

The Fossils of the Urban Sanctuary:

Rickett's Point Victoria 3193

Fearghus McSweeney & John Buckeridge

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Marine Care Rickett's Point
PO Box 7356, Beaumaris 3193

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Cover illustration showing Beaumaris Beach during the earliest Pliocene, in the sky is the large bony-toothed *Pelagornis*, on the beach are penguins, seals, *Macropus* (kangaroo), cetacean vertebra and an early marsupial *Zygomaturus*. **Digital reconstruction art © Peter Trusler**

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Figure 1: Beaumaris Sandstone cliffs exposed looking towards Watkin's Bay, Beaumaris.
(photo: JB)

The fossils of the Urban Sanctuary: Rickett's Point, Victoria 3193.

Preamble:

This book has been written to help enthusiasts identify and to appreciate the rich fossil heritage that is preserved in coastal outcrops around Rickett's Point, Beaumaris, Victoria. It is a further addition to books dedicated to the natural history of Rickett's Point, the first of which, *The Urban Sanctuary: Algae and Marine Invertebrates of Rickett's Point Marine Sanctuary* by Reeves & Buckeridge, was published in 2012. In line with this series, the same Canadian binding has been adopted, which provides the field worker with an easy to use field-text that also sits well in the bookshelf.

An Introduction to Sedimentary Geology:

Geology is unlike other sciences in that geologists are primarily trying to unravel how and why past events happened. In many cases the causes are extremely complex and sometimes even unfathomable. In response to this uncertainty, geologists can use somewhat non-definitive terms, such as "may have formed by" and "most likely formed from". Nonetheless, there are many deductions concerning the Beaumaris Sandstone of which we can be confident. The Beaumaris Sandstone is a marine sedimentary rock, and possesses characteristics typical of sedimentary rocks. It is comprised primarily of *clastic* mineral grains that originated following the weathering and erosion of pre-existing rocks. In addition to these *clasts*, there are biogenic components (shells and burrows) and chemical components (which are derived from the precipitation of non-organic minerals).

The composition, shape and size of clasts in sedimentary rocks gives an indication of how (and where) the rock formed. When the clasts are overwhelmingly made up of well-rounded grains of a detrital mineral such as quartz, we may conclude that:

- The grains have been in a weathering/transportation phase for a while (quartz is a tough mineral and wears down slowly, as such rounded quartz grains are likely to have been in the system for considerable time).
- The source rock would have contained free quartz (such as granite, quartzite or quartz sandstone).
- If the clasts are coarse (i.e. comprised of large grains of minerals), transportation from "source" is likely to have been less than in deposits where clasts are fine (e.g. muds and clays).

Further, in marine deposits, if the mineral grains are uniform in size, we may conclude that some degree of sorting has occurred prior to deposition. Sorting is a term applied when sedimentary particles have remained in a fluvial, marine or aeolian system for sufficient time and transportation to separate out coarse from fine particles.

Sedimentary rocks are generally deposited as beds; typically each bed represents a single hydrodynamic event, such as when sediment settles from a slurry of suspended grains. The easiest way to understand the process is to carefully note the grain size and composition of sediments on the beach today. You should be able to find similar grain sizes and dispositions to that observed in the Beaumaris Sandstone; from this we may deduce that the sandstone formed in conditions not unlike present-day Rickett's Point – i.e. in relatively shallow water on and near beaches.

This approach employs the scientific principle known as uniformitarianism, wherein present processes are seen to reflect those that have occurred in the past. Loose sediments however do not comprise rock. They must undergo what is known as lithification, a process in which both sediment grains are variously compressed and cemented, and volatiles such as water are released. The rocks at Rickett's Point are variably cemented by goethite, a ferric oxy-hydroxide that is preferentially deposited in fissures and porous sands; in doing so it makes these layers more resistant to weathering. Hard, dense sedimentary rocks are classified as well indurated; loose sediments are non-indurated. As the Beaumaris Sandstone lies between these extremes we classify it as moderately indurated.

The Beaumaris Sandstone comprises much of the cliff and shore platform that is exposed at Rickett's Point. It contains sufficient ferruginous minerals to impart the reddish-brown hues that gave this coast artistic appeal to some of Victoria's 19th century impressionist painters such as Tom Roberts, Frederick McCubbin and Arthur Streeton (of the "Heidelberg School of Art").

An Introduction to Palaeontology:

Palaeontology is the scientific study of prehistoric life that is preserved in rocks (primarily sedimentary), and the evolution of life. It is integrative, using geology, biology, chemistry and physics to unravel past environments and the nature and phylogeny of the organisms that inhabited them.

Although other strata outcrop near Rickett's Point, it is in the Beaumaris Sandstone, a shallow water marine deposit, that fossils are primarily found. The term "fossil" is derived from the Latin word *fodere* (= to dig) and as such was originally used to describe anything excavated from the ground. Today, the word is reserved for either the preservation of organic remains, or evidence of past organic activity.

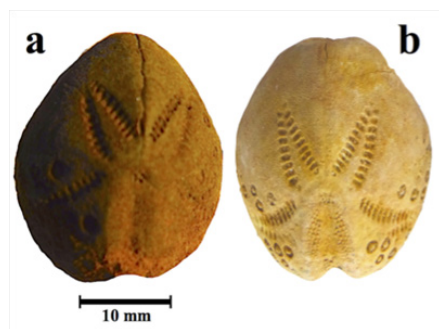


Figure 2: Mineralization. These two fossils, from different horizons in the Beaumaris Sandstone, are remains of the echinoderm *Lovenia woodsii*. In **a**, all of the original calcite has been dissolved away and replaced by goethite. The process may take a considerable time to complete, such that delicate structures in the original are preserved. In **b**, although the calcareous shell has absorbed some iron minerals, it is for the most part, much as it was the instant the animal died.
(photos: JB)

The most common fossils comprise the mineralized shells or bones of organisms, in time these remains may retain their original mineralogy (e.g. for many molluscs this is calcite or aragonite (CaCO_3), but sometimes during lithification, the original mineral is replaced and the shell or bone is preserved by other minerals, such as opal (a form of hydrated silica), pyrite (FeS_2) and goethite (FeO.OH) (see Figure 2). Fossils may represent a "life assemblage" (biocoenosis), meaning that they are preserved as and where they lived. However this is not the norm, as upon death, organic remains tend to be transported, finally resting as thanatocoenoses or "death assemblages".

In addition to shells and bones, fossils may represent organic activities, such as footsteps, feeding trails and burrows. These are often the only indication that soft-bodied organisms, such as annelids, lived in the sediment. Collectively, these tracks, trails and burrows are known as ichnofossils or "trace fossils".

To a casual observer, the most obvious fossils in the Beaumaris Sandstone are long branching tubular structures.

These tubes, up to 4 metres long, and 55 mm in diameter were previously interpreted as fossilized *Banksia* trees. There was, until 2015, official signage testifying this at Black Rock Beach car park (Figure 3). However this interpretation was mistaken, these *Banksia*-like fossils have nothing to do with plants. Indeed, they are not even terrestrial: rather they are the ferruginised burrows of crustaceans that lived in the shallow waters of a proto-Balcombe Bay some 5-6 million years ago (MA). The burrows may look a little like the branches of *Banksia serrata*, but appearance is only part of the assessment of any fossil. A more careful assessment of their disposition, association and overall morphology leads to the recognition that they are neither skeletal nor carbonaceous remains. Instead, they are more correctly classified as ichnofossils, representing the past activities of organisms.

The burrows are now recognized as having been produced by a mud crab. These fossils are sufficiently well-preserved to have warranted formal description as an ichnospecies. The most abundant ichnospecies in the Beaumaris Sandstone is *Ophiomorpha beaumarisensis*, which is preferentially weathered out of the surrounding sediment because it has been preserved in goethite, a mineral that is more resistant to weathering than the surrounding rock.

In nature, nothing is static, and today we can see processes operating at Rickett's Point that will produce the fossils of tomorrow. Figure 4 shows recent accumulation of mollusc shells near the Beaumaris Surf Life Saving Club, Rickett's Point. These are uncemented and loose. However only 3 metres away, similar shell accumulations have been cemented together (Figure 5). These are probably less than a thousand years old, and as such best classified as “sub-fossil”. The cement that binds them together has come from groundwater that contained low levels of calcium bicarbonate, which when exposed to the air, reverted to calcium carbonate, thus cementing these shells to each other and their sandy matrix.



Figure 3: Previous signage testifying that the abundant fossils in the Beaumaris Sandstone (once called the Black Rock Sandstone) are tree remains. This is incorrect; they are the preserved burrows of mud lobsters, and were described in 2012 as *Ophiomorpha beaumarisensis*. (Ter & Buckeridge, 2012: 227).



Figure 4: Recent build-up of mollusc shells (photo: JB)



Figure 5: Accumulation of “sub-fossil” molluscs. (photo: JB)

Thousands of years ago, the Boon Wurrung people, who are part of the Kulin Nation, sat on the foreshore at Beaumaris and feasted upon the sea life in the bay. Evidence of their time at Rickett's Point is preserved as middens (or accumulations of discarded mollusc shells). Middens are found at numerous locations along Bayside beaches including one near the Beaumaris Surf Life Saving Clubhouse. Although most of these middens are buried by sediment, their relatively young age determines their classification as sub-fossil rather than fossil remains.

Understanding Nature:

The natural environment fascinates us. Since the Age of Enlightenment, we have enthusiastically sought to understand the processes of nature, and it is formative to contemplate why we do this. Not surprisingly, there are a number of possible reasons, the least appealing of which may be *utility* – in the sense that if we understand nature better, it will be more useful. This attitude was certainly prevalent in the 19th and early 20th centuries, when an imperative to *tame nature* existed.

The widespread environmental damage that followed this initiative led to a modified approach, to *manage* the environment, and hopefully to do this sustainably. Humanity is still struggling with this concept.

A third reason is simply *curiosity* – a desire to understand something simply because it is there. It is this inquisitiveness, combined with the fourth reason, recognition that we are a *part* of nature, rather than *apart* from nature (Buckeridge, 2013) that is a growing motive to understand our world. It is hoped that this volume will, in its own small way, contribute to the joy in understanding that a closer relationship with nature can precipitate.

How to use this book:

This book has been designed to help keen naturalists, high school students and university undergraduates identify the fossils within the Rickett's Point Marine Sanctuary. The organisms are listed in systematic fashion; as a general rule the least specialized organisms are listed first, with vertebrates at the end.

A section at the back provides keys, designed to help users identify the group to which any organism is included, e.g. bivalve, echinoderm, gastropod etc. The different organisms are systematically listed with a separate entry for each. This includes a brief synonymy (its classification and any other names that it is commonly known by), its size, its habitat (where it may be found and if known, the typical substrate and the preferred depth), its stratigraphic distribution (i.e. the period between the first record of a species and its extinction), its geographic distribution, its abundance and a photograph. Abbreviated references show the primary source for information and/or specimens. Additional abbreviations used: DPK = David Pickering; EF = Erich Fitzgerald; FMcS = Fearghus McSweeney; JB = John Buckeridge; MO = Murray Orr; NHM = Natural History Museum, London; NMV, MV = National Museum of Victoria; P = Museum Victoria collection number prefix; RC = Richard Casley; RH = Rob Hamson; RS = Rolf Schmidt; VK = Vicki Karalis.

Abundance of fossils:

The abundance of each species is provided in graphic form. When a fossil is listed as **rare**, it means that you will be very lucky to find one, although they will have been recorded in the sanctuary; **uncommon** implies that sustained careful collecting should result in the finding of one or two specimens; **common** fossils are easy to find; **abundant** fossils comprise a significant portion of the fossil assemblage. Whilst most of the specimens illustrated in this book have been removed from the matrix prior to photographing, it is formative to remember that they were once part of the Beaumaris Sandstone. Figure 6 shows the remains of a *Monostychia* sp. While it is clearly recognizable as an echinoderm, an accurate identification at species level is difficult, and it is certain that it could not be removed from the rock without irreparable damage.



Figure 6: *Monostychia* sp. in situ in the Beaumaris Sandstone, Beaumaris. (Photo: JB)

Representative specimens of a species that is only known from this site were, when first described, classified as **type specimens**. Type specimens have a **type locality**, and for a number of important species, this is the strata at Beaumaris. If the type locality for a species is at Beaumaris, this is designated by a single red square if rare, by two red squares if uncommon etc. Organisms that are only known from rocks at Beaumaris may be classified as endemic.

