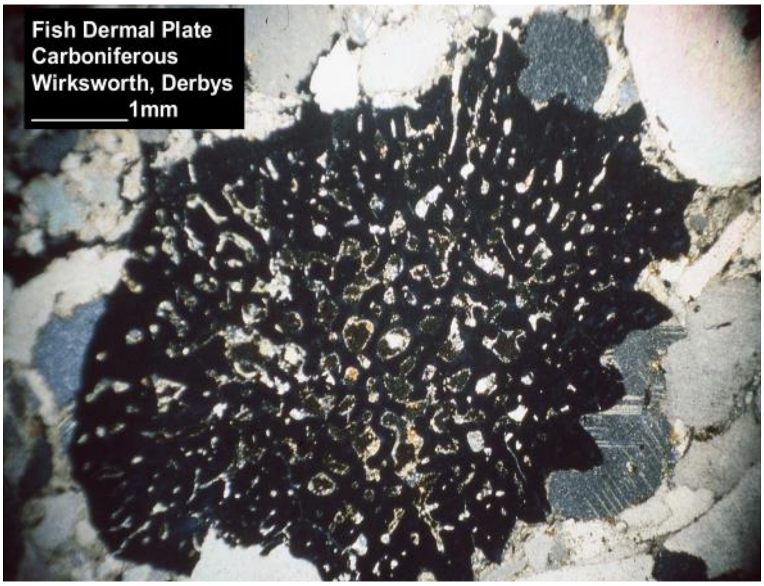
This specimen (right) from the Middle Chalk may be partial,

But the smallest whole tooth I have is from the Lower Chalk at Blue Bell Hill. It is about 1mm across



Vertebrae can be even smaller. This one is from the Upper Chalk at Birling, Kent. (below)

Other fragments can occur, such as dermal plates. Below is a thin section through a specimen from the Steeplehouse quarry, near Matlock. So this is from the Lower Carboniferous, and gives a good picture of the bone structure.

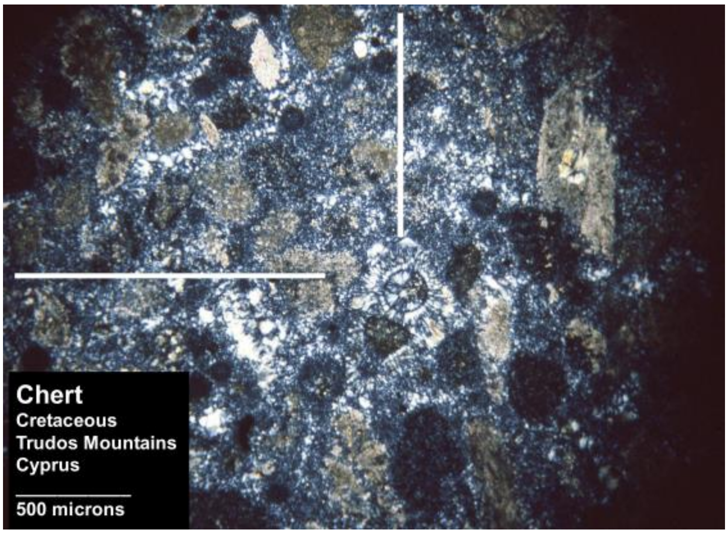


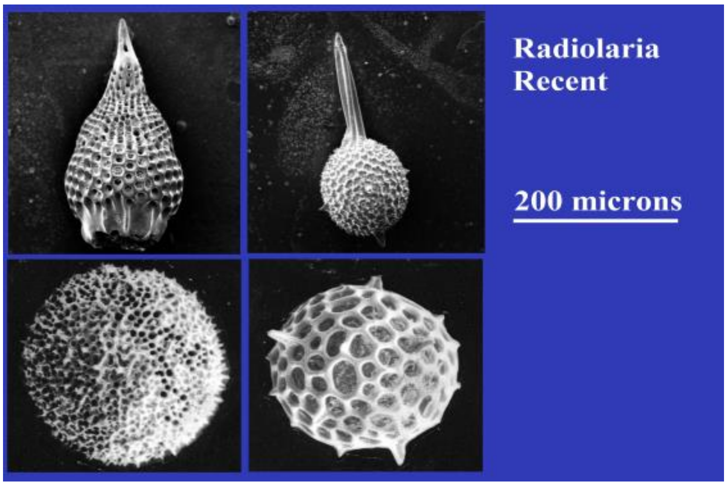
In my original talk I forgot to mention fish otoliths (ear bones). Their size will depend on the size of the fish and can be quite common in some locations. For instance in the Eocene at Barton and Bracklesham, or the Palaeocene at Abbey Wood and the North Kent coast. To the untrained eye they may appear as debris, but will be indicated by the sudden appearance of debris having exactly similar features. See examples in the photo on next page.