Rare	■			
Uncommon	■	■		
Common	■	■	■	
Abundant	■	■	■	■
Type Locality	■			

We have strived to keep the language from becoming too complex – but there is a need to minimise ambiguity, and because of this we have needed to retain a scientific approach. For the names of organisms (i.e. “nomenclature”), the system adopted has been to define each organism on the basis of two names: the genus and the species. Most fossils at Rickett’s Point are the remains of animals, so we have followed the International Code of Zoological Nomenclature, and provide the author (the person who first described the species) plus the date in which the description was first published. If the genus name has changed over the years (this is often the case when a species was first described more than a century ago), the author’s name and date of description are placed in parentheses, e.g. *Lovenia woodsii* (Etheridge, 1875) means that

the organism was first described by Etheridge in 1875, but that he did not, at that time, call it *Lovenia* (he actually called it *Hemipatagus Woodsii*). Changes in the placement of species within genera are common in science, and are generally a reflection of a greater understanding of the systematic taxonomy of species. This understanding may be because we have since found more material than was originally available, and thus have a greater appreciation of what a fossil was, but it can even reflect the genome. Surprisingly, some fossils still contain fragments of DNA and this can be used to show linkages with living species.

A glossary of technical terms is included at the end of the book.

Pseudofossils:

Note that not everything that looks like a fossil has an organic origin. Figure 7 shows what appears to be a ribbed bivalve shell. This is however an inorganic structure, produced by the movement (and subsequent deposition) of iron-rich minerals in the rock. At Rickett's Point, these chemical deposits are comprised of the mineral goethite, and are known as *Liesegang* rings.



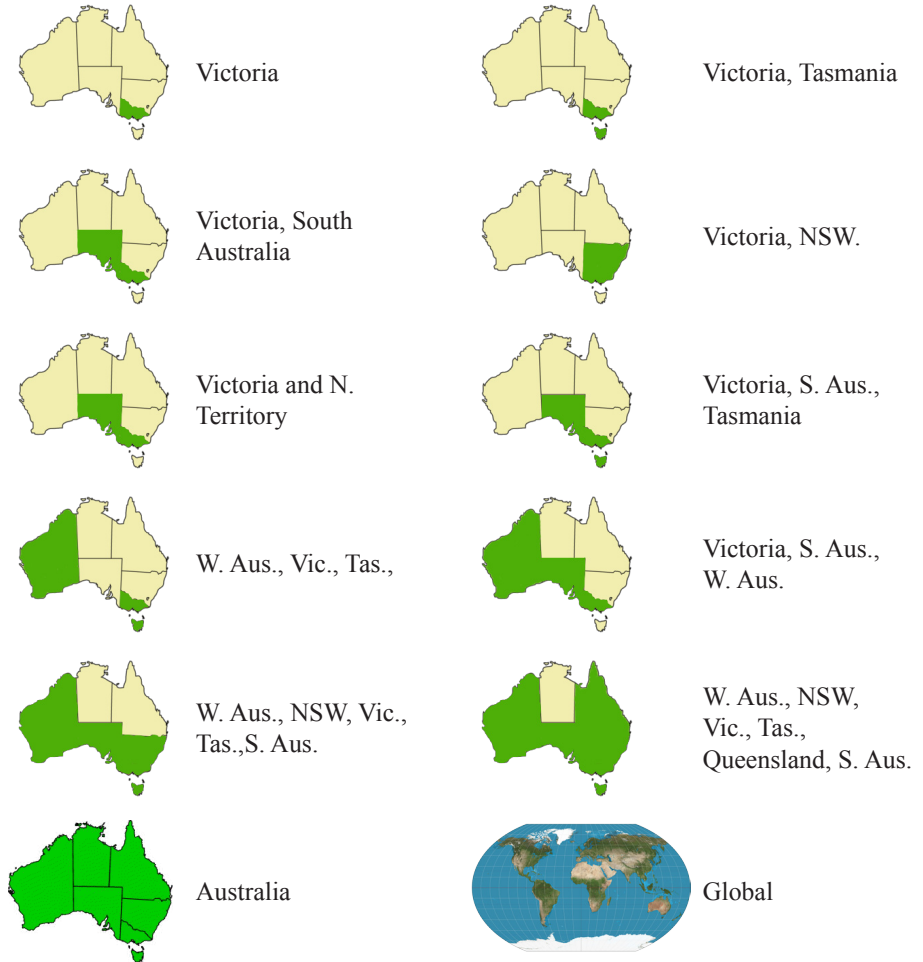
Figure 7: Pseudofossil *liesegang* rings (scale coin dia. 31.65mm).
(photo: FMcS)

The Future of the Rickett's Point Sanctuary:

Guidance on how best to conserve both living organisms and fossils in the sanctuary is provided by Parks Victoria, who have installed strategically placed notices about the biodiversity, and how best to minimise human impact on it. Nonetheless, a message we would like to endorse is to remove nothing from the sanctuary except memories and photographs, with the obvious caveat that collection and disposal of accumulated rubbish is always welcome. Unfortunately some overzealous collectors (and developers) have excavated rock to extract fossils and enlarge car parks. In doing so, they damaged the fragile geology and have almost certainly destroyed valuable fossils in the process. Providing it is done scientifically (i.e. with careful recording of the exact locality, associated fauna etc.), collecting is not discouraged, but it should be done with care and ideally with the permission of Parks Victoria. In this way we will be able to preserve this very special record of past life for future generations.

Distribution

The distribution of taxa is shown using the following maps:



Acknowledgements:

This book is representative of the knowledge of a great number of amateur naturalists and professional scientists; it is a culmination of their effort and enthusiasm – which has provided distribution data, some of the photographs and confirmed identifications. Each photograph is attributed to a photographer. The specimens included herein are for the most part in the collection of Museum Victoria, and we gratefully acknowledge the access to collections and the support that the museum staff has provided, especially from David Pickering and Drs Rolf Schmidt, David Holloway and Erich Fitzgerald. Local residents Raymond Lewis, Murray Orr, Assoc. Prof. Vicki Karalis, Dr Peter Carpenter, Richard Casley, Paul Ter, Rob Hamson, Joe Mumford and Bill Boyle provided invaluable specimens and/or encouragement. We would also like to thank Peter Trusler for kindly providing the cover and *Pelagornis chilensis* images.

On 22nd February 2015 a remarkably successful Fossil Open Day was held at Rickett's Point. The idea for the event was the brain-child of local conservationist Raymond Lewis, but organization and orchestration of the event was by Assoc. Prof. Vicki Karalis, who enlisted the support of the Sandringham Foreshore Association, Museum Victoria, Beaumaris Conservation Society, RMIT University and the Marine Education Science & Community Centre (Rickett's Point), Marine Care Rickett's Point and Bayside City Council. Fossil Open Day was attended by well over a thousand enthusiastic naturalists, all of whom helped make this book a reality.

We gratefully acknowledge the financial support for publication from Parks Victoria, Department of Environment, Land, Water and Planning (Government of Victoria), Bayside City Council and the International Union of Biological Sciences, Paris.



John St J. S. Buckeridge

15th October, 2016

Species descriptions

	Major group	Page
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	Phylum Retaria (= Protozoa)	1
	Kingdom Plantae	
	Phylum Angiospermae (flowering plants)	2
	Kingdom Animalia	
	Invertebrata	
	Phylum Cnidaria	
	Class Anthozoa	
	Order Scleractinia (corals)	3
	Phylum Bryozoa (lace corals)	7
	Phylum Brachiopoda (lamp shells)	8
	Phylum Annelida (worms)	10
	Phylum Mollusca	
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Species descriptions

Major group	Page
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Systematic Taxonomy



Amphistegina sp.

Synonym Foram.

Habitat: Warm shallow waters (<30m deep).

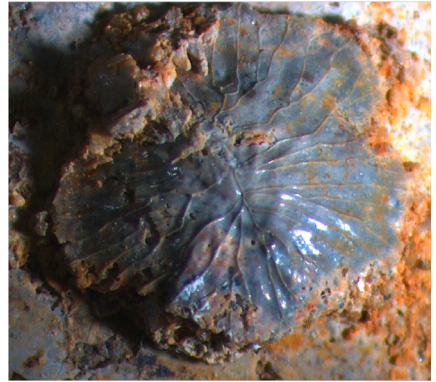
Description: Preserved as a cast, showing the internal structure of the inner walls, typical of the genus. Large, discoidal and involute. Specimen 4.6mm in diameter, which is large for foraminifera.

Distribution and range: Cosmopolitan. This specimen was found at grid reference 39°59'40"S 145°02'23"E in Beaumaris. L. Eocene - Recent.

Feeding: Stationary semi-infaunal omnivore.

Comment: The shells (tests) or foraminifera generally dissolve during diagenesis. Museum Victoria's database lists over ten species of forams found at Beaumaris; including the holotypes:

Pyrulina crespinae (NMV P14673), *Pseudopolymorphina doanei beaumarisensis* (NMV P14672) and *Polymorphina myrae* (NMV P14670). Other taxa include: *Guttulina costulata*, *Calcarina hamiltoniensis*, *Elphidium imperatix*, *Sigmoidella kagaensis*, *Flintina intermedia*, *Guttulina regina crassicostata* and *Baggina philippinensis*.



1mm

Abundance:



References: FW, RDV, W, MV.

Specimen: JB

Photo: JB



Habitat: Terrestrial, temperate climates.

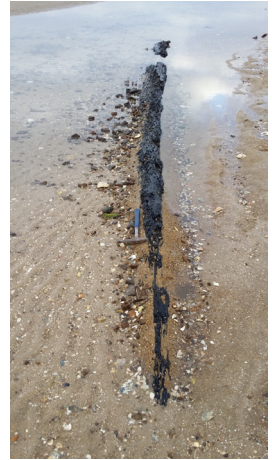
Description: Cast (impressions) of tree trunks; probably *Nothofagus* (*Southern/ Antarctic beach*) based on palynology.

Distribution and range: *Nothofagus* has been found in Australasia and South America; at Beaumaris they are located on the shore platform near Rickett's Point and near Table Rock. U.Cretaceous - Recent.

Comment: Washed into near-shore environment, where the trees were buried quickly by sediment; wherein an anoxic environment reduced decay, allowing time for lithification. The cast was preserved, and selectively mineralised after the Beaumaris Sandstone was elevated above sea level.

The Red Bluff Sandstone overlies the Beaumaris Sandstone. However it is not exposed at Rickett's Point. The Red Bluff Sandstone, which formed as a result of regression of the sea and uplift of the hinterland, resulted in fluvial deposition – also contains plant remains.

Abundance: ■ ■ ■
References: TB, BE
Specimen: *in situ*.
Photo: FMcS



Note: Estwing hammer 328mm long (photo: FMcS)

*Deltocyathus* sp.

Synonyms Stony coral, *Levipalifer*.

Habitat: Stationary, most below 150m and down to a depth of c. 5000m, based on extant species.

Description: Discoidal to patellate, solitary corallum (in adults); well developed costae septotheca; P3 fusing P2 near columella forming chevrons; papillose columella; papillose lobes present in some species, before the last cycle.

Distribution and range: Cosmopolitan (warm temperate waters). U. Cretaceous - Recent.

Feeding: Suspension feeder.

Comment: *Deltocyathus* spp. are azooxanthellate, and thus do not have symbiotic zooxanthellae, in their tissue.

Abundance: ■ ■

References: KC, MS, FW.

Specimen: NMV P117555.

Photo: VK

†*Deltocyathus fontinalis* Dennant, 1904

Synonyms Stony coral

Habitat: Marine.

Description: Corollum discoid, sometimes cylindrical; base generally with rounded flat margin. Calice circular, with shallow central fossa. Septa broad, unequal in length, in 6-systems with 4-cycles.

Distribution and range: Beaumaris Sst. and Spring Creek (type location) Victoria and Mulgundawa bore near Wellington in South Australia. Eocene - Miocene.

Feeding: Fixed epifaunal suspension feeder.

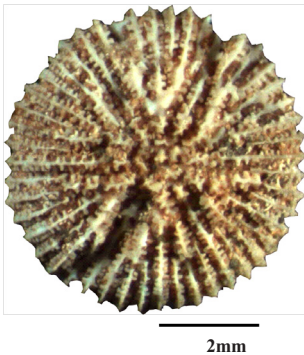
Comment: Close to *D. vincentinus*, which is taller and without tertiary pali.

Abundance: ■ ■

References: DJ

Specimen: NMV P3311.(Table Cape, Tasmania)

Photo: JB





Trochocyathus sp.

Synonym Button coral.

Habitat: Found to depths of 522m.

Description: Solitary, attached or free-living corals; small coralla usually <3mm high and conical in shape. Theca solid (septothecate), usually ridged (costate); inner and upper septal edges smooth, with the upper edges of larger septa exsert. Usually 3 crowns of pali before the last cycle. Columella well developed and papillose.

Distribution and range: Cosmopolitan (tropical and temperate waters). M. Jurassic - Recent.

Feeding: Filter feeders.

Comment: These corals are azooxanthellate, and do not have a symbiotic zooxanthellae in their tissue.

Abundance: ■ ■

References: MS, RB.

Specimen: NMV P117498.

Photo: VK.



4mm



†*Truncatoflabellum gambierense* (Duncan, 1870)

Synonyms Gambier fossil coral,
Flabellum gambierense Duncan, 1870.

Habitat: Shallow to mid shelf.

Description: Relatively tall narrow pedicellate form; slightly curved. Calice oval-elliptical; 6 septa of 4-cycles; primary and secondary are equal and stout.

Distribution and range: South Australia and Muddy Creek (type location) and Beaumaris Sandstone, Beaumaris, Victoria, Australia. M. Miocene - L. Pliocene.

Feeding: Static epifaunal suspension feeder.

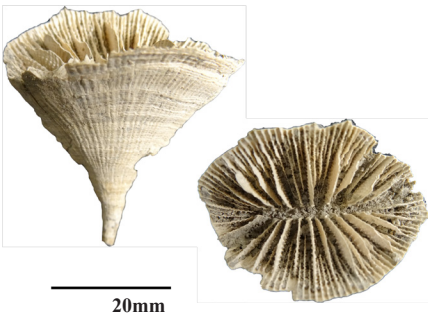
Comment: Internally a basic parietal columella can be found. Small spines were present on the holotype nearer the calice than the pedicel.

Abundance: ■ ■

References: SC

Specimen: NMV P116438.
(Balcombe Bay, Victoria)

Photo: JB.



20mm

Class Anthozoa

Family Flabellidae



†*Truncatoflabellum gippslandicum* (Dennant, 1899)

Synonyms Gippsland fossil coral, stony coral. *Flabellum gippslandicum* Dennant, 1899

Habitat: Upper to mid shelf.

Description: Corallum compact, slightly wedge-shaped. Anterior and posterior surfaces straight; base crescent-shaped with horns of crescent slightly protruding. 5-cycles of septa with 6-systems, of which the two central ones are complete. Fossa long, narrow; number of septa greater than 48 but less than 78.

Distribution and range: Gippsland Lake (type location), and Beaumaris Sandstone, Beaumaris, Victoria, Australia. Miocene - Pliocene.

Feeding: Static epifaunal suspension feeder.

Comment: *Flabellum* is a common solitary coral found throughout Australasia in late Cainozoic horizons.

Abundance: ■ ■

References: DJa, SC.

Specimen: NMV P116486.

Photo: VK.



4mm

Class Anthozoa

Family Flabellidae



†*Placotrochus deltoideus* Duncan, 1864

Synonyms Gambier fossil coral, *Flabellum gambierense* Duncan, 1870.

Habitat: Upper to mid shelf.

Description: Deltoid shape, angle of sides approximately 60°, long narrow columella, septa extend to this.

Distribution and range: Victoria and Tasmania. U.Miocene - L. Pliocene.

Feeding: Epifaunal microcarnivore, feeding on plankton and larvae.



5mm

Abundance: ■ ■

References: DP1, FW.

Specimen: MO

Photo: FMcS.



†*Bathyactis beaumariensis* (Dennant, 1904)

Synonyms Button coral, *Fungiacyathus (Bathyactis) beaumariensis* Dennant, 1904

Habitat: Shallow to mid shelf.

Description: Small coral; corallum discoid and free; calice circular and flat, primaries free. Four cycles of septa and six systems (often incomplete). Base flat to slightly concave, rim covered with white epitheca. Smooth surface, minor blister like swellings random. Costae portly, prominent on basal margin of most specimens; edges can be crenulated.

Distribution and range: Beaumaris Sandstone, Beaumaris (type locality) and Grange Burn, in Victoria, Australia. U. Miocene - L.Pliocene.

Feeding: Stationary epifaunal microcarnivore.

Abundance: ■ ■
References: DJ, FW.
Specimen: NMV.
Photo: VK.



†*Montlivaultia* sp.

Synonym cup coral.

Habitat: Shallow sub-tidal.

Description: Solitary coral; cup-shaped to cylindrical; no columella (filled during deposition and diageneses in the above specimen); numerous septa project above the shallow calice; many dissepiments (not visible here).

Distribution and range: Cosmopolitan. L.Triassic - U.Pliocene.

Feeding: Suspension feeder.

Comment: Photosymbiotic with zooxanthellae. Despite being solitary corals, they formed grouped together to form bioherms (a body of sedentary organisms e.g. corals, molluscs and algae).



Abundance: ■ ■
References: RB, MR.
Specimen: NMV P327353.
Photo: VK.



†*Celleporaria nummularia* (Tenison & Wood, 1861)

Synonyms Moss animal, lace coral.

Habitat: Shallow marine, low sedimentation regime.

Description: This is a colony of several thousand individuals (zooids). Each zooid (c. 0.4mm in diameter) being surrounded by a calcareous shell. Shapes vary, this organism may be encrusting.

Distribution and range: Australia including the Beamaris Sandstone, Beamaris, Victoria. U.Miocene - L. Pliocene.

Feeding: Stationary epifaunal suspension feeder.

Comment: The zooids occupied small holes, which are significantly smaller than seen in colonial corals. †*Lumulites canaliculata* (NMV P12633) belongs to the same class as *C. nummularia* and has also being found at Beamaris. *Celleporaria* sp. lives in Beamaris waters today (RBK: 86).

Abundance: ■ ■
References: EG, RBK, S.
Specimen: NMV P327356.
Photo: VK.



20mm



Hornera foliacea (MacGillivray, 1869)

Synonym Lace coral.

Habitat: Hard substrate with low sedimentation rates.

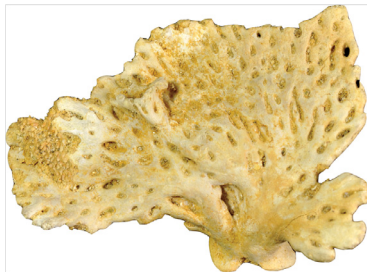
Description: Colonial animals in a delicate fenestrate form. Crossbars connect adjacent branches. Openings for the zooids are elliptical-circular, a collar surrounds the opening. The colonies can grow up to about 125mm across and 100mm high, based on *H. foliacea* found on the Otago Shelf, New Zealand.

Distribution and range: Australia and New Zealand. Cainozoic - Recent.

Feeding: Filter-feeders of dinoflagellates.

Comment: Fenestrate form refers to the “window-like” openings/mesh-like appearance of some bryozoan-s, including *Hornera foliacea*.

Abundance: ■ ■
References: MS, PEB, EG.
Specimen: NMV.
Photo: VK.



10mm



†*Murravia catinuliformes* (Tate, 1896)

Synonyms lamp shell, *Terebratulina catinuliformis* Tate, 1896.

Habitat: Marine.

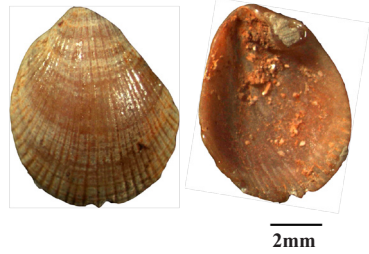
Description: Shell small, thick and ovate. Finely capillate (very fine ridges on the outer surface) surface ornament. Foramen hypothryid (pedicle opening being located on or below the dorsal side of the beak ridges), deltidial plates disjunct (divided). Prominent swollen cardinal process.

Distribution and range: Australia (U. Oligocene to Pliocene) and New Zealand (U. Oligocene); according to MacKinnon (1993), restricted largely to earthquake zones in New Zealand. U. Oligocene - Pliocene.

Feeding: Filter-feeder.

Comment: The brachiopod acme was in the Palaeozoic and Mesozoic eras, and they are used as an index fossil species. The shell of brachiopods is secreted by the mantle and consists two dissimilar but equilateral shells. They can be either Articulata (hinge structure - shells usually chitinophosphatic) or Inarticulata (no hinge, valves closed by muscles - shells calcareous).

Abundance: ■ ■
References: MK, FW, MSI.
Specimen: NMV P3788.
Photo: JB.



†*Murravia planidorsata* (Chapman & Crespin, 1928)

Synonyms *Malleia planiclorsata* Chapman & Crespin, 1928, lampshell.

Habitat: Shallow subtidal, coastal.

Description: Shell very small (holotype length 4.5mm), outline is subcircular; pedicle valve convex; brachial valve relatively flat; minor growth lines perpendicular to radii; delthyrium small and triangular.

Distribution and range: Portland (Jan Juc Marl), Sorrento Bore on the Mornington Peninsula and the Beaumaris Sandstone, Beaumaris, Victoria. Oligocene - L. Pliocene.

Feeding: Suspension feeder.

Comment: †*Malleia portlandica* (Chapman, 1913) is also found in the Beaumaris Sandstone, Beaumaris. It is similar to *Murravia planidorsata* in having a flattened brachial valve, but differs by having a posterior sinus.

Abundance: ■ ■
References: MV, CP3.
Specimen: NMV P14051.
 (holotype - Sorrento Bore, Victoria)
Photo: RS





†*Anakinetica compta* (Sowerby, 1845)

Synonyms *Magasella compta* Sowerby, 1845, lamp shell.

Habitat: Shallow waters, epifaunal.

Description: Shell outline subquadrate, with the greatest width at or slightly posterior to the mid-length. Dorsal valve with flattened umbo. Beak suberect and a length almost 1/4 of valve length. Cardinal margin straight. Medium septum thick and terminating midlength of valve. Hinge teeth triangular in outline. Anterior commissure strongly sulcate (furrowed) and narrow.

Distribution and range: Beaumaris Sandstone, Beaumaris, Victoria, Tasmania and South Australia. Type location is Port Fairy, Victoria. Oligocene - Pliocene.

Feeding: Suspension feeder.

Abundance: ■ ■

References: WA, R.J.

Specimen: NMV.

Photo: J.B.



2mm



†*Anakinetica tumida* Richardson 1991

Synonym Lamp shell.

Habitat: Marine - shallow waters, down to about 60m (based on *A. cumingii*, which can be found in Tasmania).

Description: Outline trapezoidal, with the greatest width posterior to the mid-length; unequally convex, the ventral (pedicle) valve deeper than the dorsal (brachial) valve. The dorsal valve has a flattened umbo and shallow median sulcus. The anterior commissure is also sulcate. Hinge teeth are triangular in outline while the cardinal margin is straight, or nearly so.

Distribution and range: Beaumaris Sandstone, Beaumaris, Victoria only (type location). U. Miocene - L. Pliocene.



10mm

Feeding: Epifaunal suspension feeder.

Comment: The species name "*tumida*" is Latin for "swollen", a reference to the size of the cardinalia.

Abundance: ■ ■

References: MV, RB, R.J.

Specimen: RC.

Photo: FMcS.



Polychaete tube

Synonym Segmented worm.

Habitat: Benthic, subtidal.

Description: The animals inhabited vertical and branching tubes; colonial. These tubes have been subsequently mineralized by goethite.

Distribution and range: Global. Cambrian - Recent.

Feeding: Filter feeders or feed on organic material in the sediment.

Comment: The polychaetes *Sabella spallanzanii*, *Sabellastarte spectabilis*, *Galeolaria caespitosa* live at Beaumaris today (RBK: 31-32).



Scale - 1 Euro coin (23.25mm in diameter)

Abundance:



References:

EG, RBK.

Specimen:

In situ.

Photo:

JB.



Monia zelandica (Gray, 1843)

Synonyms *Anomia zelandica* Gray, 1843.

Pododesmus zelandicus Gray, 1843,

Placunanomia ione Gray, 1850,

Placunanomia australica Reeve, 1859,

Anomia furcata Suter, 1907,

Monia furcilla Marwick, 1928, jingle shells, golden oysters, saddle oysters.

Habitat: Marine; attached to hard substrate via byssal threads.

Description: Shell thin, sub-circular and variable in shape (depends on substrate to which it's attached); concentric scaly threads with a very small byssal notch on the anterior shell.

Distribution and range: Beaumaris Sandstone, Beaumaris, Victoria. *Monia* appeared in the L. Oligocene in New Zealand. However because of the similarities between species and the variation in substrate which affects shell morphology; fossil specimens have often been reassigned to different species. Currently found off Australia, New Zealand and Antarctica.

Feeding: Stationary epifaunal suspension filter feeder.