This is an example (right) of otoliths from the Weald Clay, in Surrey

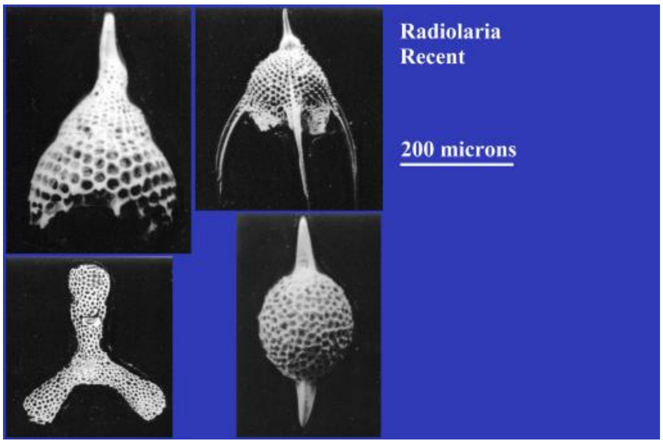
Radiolaria

I have been working my way up through the complexity of life, but I have left the smallest to the last, mainly because the Radiolaria cannot be easily seen with an optical microscope. None the less, I made thin sections from the Cretaceous chert from the Trudos Mountains of Cyprus. For some time it was thought that the object (below) in the 'cross-wires' was a Radiolarian but may be too large – more likely a Chalcedony crystal – still not certain.

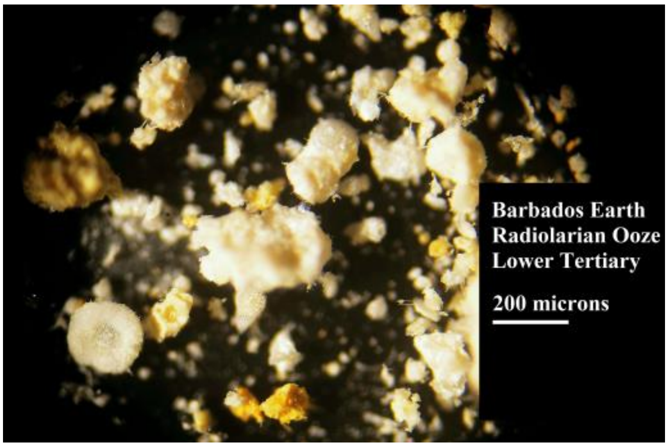




But to see the real thing you will need a Scanning Electron Microscope (SEM). These examples are from recent sediments. The animal consists of protoplasm, encased in a membrane, the silica skeleton being based in the membrane. It is the accumulation of these skeletons on a deep ocean bed that forms a silica ooze.



Barbados Earth is one such example. I attempted to try and photograph any likely suspects that I could find.