Comment: *Monia* spp. can be easily mistaken for juvenile oysters. *Pododesmus* spp. look similar to *Monia* spp. but they have a smaller byssal foramen; thicker valves and smaller fused plugged foramen. *Monia ione* Gray, 1850 is also found in the Beaumaris Sandstone (NMV P53709). *Monia ione* has also a fragile shell, plus also an upper valve convex with lower valve concave. The foramen is not plugged. Dentition would also be crurae. *Anomia trigonopsis* can be found living in Beaumaris today (RBK: 75).

Abundance: ■

References: SR, RBK, MS, BU.

Specimen: NMV P332709 (Portland Cliffs, Victoria).

Photo: FMcS.





†*Glans kalimnae* Crespin, 1959

Synonyms Clam, *Venericardia spinulosa dennanti* Chapman & Crespin, 1933, *Glans dennanti* Tate & Basedow, 1902.

Habitat: Marine, shallow subtidal.

Description: Shell sculptured with large radial ribs. Rotund-cordate (plump/round to heart-shaped); spinose ribs arc towards the margin; high tumid umbo. Dentition heterodont.

Distribution and range: Abattoir bore (type location) - found in Adelaide, South Australia and Gippsland and Beaumaris Sandstone, Beaumaris, Victoria. L.Miocene - Pliocene.

Feeding: Suspension feeder.

Comment: Some species of Carditidae have a cavity along the edge of the shell, so as to protect young when developing. †*Glans gracilicostata* (Tenison & Woods, 1877) is also present in the Beaumaris Sandstone at Beaumaris (NMV P7857).

Abundance:



References:

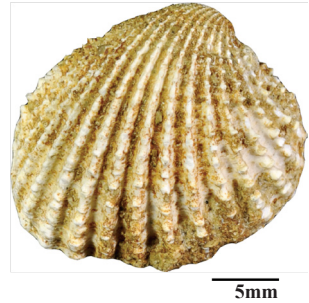
D5, EG.

Specimen:

NMV P327360.

Photo:

JB.



†*Cucullaea corioensis* McCoy, 1876

Synonyms Clam, false arc shell.

Habitat: Shallow subtidal, marine.

Description: Shell equivalve, straight hinge line; beak large; dentition taxodont. The above specimen is an internal cast of this bivalve, with the serrations at the base showing a mirror image of what the edge of the shell may have looked like.

Distribution and range: Victoria, Australia at locations such as Corio Bay, Bird Rock, Point Addis, rare east of the Gellibrand River, found occasionally in the Beaumaris Sandstone, Beaumaris and Muddy Creek. Miocene - L. Pliocene.

Feeding: Filter feeder.

Comment: The beak tends to be incurved nearer to the anterior than posterior end of the hinge line. *Cucullaea corioensis* is named after the location, Corio Bay, where these bivalves are common in the Miocene beds.

Abundance:



References:

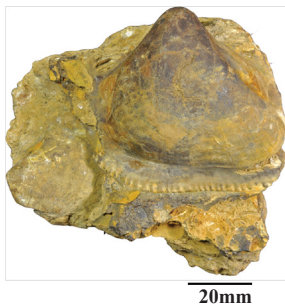
MCa

Specimen:

NMV P327347

Photo:

VK





†*Notocorbula ephamilla* (Tate, 1887)

Synonyms Basket clam, *Corbula ephamilla* Tate, 1887.

Habitat: Benthic, found just below the sediment surface.

Description: Solid shell, inequivalve (unequal shape), ovately triangular with rounded anterior and beaked posterior. Right valve with more than 20 concentric ridges which have slight flexure; whole surface striated concentrically. Umbo with two distinct ridges that radiate to ventral margin.



10mm

Distribution and range: Tasmania, South Australia and Victoria, including the Beaumaris Sandstone, Beaumaris. U.Miocene - L. Pliocene.

Feeding: Infaunal suspension feeder.

Abundance:	■ ■
References:	T.
Specimen:	NMV.
Photo:	VK.



†*Eucrassatella eupontica* Darragh, 1965

Synonyms Clam, *Crassatella*.

Habitat: Off-shore neritic zone, in coarse sand-fine silt, based on an extant species of the genus.

Description: Shell rectangular in shape; umbo small and pointed, prosogyral minor and situated 1/3 valve length from the anterior margin. Both anterior (steeper slope away from umbo than dorsal) and dorsal margins straight; siphonal ridge not prominent. Cartilages attach into a pit on each hinge, small lateral teeth.



20mm

Distribution and range: Holotype is from Beaumaris (Beaumaris Sandstone); *E. eupontica* has been found at other locations such as Lakes Entrance, Warrambine

Creek near Inverleigh, Bairnsdale, Gippsland, and in the parishes of Yeerung and Moormung, all in Victoria. U. Miocene - L. Pliocene.

Feeding: "Mobile" semi-infaunal suspension feeder.

Comment: Etymology - species "*eupontica*" is derived from the Greek: *eu* = fair, *pontos* = sea, which is a translation of the type location Beaumaris. Very similar to *E. oblonga*, but *E. oblonga* is elongate and has greater attenuation of the posterior end. †*Eucrassatella camurus* (Pritchard, 1903), previously known as *Crassatellites camurus*, has also been found in the Beaumaris Sandstone at Beaumaris (NMV P13148). *E. camurus* differs by having an ovate shell and ≥ 15 ridges near the umbo.

Feeding: Infaunal suspension feeder.

Abundance:	■ ■
References:	D, EG, PG1
Specimen:	MO.
Photo:	FMcS.



†*Glycymeris cainozoica* (Tenison & Woods, 1877)

Synonyms *Cucullaea cainozoica* Tenison & Woods, 1877, *Glycymeris cainozoicus*, *Pectunculus cainozoicus*, clam.

Habitat: Benthic, upper shelf.

Description: Shell sturdy and subcircular; umbos curve towards each other (orthogyrous); external sculpture with radial costellae in groups of 6-7; taxodont hinge teeth.

Distribution and range: Western Australia, Tasmania and Victoria, including the Beaumaris Sandstone, Beaumaris, Australia. Eocene - Miocene.

Feeding: Facultatively mobile infaunal suspension feeder.

Abundance: ■

References: FW, DK.

Specimen: NMV (Newport Formation)

Photo: JB.



†*Tucetona convexa* (Tate, 1886)

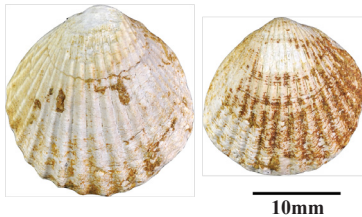
Synonyms *Glycymeris convexa* Tate, 1886, dog cockle.

Habitat: Benthic, shallow water.

Description: Shells heavy, rounded with a semi-circular row of taxodont teeth. Strong radial ribs.

Distribution and range: Southern Australia, including Victoria and New Zealand. U. Miocene -Pliocene.

Feeding: Suspension feeder.



Abundance: ■ ■

References: MV, EG.

Specimen: NMV.

Photo: VK.



†*Limopsis beaumariensis* Chapman, 1911

Synonym Clam.

Habitat: Benthic, shallow to moderately deep water.

Description: Valves subtriangular, thick; ligament pit large and triangular. Hinge strongly arched; longovate shell outline. Taxodont dentition.

Distribution and range: Victoria with Beaumaris as type location, from the Kalimnan white clay. Oligocene - Pliocene.

Feeding: "Mobile" epifaunal suspension feeder.

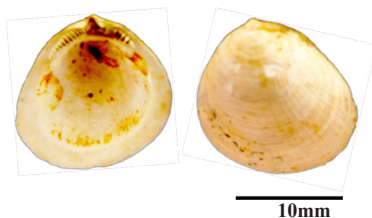
Comment: †*Limopsis maccoyi* Chapman, 1911 (NMV P12746) is found also in the Beaumaris Sandstone. *L. maccoyi* is ovate with numerous long hinge teeth in comparison with *L. beaumariensis*.

Abundance: ■ ■

References: CH.

Specimen: NMV P4094.

Photo: JB.



†*Mactra hamiltonensis* Tate, 1887

Synonyms Mactrid, trough shell, clam.

Habitat: Benthic, shallow waters.

Description: Ovate; subequilateral and slightly convex. Anterior side shorter than posterior. Ornament of thin elevated growth lines. Long lateral teeth and small central teeth in a V-configuration; heterodont dentition. Beside the central teeth can be seen a depression for an internal ligament.

Distribution and range: Beaumaris Sandstone, Beaumaris and Upper bed Muddy Creek, Hamilton (Type Location), Victoria, Australia. U.Miocene-L. Pliocene.

Beaumaris and Upper bed Muddy Creek, Hamilton (Type Location), Victoria, Australia. U.Miocene-L. Pliocene.

Feeding: Infaunal suspension feeder.

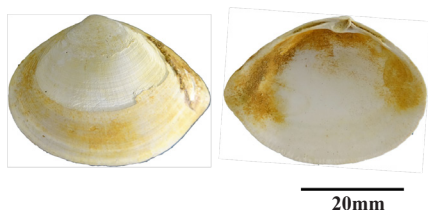
Comment: Similar to extant species *Mactra polita* of Southern Australia; but has flatter valves and less of a triangular outline, plus ventral margin not as broadly curved. The specimen illustrated (right) is a cast. The shell (calcium carbonate) having been dissolved away by groundwater. The brown colouration is due to ferruginous staining.

Abundance: ■ ■

References: FW, T, EG.

Specimen: NMV and NMV P7625.

Photo: JB (above)
VK (right).





†*Zenatiopsis phorca* Darragh & Gill, 1963

Synonyms Mactrid, trough shell, clam.

Habitat: Infaunal - based on related living species, they inhabit quite areas below low water mark in muddy to marly sand.

Description: Thin shell; elongate oval; concentrically striated with growth lines; porcellanous interior. Umbo small, marginally raised. Lunule encroaching inner dorsal margins of valves. Hinge narrow and short. Muscle scar subequal, located close to dorsal and anterior margin. Pallial sinus deep, extending slightly beyond middle of valve. Inverted v-shaped cardinal teeth - heterodont dentition.

Distribution and range: Victoria, including locations such as Lakes Entrance, Jemmy's Point, Grange Burn near Hamilton (Type location) and the nodule beds of Beaumaris. U.Miocene - L.Miocene.

Feeding: Infaunal filter feeders.

Comment: The species name *phorca* was a Greek god of the sea.

Abundance: ■ ■

References: D3.

Specimen: NMV P21899
(Muddy Creek, Victoria)

Photo: JB.



20mm



†*Lopha hyotidoidea* (Tate, 1899)

Synonyms Oyster, *Ostrea Hyotidoidea* Tate, 1899.

Habitat: Encrusting, shallow marine, subtidal.

Description: Irregular outline with foliaceous shell. Foliaceous scales rarely found to have developed into tubular spines. No dentition.

Distribution and range: River Murray Cliffs and Aldinga Bay in South Australia, Moorabod valley, Muddy Creek, Mornington, Shelford and Beaumaris Sandstone, Beaumaris, Victoria. Oligocene - Pliocene.

Feeding: Stationary epifaunal suspension feeder.

Comment: A related species †*Meleagrina crassicardia* (Tate, 1886) a pearl oyster from the family Pteriida, previously known as *Pinctada crassicardia* has also been found in the Beaumaris Sandstone, Beaumaris (NMV P12719-20).

Abundance: ■ ■

References: MV, FW, T1.

Specimen: NMV P7626.

Photo: VK.



10mm

Class Bivalvia

Family Ostreidae

† *Ostrea arenicola* Tate, 1886

Synonym Oyster

Habitat: Shallow subtidal, coastal.

Description: Inequivalved, lower valve deeper, shell rugose, ribbed. No dentition.

Distribution and range: Lakes Entrance and Beaumaris Sandstone, Beaumaris Victoria. U.Miocene - L. Pliocene.

Feeding: Stationary epifaunal suspension feeder.

Comment: *Ostrea angasi* is the only living member of this genus found at Beaumaris today (RBK: 76).

Abundance: ■ ■

References: EG, FW, RBK

Specimen: NMV P12787

Photo: JB.



20mm

Class Bivalvia

Family Ostreidae

† *Ostrea manubriata* Tate, 1887

Synonym Oyster

Habitat: Shallow subtidal, coastal.

Description: Thick shell, oblong. Upper valve flat to sub-concave with adpressed lamellae of growth. Lower valve concentrically flexuously ridged and striated; hinge elongate, no teeth.

Distribution and range: Upper beds of Muddy Creek, Hamilton (Type locality) and Beaumaris Sandstone, Beaumaris, Victoria. U.Miocene - L. Pliocene.

Feeding: Epifaunal suspension feeder.

Comment: This species is quite unlike any known species inhabiting



20mm

Australian waters today.

Abundance: ■

References: T, FW, MS

Specimen: NMV. (Grange Burn, Victoria)

Photo: JB.



†*Serriptecten carteri* Beu & Darragh, 2001

Synonyms Scallop, fan shell.

Habitat: Shallow water.

Description: Large, right valve more inflated than left. Umbonal angle extremely wide c. 145°-150°. Radial sculpture with numerous fine costellae. Right valve sculptured with c. 46-52 primary radial costae, the left valve has c. 85-100 low narrow radial costae. Isodont dentition.

Distribution and range: Beaumaris Sandstone, Beaumaris and Port Phillip and Gippsland basins, Victoria. Holotype from the Tambo River Formation at Lakes Entrance. U. Miocene - L. Pliocene.

Feeding: Low-level epifaunal mobile suspension feeder.

Comment: A related species, *Pecten fumatus* lives at Beaumaris (RBK: 75).



20mm

Abundance:



References:

FW, BD, AS, RBK.

Specimen:

NMV P302214.
(Paratype - Tambo River Fmn.)

Photo:

FMcS.



†*Serriptecten semilaevis* (McCoy, 1876)

Synonyms Scallop, fan shell,
Lentiptecten adelaidensis Ludbrook, 1955,
Pecten yahliensis semilaevis McCoy, 1876.

Habitat: Shallow waters.

Description: Moderately large; umbonal angle very wide c. 145°. Right valve moderately inflated and almost smooth; left valve weakly inflated with fine, close, scaly radial sculpture, but weak commarginal growth ridges. Auricles separated from disc by shallow groove. Isodont dentition.

Distribution and range: Beaumaris Sandstone, Beaumaris, Victoria and South Australia. The Gellibrand Marl, Port Campbell Fmn, Goodwood Fmn, Rutledges Creek member, Bairnsdale Limestone and is common in Bookpurnong Fmn, Victoria. M.Miocene - L. Pliocene.

Feeding: Low-level epifaunal suspension feeder.

Comment: There has been confusion in literature concerning the relationship of the smooth right valve to the sculptured left valve. Ludbrook (1955) based her work only on right valves - which resulted in that valve mistakenly called *Lentiptecten adelaidensis*.

Abundance:



References:

BD, FW.

Specimen:

NMV P300213.

Photo:

JB.



10mm



†*Mimachlamys asperrima* *asperrima*
(Lamarck, 1819)

Synonyms: Scallop, fan shell,
Pecten asperrimus Lamarck, 1819,
Mimachlamys australis (G.B. Sowerby II, 1842),
Ostrea matoni Donovan, 1824.

Habitat: Littoral to sub-littoral.

Description: Moderately large (length equal to width in adults); both valves inflated; umbonal angle c. 95° (juvenile) to c. 110° (adult). The hinge is dominated by a prominent and thick resilial teeth in the right valve; isodont dentition. Exterior sculpture of 24-30 prominent radial costae, which are fixed and undivided throughout ontogeny.

Distribution and range: South-central Western Australia down to Southern Australia and to Southern Queensland, including Victoria. U. Miocene - Pleistocene.

Feeding: Suspension feeder.

Abundance: ■ ■

References: MS, BD.

Specimen: NMV P301158
(Tambo River, Victoria)

Photo: JB.



20mm



†*Annachlamys murrayana* (Tate,
1886)

Synonyms Scallop, fan shell.
Chlamys (*Annachlamys*) *murrayana*,
Chlamys murrayanus Tate, 1886,
Pecten murrayanus Tate, 1886.

Habitat: Subtidal.

Description: Moderate in size; umbonal angle wide c. 105° (juvenile) to c. 125° (adult). Right valve more inflated than the left valve; left valve flat umbonal area. Both valves 18-22 regular, evenly spaced radial costae; crossed by numerous high and thin commarginal lamellae, ends of these lamellae in unabraded specimens pointing down towards the venter. Isodont dentition.

Distribution and range: Western Australia, South Australia and Victoria, including the Beamaris Sandstone, Beamaris. Miocene-Pliocene.

Feeding: Low-level epifaunal suspension feeder.

Comment: *A. murrayana* is related to *A. flabellata*, which can reach 100mm, and lives in tropical waters. According to Beu & Darragh (2001) *Annachlamys* became absent from the fossil record in southern Australia around the U. Miocene (Port Campbell Limestone and Gellibrand Marl Formations), being only found in in the U. Pleistocene and Holocene in Western Australia.

Abundance: ■ ■

References: BD, FW, EG

Specimen: NMV P300363

Photo: JB.

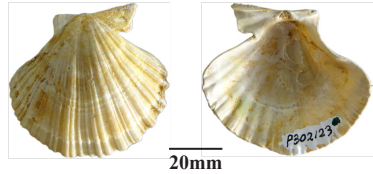


20mm


 †*Mesopeplum divergens* Beu & Darragh, 2001

Synonym Scallop

Habitat: Upper shelf.

Description: Moderate size, wide shape is distinctive; acline to slightly prosocline, with relatively wide umbonal angle (c. 100-105°). Right valve inflated, left valve flat. Coarse radial sculpture, weak ribs near the centre of the valve. Low triangular scales on major costal crests. Isodont dentition.

Distribution and range: Beaumaris Sandstone, Beaumaris as well as Port Philip and Gippsland Basins, Victoria. U. Miocene - L. Pliocene.

Feeding: Mobile low-level epifaunal suspension feeders.

Comment: Specimens from Beaumaris tend to be abraded and lack microsculpture (such as triangular scales).

Abundance:

References: BD, FW.

Specimen: NMV P302123.

Photo: JB.

 †*Barnea tiara* Tate, 1887

Synonyms Angel wings, piddocks.

Habitat: Benthic, shallow marine. Borers into soft rock, stiff mud and wood.

Description: Valves thin, accessory plates of shell which protect the beak and ligaments. Elongate, reduced in width at both ends, acutely rounded at the front. Surface covered in concentric lirae, which are crossed by subspinose radiating threads. On the posterior half of valve

the concentric lirae are rounded, and orientated towards the umbonal ridge, the surface is very much granular. Dentition desmodont.

Distribution and range: Upper Beds at Muddy Creek and Beaumaris Sandstone, Beaumaris, Victoria. Neogene.

Feeding: Stationary boring suspension feeder.

Comment: The extant species *Barnea australasiae* is present in Beaumaris (RBK: 83).

Abundance:

References: T, EG, RBK.

Specimen: NMV P327354.

Photo: VK.




†*Spondylus baileyana* Chapman, 1922

Synonyms Scallop, thorny oysters, spiny oysters.

Habitat: Shallow reef environments.

Description: Valves ovate; left valve depressed, right valve somewhat convex. Hinge line long for genus. Anterior margin of shell rounded curving towards the ventral margin. The shell's surface is ornamented with 6-principle radii, at intervals projecting into spines. Growth lines faint. Muscle impression situated close to umbo. A key characteristic of *Spondylus* is that the shells are hinged (isodont arrangement) together using a ball-and-socket, rather than the more usual toothed hinge seen in other bivalves. They also retain vestigial anterior and posterior auricles ("ears", triangular shell flaps) along the hinge line.

Distribution and range: Type location Beaumaris in the calcareous shelly marl, also found in Rose Hill (near Bairnsdale) and Muddy Creek (Hamilton), Victoria. U. Miocene - L. Pliocene.

Feeding: Epifaunal suspension feeder.

Comment: Thorny oysters are closely related to scallops, differing in the long spines from their right valve (usually lost prior to fossilization).

Abundance: ■ ■

References: CP2, MV, EG.

Specimen: MO.

Photo: FMcS.



10mm



†*Spondylus pseudoradula* McCoy, 1877

Synonyms Thorny oyster, scallop.

Habitat: Benthic waters, shallow reef.

Description: Longitudinally ovate with an apical angle of c. 85°; both valves moderately convex, and fragile. Upper valve c. 10-15 ridges, separated by 3, 5, 7 or 13 striae (small spinulose ridges) with setaceous spines, with the middle striae being the largest. Ears small with spinulose striae. Dentition isodont.

Distribution and range: Fyansford (Type location); Hamilton, Mount Eliza, Hamilton, Wy Yung, Bairnsdale and Beaumaris Sandstone, Beaumaris, Victoria. U.Miocene - L. Pliocene.

Feeding: Epifaunal suspension feeder.

Abundance: ■

References: MV, FW, MC.

Specimen: NMV P3953.
(Hamilton, Victoria)

Photo: JB.



10mm



†*Neotrigonia acuticostata* (McCoy, 1866)

Synonyms *Trigonia acuticosta* McCoy, 1866, brooch shell.

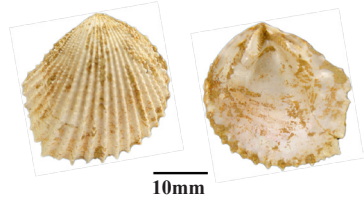
Habitat: Sheltered to moderately exposed sand; shallow depths.

Description: Rhombic inequilateral; umbones small; anterior margin strongly convex; posterior margin almost straight, surface with ribs converging to an apex; numerous tubercles; intervening spaces coarsely striated. Escutcheon elongate, somewhat depressed, with 3-4 riblets with minor tubercles. Dentition schizodont.

Distribution and range: Beaumaris Sandstone, Beaumaris (Type location), Lakes Entrance, Victoria and NSW, Australia. M.Miocene - L.Pliocene.

Feeding: Infaunal suspension feeder.

Comment: The genus *Neotrigonia* were once thought to have been extinct, but were discovered (*Neotrigonia margaritacea* was the first living species found) in the 19th century in Australian waters, they are often called living fossils.



10mm

Abundance:	■ ■
References:	D2, EG.
Specimen:	NMV.
Photo:	JB.



†*Kereia johnstoni* (Tate, 1887)

Synonyms *Venus* clam,
Dosinia johnstoni Tate, 1887.

Habitat: Upper shelf.

Description: Shell thick and glossy; regular concentric ridges, ring shaped, moderately convex. Lunule ovately cordate; exterior ornamented with concentric ridges with reflexed ridges and separated by deep sulci. Posterior hinge angulated and lamellated. Pallial sinus triangular with a broad base, to slightly beyond the middle of the valve. Dimensions of holotype: Antero-posterior diameter 27mm and umbo-ventral diameter 25mm. Heterodont dentition with three cardinal teeth on both valves.

Distribution and range: Upper beds Muddy Creek in Hamilton, Lakes Entrance, Beaumaris Sandstone, Beaumaris, Victoria, and Table Cape, Tasmania. U. Miocene - L. Pliocene.

Feeding: Filter feeder.

Abundance:	■ ■
References:	T, D5.
Specimen:	NMV.
Photo:	JB.



10mm



†*Placamen subroborata* (Tate, 1887)

Synonyms *Venus* clam,
Chione subroborata Tate, 1887,
Clausinella subroborata Tate & Woods, 1931,
Circomphalus subroboratus.



Habitat: Subtidal.

Description: Shell trigonal; sculpture of c. 15 somewhat thick recurved concentric lamellae, erect on the posterior. Heterodont dentition with three cardinal teeth on both valves.

Distribution and range: Adelaide, South Australia and Victoria, including the Beaumaris Sandstone, Beaumaris. Type location Hamilton, Victoria. Miocene - Pliocene range.

Feeding: Facultatively mobile infaunal suspension feeder.

Abundance: ■

References: LNHI, FW, T.

Specimen: NMV.
(Hamilton, Victoria)

Photo: JB.



†*Proxichione moondare* Darragh, 1965



Synonym *Venus* shell.

Habitat: Subtidal.

Description: Shell with radial sculpture and simple rounded radial ribs. Broad posterior margin; ovate proxichione; umbones curved anteriorly. Heterodont dentition with three cardinal teeth on both valves.

Distribution and range: South Australia, Tasmania, Victoria and New Zealand (South Island). Type locality Moondara Farm Mitchellian which

is part of the Tambo River Formation, in the Middle Miocene Gellibrand formation, East Gippsland. M.Miocene - U. Pliocene.

Feeding: Filter feeder.

Comment: Four living species of this genus exist today.

Abundance: ■ ■

References: D1, D4.

Specimen: NMV P4207.

Photo: VK.



†*Pisinna* sp. cf. *P. paucirugosa* Ponder and Yoo, 1976

Synonym None.

Habitat: Continental shelf.

Description: Spire slightly convex; protoconch sculptured with tiny pits; aperture sub-circular; whorls with faint axial riblets or absent; protoconch 1.5 whorls.