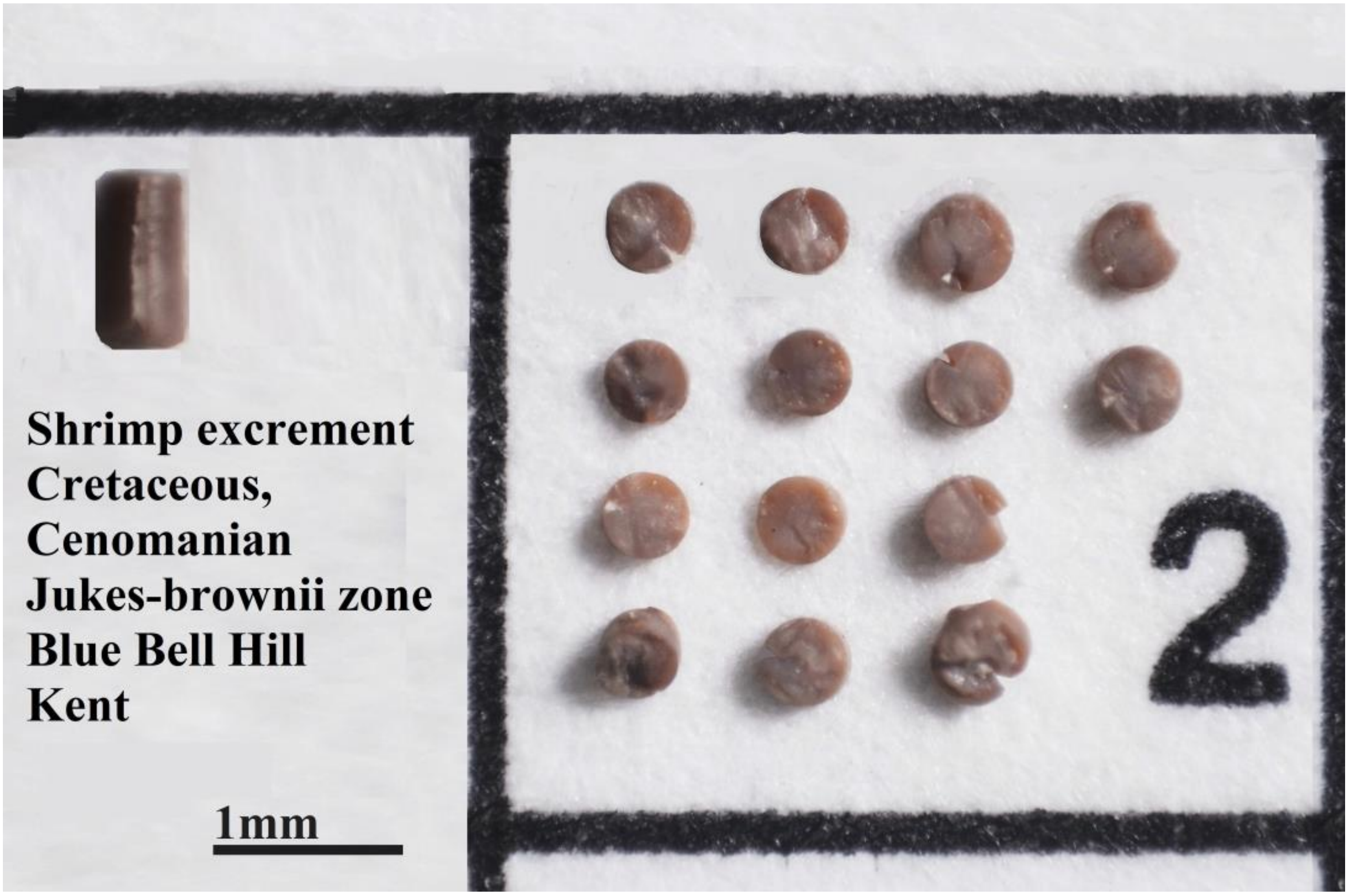
Without a special photo program I was pressing the depth-of-field to the limit. But here is what I have. The set-up was not secure enough for a repeat.

And now, before I leave, here is a micro-palaeo mystery—next page

Some years back I collected a sample from the top of the Culand Pit at Blue Bell Hill. In the sample I recovered these small phosphate discs, about 400 microns in diameter. What was strange was the similarity of some of them – the small notch in one side. Adrian Rundle reported to me that they were deformed mega-spores. My problem was that deformation is usually random in its effect, whereas the specimens seem to demonstrate a degree of sameness. There is variation but it seemed to be graded. There were others in addition to those shown, and it would have been possible to join them together to produce a length of material with a groove, rather than a segment with a notch. I subsequently found such an item.

Adrian subsequently confirmed that this was excrement and was able to identify that it was left by a type of shrimp. Adrian had made a study of this! Adrian's teaching method relied on the 'student' checking the validity of the information that Adrian had given. To not do that was to fail.

The groove was produced by a structure in the side of the shrimp gut!



Thank you all for coming along and listening and watching.