Distribution and range: Currently they are endemic to NSW and Queensland, Australia.

Feeding: Epifaunal grazer.

Comment: As the only known *Beumaris* specimen (NMV P53514) was poorly preserved, this identification is tentative.



Abundance: ■

References: PY, MS.

Specimen: 4998-1
(holotype - Queensland)

Photo: AM.



†*Calyptraea* (*Sigapatella*) sp. cf. *C. crass* Tate, 1893

Synonym Slipper shell.

Habitat: Upper shelf.

Description: Broad stout spire; convex whorls with small apex. Bodywhorl only slightly convex and lamellose ridge. Septum concave edge.



Distribution and range: South Australia and Victoria, including the Beumaris Sandstone, Beumaris. Miocene - L.Pliocene.

Feeding: Epifaunal suspension feeder.

Comment: Today *Sigapatella calyptraeiformis* is found at Beumaris (RBK: 63).

Abundance: ■

References: T5, MS, RBK.

Specimen: NMV P316592.
(TA Darragh collection)
Muddy Creek, Victoria.

Photo: FMcS.



†*Austrocypraea subsidua* (Tate, 1890)

Synonyms Cowry,
Cypraea subsidua Tate, 1890.

Habitat: Reef.

Description: Shell elongate, oval to trapezoidal; smooth surface; obtuse at both ends; left shell more arched than right shell. Spire exert. Aperture narrow, outer lip not margined, c. 25 stout rounded ridges with c. 20 acute ridges on the inner lip.

Distribution and range: Beaumaris Sandstone, Beaumaris and Muddy Creek (Type location), Victoria, Australia. U. Miocene - L. Pliocene.

Feeding: Epifaunal omnivore grazer on sponges.



5mm

Abundance: ■

References: T3.

Specimen: NMV P9107.

Photo: VK.



10mm

†*Umbilia hesitata* Iredale, 1916

Synonyms Umbilcate cowry, wonder cowry,
Cypraea hesitata Iredale, 1916,
Umbilia cera Cotton, 1947,
Cypraea amydalina Tate, 1890,
Cypraea tatei Cossmann, 1903,
Cypraea umbilicata Sowerby, 1825.

Habitat: Subtidal, sand, silt; 12-200m.

Description: Small to average size; highly glazed, colour white with irregular brown spots over dorsum and brown patches on anterior rostrum (some specimens can appear almost all white). Tapering anteriorly with short rounded rostrum. Aperture slightly sinuous, outer lip 30-40 teeth; inner lip up to 37 teeth. Maximum length up to 136mm.

Distribution and range: Beaumaris Sandstone, Beaumaris, Victoria and South Australia to Southern Queensland, including Tasmania. Living specimens can found off Cape Jaffa, S. Australia to Frasier Island, Queensland and Tasmania. L. Miocene - Recent.

Feeding: Epifaunal omnivore grazer on sponges.

Comment: This cowry may be distinguished from †*Austrocypraea subsidua* by the more elongate shell.

Abundance: ■ ■

References: D6, MV, EG.

Specimen: NMV P302883.

Photo: VK.



†*Amaea triplicata* Tate, 1890

Synonym Wentletrap,
Trichotopis triplicata Tate, 1890.

Habitat: Subtidal.

Description: Shell small and thin with 4-5 convex whorls; spire stout and conical ending in an apex of two lirate whorls. Lirae strong, body whorl stout with quadrate aperture. Inner lip reflected, outer lip crenulated and thin.

Distribution and range: Adelaide Bore (type location), South Australia and the Beaumaris Sandstone, Beaumaris, Victoria. Miocene - L. Pliocene.

Feeding: Epifaunal carnivore.

Comment: The term “wentletrap” comes from the Dutch for a spiral staircase; reflecting the strong sculptural lirae on the shell.



10mm

Abundance: ■

References: FW, T4.

Specimen: NMV P5565.

Photo: FMcS.



†*Fusinus dictyotis* (Tate, 1888)

Synonym *Fusus dictyotis* Tate, 1888.

Habitat: Shallow water, coastal.

Description: Shell robust and fusiform; 9 whorls including the apex (protoconch); spiral lirae crossed by lamellae. Strong ridge (keel) on anterior (front end of shell) whorls. Aperture round; outer lip thin with lirate within and also present on the inner thin lip.

Distribution and range: Table Cape in Tasmania, South Australia and the Lower beds of Muddy Creek and the Beaumaris Sandstone, Beaumaris, Victoria. L. Miocene - L. Pliocene.

Feeding: Epifaunal carnivore.

Comment: The above specimen, along with two others, were presented to the Museum by Mr. J. Cunningham of Frankston in 1966.



10mm

Abundance: ■

References: T6, FW.

Specimen: NMV P317574
(Fossil Beach, Balcombe Bay, Victoria).

Photo: FMcS.



†*Polinices subvarians* (Tate, 1893)

Synonyms Moon snail,
Natica subvarians Tate, 1893.

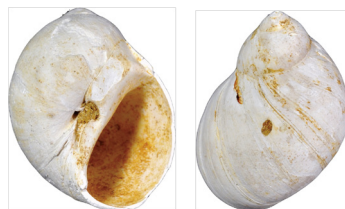
Habitat: Sheltered marine, seamounts and knolls.

Description: Smooth swollen shell; low spire; operculum calcium carbonate.

Distribution and range: Victoria, including Beaumaris Sandstone, Beaumaris. U.Miocene - L.Pliocene.

Feeding: Infaunal carnivore; active predators feeding mainly on bivalves.

Comment: In Beaumaris the extant species *Polinices conicus* and *Polinices sordidus* are present (RBK: 56).



10mm

Abundance: ■ ■
References: MS, EG, D8, RBK.
Specimen: NMV P327352.
Photo: VK.



†*Tylospira clathrata* (Tate, 1885)

Synonym *Pelicaria clathrata* Tate, 1885.

Habitat: Epifaunal, coastal, shallow subtidal.

Description: Shell small for genus (26-36mm height); 4-5 shouldered whorls (which are approximately half the height of the shell). Aperture lenticular; columella slightly arched. Protoconch planorboid of approximately 2 smooth whorls, that merge with the teleoconch. Spiral sculpture of fine lirae on the first adult whorl, with narrow interspaces.

Distribution and range: Beaumaris Sandstone, Beaumaris, the Tambo River formation and Moondarra Farm (Type Location), Victoria, Australia. U. Miocene - L. Pliocene.

Feeding: Epifaunal grazer.

Comment: *Tylospira clathrata* has very fine sharp plicae, whereas *T. cononata* has tubercles and a prominent sutural channel.

Abundance: ■ ■
References: D7, MV.
Specimen: NMV P135669.
(Tambo River fmn, Victoria)
Photo: JB.



10mm



†*Tylospira coronata* (Tate, 1885)

Synonym *Pelicaria coronata* Tate, 1885.

Habitat: Epifaunal, coastal, shallow subtidal.

Description: Medium size; aperture ovate to sublenticular with 6-8 shouldered whorls (which make up approximately half the height of the shell). Sutural channel posterior.

Distribution and range: Beaumaris Sandstone, Beaumaris, Lakes Entrance and Muddy Creek, Hamilton (Type location), Victoria, and Tasmania, Australia. U. Miocene - L. Pliocene.

Feeding: Epifaunal grazer.



10mm

Abundance:



References:

D7.

Specimen:

NMV P135682.

Photo:

JB.



†*Astele millegranosa* Pritchard, 1904

Synonym Top snail.

Habitat: Shallow subtidal.

Description: 8-9 whorls (the above specimen is missing the apex); whorls flattened to slightly concave with fine spiral threads, which are strongest at the base of each whorl. Body whorl c. 11-12 spiral threads. Between these threads are oblique striae. Aperture quadrate; inner and outer whorl narrow and marginally crenulate.

Distribution and range: Lower beds Muddy Creek, Hamilton and the Beaumaris Sandstone, Beaumaris, Victoria. M. Miocene - L. Pliocene.

Feeding: Epifaunal grazer.



10mm

Abundance:



References:

PG.

Specimen:

NMV P315465.

Photo:

FMcS.



†*Leiopyrga quadricingulata* (Linnaeus, 1758)

Synonym None.

Habitat: Coastal, shallow subtidal.

Description: Shell turreted with c. 8.5 whorls; whorls marginally convex; ribs spiral, equidistant and in some specimens elevated - they are separated by a furrow; aperture quadrate. Apex rounded. Trace of light purple colour found on white shell on some specimens.

Distribution and range: Victoria, including Beaumaris Sandstone, Beaumaris. U.Miocene - L.Pliocene.

Feeding: Epifaunal grazer.



5mm

Abundance:



References: D8, T8.

Specimen: NMV P315687.
(Jemmy's Point, Victoria)

Photo: JB.



†*Leiopyrga sayceana* Tate, 1891

Synonym None.

Habitat: Subtidal.

Description: Relatively narrow, turreted shell, spire-whorls are cingulate (long and curved); suture concealed to partially concealed by sutural threads. Oval aperture is relatively small; columella arcuate at its base. The penultimate whorl has 3 primary compressed, acute cinguli, which are equal and equidistant, with a slender thread on each suture.

Distribution and range: Type location Beaumaris Sandstone, Beaumaris, Victoria, Australia. U.Miocene - L. Pliocene.

Feeding: Epifaunal grazer.

Comment: There are three extant species today: *L. cingulata*, *L. lineolaris* and *L. octona*; which are endemic to Australia.



2mm

Abundance:



References: MS, T2.

Specimen: NMV P315528.

Photo: FMcS.



†*Gazameda victoriensis* (Cotton & Woods, 1935)

Synonyms Turret shell, tower shell,
Turritella acricula victoriensis Cotton & Woods, 1935.

Habitat: Subtidal.

Description: Long spire shells, shallow spire angle, flattened convex base with circular periphery, pitted surface on some.

Distribution and range: Beaumaris Sandstone, Beaumaris and near Mount Martha Victoria, Australia. Miocene - Pliocene.

Feeding: 'Mobile' epifaunal suspension feeder.

Comment: Both †*Colpospira tristira* (Tate, 1885) and †*Ctenocolpus* aff. *pagodulus* (Tate, 1893) from the family Turritellidae are found in the Beaumaris Sandstone, Beaumaris (NMV P316272 and NMV P315865 respectively). †*Colpospira tristira* tapers to a point with an apical angle of c.15°; the shell is made up c.12 marginally convex whorls. Suture line linear and a surface ornamentation made up of 3 spiral ribs and transverse striae; aperture quadrate with outer lip which is not fully formed. †*Ctenocolpus pagodulus*, originally called †*Turritella pagodula* Tate, 1893, has a shell tapering to a point, made up of 13 whorls. The shell is quite small (c. <15mm long) with a relatively smooth surface with an aperture that is subquadrangular. The outer lip appears semicircular above the anterior keel.



10mm

Abundance:



References: CW, D5, T5, T7.

Specimen: MO.

Photo: FMcS.



Volutidae sp. Rafinesque, 1815

Synonym Volute.

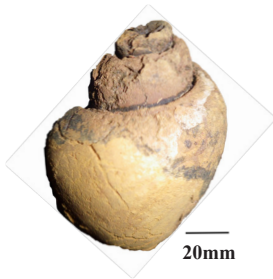
Habitat: Sheltered to moderately exposed; depths down to c. 500m.

Description: Extant volutes are highly patterned, but this may not be preserved in fossil specimens. Most species do not possess an operculum.

Distribution and range: Cosmopolitan. Palaeocene - Recent.

Feeding: Predatory snails, they usually remain buried in sediment during the day, coming out at night.

Comment: Similar to mitres (family Mitridae), however Volutidae are larger and wider.



20mm

Abundance:



References: EG.

Specimen: Ter & JB.

Photo: Ter.



2mm

†*Fissidentallium mantelli* (Zittel, 1865)

Synonyms Tusk shell,
Entalis mantelli Zittel, 1865,
Dentalium mantelli Harris, 1897.

Habitat: Based on the extant species *Fissidentallium candidum*, found 100-2743m.

Description: Shell medium to large, solid, moderately curved near circular apex, tapered; many longitudinal ribs, approximately 23 fine ribs at the apex increasing to approximately 50 ribs at the ovate aperture; secondary ribs in interspaces.

Distribution and range: River Murray Cliffs (Type location), Murray Creek, South Australia, New Zealand and Beaumaris, Victoria. U-Miocene - Pliocene.

Feeding: Feed on microscopic organisms, such as foraminiferans.

Comment: †*F. mantelli* resembles *F. ponderi* Maprell & Healy, 1998, which is found in the Tasman sea today. However *F. mantelli* is smaller and lighter, less ribbed and lacks a pronounced dorsoventral compression; *F. mantelli* has a rib obsolescence near the aperture, which is not present in *F. ponderi*. †*Dentalium (Fissidentallium) mawsoni* Ludbrook, 1956 has also been found in the Beaumaris Sandstone, Beaumaris (NMV P47298). This species has a shell that almost appears straight, with very fine irregularly sized and spaced ribs. It has been found in Western Australia, South Australia and Victoria; ranging from the U.Eocene - Miocene.

Abundance: ■ ■

References: LH, LNH, MS, EG, DK1.

Specimen: NMV P6752.

Photo: JB.



1mm

†*Laevidentalium lacteolum* (Tate, 1899)

Synonyms Tusk shell,
Dentalium largicrescens Tate, 1899.

Habitat: *Laevidentalium* is known from depths as shallow as 70m today.

Description: Transverse (crosswise) section circular; slender shell; no apical notch.

Distribution and range: Muddy Creek, Beaumaris Sandstone, Gelibrand River and the Fyansford formation in Victoria and Tasmania, Australia. Oligocene - Pliocene.

Feeding: Slow moving semi-infaunal deposit feeder.

Comment: Similar to *Laevidentalium largicrescens*, but *L. largicrescens* possess an apical notch.

Abundance: ■ ■

References: T1, F, FW, EG, MV.

Specimen: NMV P6730.

Photo: VK.

*Laevidentalium largicrescens*

(Tate, 1899)

Synonyms Tusk shell, scaphopod,
Dentalium largicrescens Tate, 1899.

Habitat: Extant specimens have being recovered at depths c. 308m.

Description: Shell smooth, moderately curved, with sculpture of oblique incremental growth lines. Apex and arpture circular; in some specimens ventral notch, no plug. Dimensions up to a length 55.4mm; aperture diameter 8.2mm; apex diameter 3.2mm. Bone to grey white colouration.

Distribution and range: Extant species range from the Bass Strait to southern Queensland. The fossil locations are from the U.Miocene L. Pliocene of Victoria. The type location is the Beaumaris Sandstone, Beaumaris, Victoria. U. Miocene - recent.

Feeding: Feed on microscopic organisms, such as foraminiferans.

Comment: It was only known from Beaumaris until extant specimens were recovered from dredging off Australia's east coast. The name *largicrescens* refers to its large aperture.

Abundance:	■ ■
References:	LH, EG.
Specimen:	NMV.
Photo:	VK.

†*Aturia coxi* Miller, 1947

Synonym Chambered nautilus.

Habitat: Nektonic carnivore. Probably lived in deeper waters during the day and moved to shallower depths at night (vertical diurnal migration).

Description: Compressed involute aragonite shell made up of a body chamber and numerous smaller chambers (phragmocone), separated by fluted septa, which surrounded its siphuncle. The siphuncle (chalky porous tube) extended from the body chamber through to the protoconch. Its function was to control gas within the chambered part of the shell, and thus bouyancy.



Distribution and range: New Zealand and Australia (including the Beaumaris Sandstone), Japan (Senhata Formation) Boso Peninsula of Japan. Miocene - L. Pliocene.

Feeding: Used tentacles to grasp food (fish and crustaceans), and move it towards its two strong biting beak-like jaws (made of chitin with calcified tips). A radula (found in all molluscs except bivalves), acted like a tooth in moving the food, except it was also covered in tooth-like spines.

Comment: Could retreat inside body chamber and close aperture with muscular hood. This is not an ammonite; ammonites became extinct at the close of the Mesozoic. Two other species of cephalopoda have been recovered from Beaumaris: †*Eutrephoceras geelongensis* (NMV P53505 - previously known as *Nautilus geelongensis*) and †*Aturia australis* (NMV P4899).

Abundance:	■ ■
References:	PB.
Specimen:	MO.
Photo:	MO.



†*Fellaster incisa* (Tate, 1893)

Synonyms Sand dollar,
Arachnoides incisa Tate, 1893.

Habitat: Subtidal, sandy substrate.

Description: Calcareous shell (test) thin, indented at ambulacral midpoints. Petals broad, open and slightly raised (upper surface), lower surface flat. No channel between periproct and basicoronal plates. Oral surface well defined, ambital ambulacral indentations.

Distribution and range: Parish of Werriko (Pleistocene), Lakes Entrance and Beaumaris in the Beaumaris Sandstone, Victoria. L.Pliocene (Kalimnan stage) - Pleistocene.

Feeding: Slow moving semi-infaunal detritivore.

Comment: *Fellaster* is separated from *Arachnoides* spp. and *Monostychia* spp. by the position of the periproct, which is aboral. *Fellaster* lack a periproctal groove and have an extension of 2-3 interambulacral plates onto the oral surface. *Fellaster* also includes *F. zealandiae* from New Zealand.

Abundance:



References: FP, NMH, SN, RBK.

Specimen: NMV P12635.

Photo: VK.



10mm



†*Monostychia loveni* (Duncan, 1877)

Synonyms Sand dollar,
Arachnoides loveni Duncan, 1877.

Habitat: Partly to completely covered in sand, shallow marine.

Description: Test subpentagonal, flat, raised slightly towards the apical disk and concave on the actinal (oral) surface. Ambitus is sharp; incised at the end of each ambulacral groove, ambulacral grooved longitudinally. The ambulacra occupy approximately the same area as the interambulacra. Periproct rounded, and located under the margin. The actinal side has oblique ornamentation on both sides of the ambulacral groove, increasing in size towards the peristome.

Distribution and range: Mordialloc (Type locality) at the mouth of Curdies River near Warumbol and the Beaumaris Sandstone, Beaumaris, Victoria. U. Miocene - L. Pliocene.

Feeding: Detritus, algae, diatoms and larvae.

Abundance:



References: DP.

Specimen: NMV P27370.

Photo: VK.



10mm

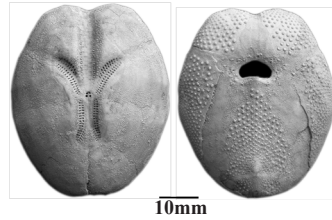


†*Brissopsis tatei* Hall, 1907

Synonyms Heart urchin.

Habitat: Soft sediment burrower.

Description: Irregular ovoid test; moderate anterior sulcus with ambulacrum III sunken and narrow; 4 genital pores; petals depressed with posterior petals slightly smaller than the anterior petals; aboral tubercles uniform.



Distribution and range: South Australia and Victoria including the Beaumaris Sandstone (e.g. NMV P133741). Middle Miocene - L. Pliocene.

Feeding: Infaunal deposit feeder detritivore.

Comment: †*Eupatagus anomalus* (Duncan, 1877) a member of the same family, has also been found at Beaumaris in the Beaumaris Sandstone (NMV P55496). *E. anomalus* has no sulcus and the ambulacra are petaloid and flush; with only the anterior ambulacrum being narrow.

Abundance: ■

References: FW, NHM, MPK.

Specimen: NMV P16173.

(holotype from the cliffs at the mouth of Sherbrooke River, Victoria).

Photo: Smith, A. B. & Kroh, A. 2011. The Echinoid Directory- <http://www.nhm.ac.uk>



†*Phyllacanthus duncani duncani* Chapman & Cudmore, 1934



Synonyms Pencil urchin,
Leiocidaris sp. Desor, 1855.

Habitat: Subtidal coastal.

Description: Shell(test) large, compressed spherical with oral surface slightly flattened. Ambulacrum undulating and narrow; pores conjugate; poriferous zone slightly sunken, pores large, with the outer ones of the pair the larger; primaries of interradia large with serobicules almost circular; associated with large smooth spines. Constriction above collar.

Distribution and range: Port Macdonnell, South Australia and Batesford (type location), Beaumaris Sandstone, Beaumaris, Bairnsdale, Swan Reach, Victoria, Australia. Oligocene - L.Pliocene.

Feeding: Epifaunal omnivore.

Comment: †*Phyllacanthus clarkii clarkii* (Chapman & Cudmore, 1934) has also been found at Beaumaris (NMV P19671-3). The specimen was made up of 3 worn radioles. *P. clarkii clarkii* differs from *P. duncani duncani* by having 9 interambulacrum plates, rather than 6 or 7.

Abundance: ■

References: CC, Ph1.

Specimen: NMV P22303,
(FA Cudmore Collection)

Photo: JB.



†*Clypeaster gippslandicus* McCoy, 1879

Synonym Sand dollar.

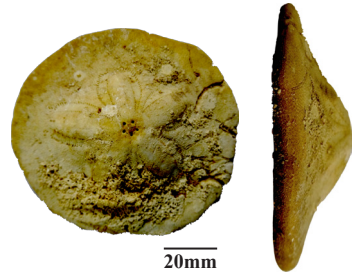
Habitat: Partly to completely covered in sand, shallow marine.

Description: Irregular echinoid, subpentagonal flat shell (test) with raised domed central part; ambulacra petaloid (well developed) with ambulacral grooves from the peristome (mouth). Interambulacra disjunct on oral surface. Peristome small central depression. Apical disc central with 5 gonopores. Pores and tubercles small and crenulated, arranged randomly.

Distribution and range: South Australia and Victoria, including the Beaumaris Sandstone, Beaumaris, Victoria. M. Miocene - L. Pliocene.

Feeding: Detritus.

Comment: Similar to *Echinathus testudinarius*, which lives in warmer tropical waters of Northern Australia.



Abundance: ■ ■
References: NHM, MC1.
Specimen: JB.
Photo: JB.



†*Evechinus palatus* Philip, 1969

Synonym Sea urchin.

Habitat: Epifaunal, subtidal.

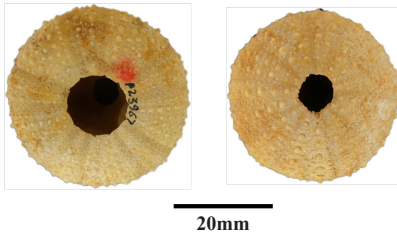
Description: Regular sea urchin; shell (test) rounded with a flattened oral surface, slightly sunken around peristome. Pore-pairs lack triserial arrangement adapically (towards the highest part of the test), but progressively developed towards the circumference of the test (ambitus) and on the aboral side of the test. Every second ambulacral triad lacks a primary tubercle, but they can be found just under the ambitus. The interambulacra have large, smooth

primary tubercles, which near the ambitus are joined by secondary tubercles. Gill slits are well defined and shallow. The perignathic girdle is made up of united auricles connected by a low apophyses.

Distribution and range: Beaumaris Sandstone, Beaumaris, Victoria (type location) and SE Australia. U.Miocene - L. Pliocene.

Feeding: Primarily on marine algae.

Abundance: ■ ■
References: Ph, RB, MS
Specimen: NMV P23967.
 (FA Cudmore Collection - holotype)
Photo: JB.





†*Lovenia woodsii* (Etheridge, 1875)

Synonyms Heart urchin, sea urchin,
Hemipatagus woodsii Etheridge, 1875.

Aboral Surface



Oral Surface



10mm

Habitat: Shallow burrower (depth 10-20cm) in sand, inshore.

Description: Irregular urchin; cordiform elongated flattened test; peristome crescent shaped oral surface and periproct is oval on the posterior end of the oral surface; anterior notch; ambulacra sunken forming lanceolate shape terminates abruptly towards apices, pores on ambulacra deep; interambulacrum with fine tubercles, but most noticeably deep inset tubercles that are surrounded by deep scrobicula on anterior of the upper surface and the lower surface of the test; spines if present long and curved. The apical system contains 4 genital pores, with the posterior pair being slightly larger than the anterior pair.

Distribution and range: Beaumaris is type location of species, found in the calcareous lower horizons above the phosphatic nodule beds, of the Beaumaris Sandstone member. *Lovenia woodsii* is found in Victoria, Tasmania and South Australia only. Miocene - Pliocene.

Feeding: Infaunal deposit feeder detritivore.

Comment: The genus *Lovenia* has a worldwide distribution.

Abundance: ■ ■ ■ ■

References: E, MV.

Specimen: JB.

Photo: JB.



Lovenia Woodsii in situ, Rickett's Point
Scale: coin (dia 23.25mm)
(photo: JB).



†*Victoriaster gigas* (McCoy, 1882)

Synonyms Heart urchin,
Pericosmus gigas McCoy, 1882,
Linthia gigas Pritchard, 1908,
Linthia mooraboolensis Pritchard, 1908.

Habitat: Upper shelf.

Description: Test flattened and ovate, with deep anterior sulcus; apical disc with 4 gonospores; ambulacrum sunken with the anterior deeply sunken in comparison; ambitus low in profile; tubercles on oral and aboral surfaces fine and dense.

Distribution and range: South Australia and Victoria, primarily in the Batesford Limestone, but also the Beaumaris Sandstone (NMV P78046), Beaumaris. Middle Miocene - L. Pliocene.

Feeding: Infaunal deposit feeder.

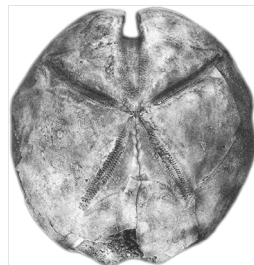
Comment: The largest *V. gigas* recorded according to McNamara & Philip (1984) was 205mm wide and 110mm high; making it probably the largest non-flexible echinoid to have ever lived.

Abundance: ■

References: MP, NHM, MV.

Specimen: fig 26 MP

Photo: MP.



50mm



†*Goniosigma singletoni* (Philip, 1969)

Synonyms Sea urchin,
Asaphechinus singletoni Philip, 1969.

Habitat: Epifaunal, subtidal.

Description: Regular echinoid, periproct (anus) situated in center of aboral surface, rounded outline; strongly crenulate (finely notched outline) tubercles, large secondary interambulacral tubercles on flattened adoral surface with sharply notched peristome; apophyses (internal projection for attachment) forms high ridges between the spatulate auricles. Apical system regularly

dicyclic with raised porous area. The ambulacra is about half the size of the interambulacra. Well buttressed buccal slit, and tubercles with scalloped bases, and like other regular echinoids has powerful jaws with five teeth, known as Aristotle's Lantern.

Distribution and range: Holotype from Beaumaris. Developmental mode was planktonic, it would suggest it was widely distributed. U-Miocene - L.Pliocene.

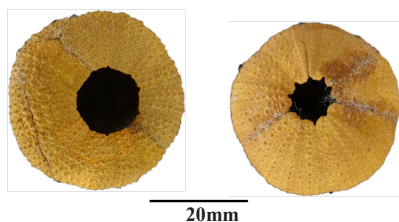
Feeding: Algae, sponges, molluscs and barnacles. Regular echinoids can leave a distinct grazing trace of star-shaped incisions called "Gnathichnus".

Abundance: ■

References: Ph, JE.

Specimen: NMV P23971.
 (FA Cudmore Collection - paratype)

Photo: JB.



20mm



†*Ortholophus woodsi* (Laube, 1869)

Synonyms *Psammechinus woodsi* Laube, 1869,
Arbacina woodsi (Laube) Pomel, 1883,
Brochopleurus australiae Fell, 1949

Habitat: Epifaunal, subtidal.

Description: Test large, oral surface flattened; relatively large tear shaped genital pores; primary tubercles weakly crenulate; peristome and apical disc both relatively small; ambulacra are approximately 1/3-2/3 the width of the interambulacra. Randomly placed secondary tubercles in adults; this echinoid changes dramatically as it grows with ridges present lost as it aged.

Distribution and range: South Australia and Victoria, Australia, including the Beaumaris Sandstone (NMV P82733). M. Miocene - L. Pliocene.

Feeding: Epifaunal deposit feeder.

Comment: †*Ortholophus lineatus* (Duncan, 1877) is from the same family as *O. woodsi*, and has also been found at Beaumaris (e.g. NMV P23981). However the specimens have generally been poorly preserved. The ambulacra tends to be 3/4 the width of the interambulacra (larger than in *O. woodsi*).

Abundance:



References: Ph, NHM, MV.

Specimen: NHM EE904 (UK)
 (Murray River near Swan Reach, SE Australia)

Photo: Smith, A. B. & Kroh, A. 2011. The Echinoid Directory- <http://www.nhm.ac.uk>



4mm



†*Ommatocarcinus corioensis* (Cresswell, 1886)

Synonym *Gonoplax corioensis* (Cresswell, 1886)

Habitat: Neritic.

Description: Carapace trapezoidal to pentagonal; on palm of claw stridulating (sound-making) ridge with numerous short striae, elongate eyestalks and chelipeds. Basal part of eyestalks concealed; ambulatory legs. Dorsal surface slightly arched transversely; sagittally slopes down to both the anterior and posterior. Male abdomen seven segments, with 3 segments reaching coxae (upper segment of leg) of the pereopods. Sternum rounded, length shorter than its width and straight posterior.

Distribution and range: Beaumaris Sandstone, Beaumaris, Victoria, NSW and Southeastern Australia including Tasmania. L. Miocene - Pliocene.

Feeding: Scavenger on detritus.

Comment: Based on oxygen isotope measurements, *O. corioensis* was at its acme (L-M. Miocene) when temperatures in the ocean was 14-17°C. Ancestral to the extant Australian *O. macgillivrayi* which has similar morphology, they are known for their burrow. *O. corioensis* left branching burrows in the Port Campbell Limestone, South East Australia, with both smooth and pelleted surfaces.

Abundance:



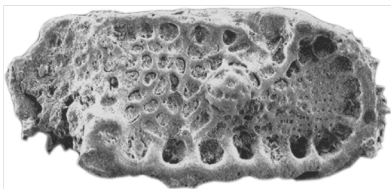
References: JK, RBK, TP.

Specimen: RC.

Photo: FMcS.



20mm



0.2mm

Alatapapifica sp.

Synonym Seed shrimps, mussel shrimp

Habitat: Zooplankton or benthos.

Description: Right valve only; subrectangular carapace (shell); ornament of buttressed ventral and dorsal ridges. Carapace pitted or smooth with prominent fossae near the anterior margin. Well developed subcentral tubercle.

Distribution and range: Australia and New Zealand. Palaeocene - Holocene. Ostracods have been around since the Ordovician (about 450 million years before present).

Feeding: Algae, detritus, plant material, based on extant species.

Comment: *Alatapapifica* sp. (*Alatapapifica septarca* and *Alatapapifica robusta*) are part of the subfamily Pterygocytherinae. Other species from the Beaumaris Sandstone include: *Bradleya praemckenziei*; *Callistocythere* spp.; *Loxococoncha australis*; *Cytherella dromedaria*; *Keijia thomi*; *Bradleya bassbasinensis*; *Krithe nitida*; *Quasibradleya paradictyonites*; *Neobuntonia batesfordiense*; *Actinocythereis jervisbayensis*; *Neohornibrookella sorrentae*; *N. glyphica* and *N. nepeani*. They suggest that the Beaumaris Sandstone was deposited during a brief period of cooler climatic conditions.

Abundance:



References: EG, UB, WR, WMT.

Specimen: NMV P314958.

Photo: WR.



†*Zullobalanus australiae victoriae*

(Buckeridge, 1983)

Synonym *Solidobalanus (Withersella) australiae victoriae*.

Habitat: Subtidal.

Description: A small conic barnacle with rhombohedral orifice; up to 10mm long and 8mm wide. The species has characteristic pattern of whitish flecks on darker background. Strong regular external ribbing with compartments and basis solid, calcereous.



Distribution and range: Jemmy's Point and Beaumaris of Victoria. U.Miocene - L.Pliocene.

Feeding: Filter feeder.

Comment: The specimens illustrated here are growing on a shell of *Lovenia woodsii* that would have been dead prior to colonization by the barnacles.

Abundance:	■ ■
References:	JB.
Specimen:	RH.
Photo:	JB.



†*Austromegabalanus victoriensis* Buckeridge, 1983

Synonym Acorn barnacle.

Habitat: Sessile, upper subtidal zone, in low sedimentary regimes.

Description: The shell is globulo-conical or cylindrical, with a large orifice and smooth exterior, with strongly convex basal margin. Colouration has been found on some specimens; with the parieties having a series of dark reddish brown longitudinal stripes, often intersected by transverse stripes of lighter colouration. Radii appear lighter in colour, buff with dark red-brown longitudinal stripes, and transverse pores. These conspicuous stripes can be used to distinguish it from *A. nigrescens* (living in Australia); which is pale blue-grey and lacking stripes.



5mm

Distribution and range: Type location Beaumaris in Victoria, in the Beaumaris Sandstone. U. Miocene - L. Pliocene

Feeding: Filter feeders, feeding on protozoans and other plankton, using cirri to entrap their food.

Comment: The specimen illustrated has circular attachment scars (upper centre) that indicate other barnacles had been growing on this specimen.

Abundance:	■
References:	JB.
Specimen:	JB R092.
Photo:	JB.



Lepas* sp. cf. *L. australis Darwin, 1851

Synonyms *Lepas* (*Anatifa*) *australis* Darwin, 1851, goose barnacle.

Habitat: Fouling species, can be found on any floating debris.

Description: Scutum triangular, thin, transversely convex; exterior with fine growth lines cut by striae radiating out from the umbo; interior with raised lip along lower (basal) margin.

Distribution and range: Beaumaris Sandstone, Beaumaris, Victoria and extant species in the Southern Ocean. Miocene - Recent.

Feeding: Epifaunal suspension feeder.

Comment: Only a single scutum has been recovered from the Beaumaris Sandstone. The scutum is the largest of the three plate-types in this stalked barnacle. The photograph above shows specimens of living *L. australis* that are washed up, following a storm, in southeast Victoria.

Abundance:



JB, Worms.

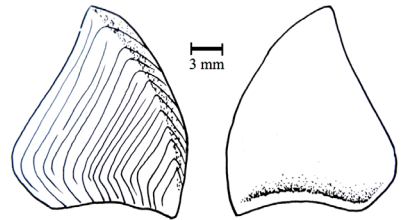
References:

Specimen (figure):

JB.

Photo:

JB (drawing)



LHS Exterior and RHS interior view of scutum



Tesseropoa* sp. cf. *T. rosea (Krauss, 1848)

Synonym *Conia rosea* Krauss, 1848.

Habitat: Low intertidal.

Description: Shell is made up of four compartmental plates, the interior of one being illustrated here. Each plate has a single row of large longitudinal tubes.

Distribution and range: Victoria including Beaumaris Sandstone, Beaumaris, in Australia, the Gulf of Mexico and New Zealand. U-Miocene-L.Pliocene.

Feeding: Filter feeders.

Comment: *T. rosea* can normally be distinguished from a related species *T. pacifica* by the lack of secondary tubeles. The fossil is only known from isolated plates, extremely rare. *T. rosea* can be found alive today at Beaumaris, albeit it has limited abundance (RBK: 112).

Abundance:



References:

JB, RBK.

Specimen:

NMV P47225.

Photo:

JB.



Carcharhinus brachyurus (Günther, 1870)

Synonyms narrowtooth shark, copper shark, bronze whaler shark, *Carcharias brachyurus* Günther, 1870, *Galeolamna greyi* Owen, 1853, *Carcharias remotus* Duméril, 1865.

Habitat: Brackish; reef-associated; depth range 0 - 360 m.

Description (dentition): Teeth single cusped, and almost equilateral. Cusps broad, with partial to complete serrated cutting edge; shoulder with fine to coarse serrations; angled notch deep on one cutting edge. Basal margin of root straight to subangular, well defined transverse groove. Sexual dimorphism in teeth, with upper teeth of males hooked at tips to a greater extent than females.

Distribution and range: Cosmopolitan; continental margins in most tropical and temperate seas; migratory in the northern part of its range. Miocene - Recent.

Feeding: Bony fishes, cephalopods, other sharks, rays.

Comment: Etymology (Greek): *Carcharhinus*: *karcharos* = sharpen + *rhinos* = nose.

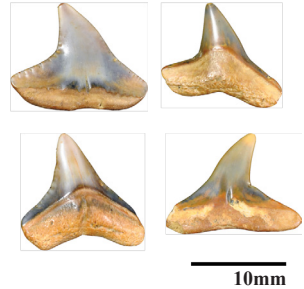
Abundance:



References: MS, P, FB, IUCN.

Specimen: NMV.

Photo: VK.



10mm



5mm

†*Galeocерdo aduncus* (Agassiz, 1843)

Synonyms Tiger shark, *Physogaleus aduncus* Agassiz, 1843

Habitat: Nektonic.

Description (dentition): Coarse complex serrations on distal shoulder; strong distal notch on distal. Shallow nutrient groove on lingual side; compressed root with root lobes; serrated compressed crown.

Distribution and range: Cosmopolitan. Oligocene - Pliocene.

Feeding: Carnivore.

Comment: †*Galeocерdo latidens* (NMV P5383) has also been found at Beaumaris, albeit quite rare. It differs from †*G. aduncus* with simple serrations on the shoulder of the tooth and a nutrient groove and are quite small (≤ 8 mm basal to apical).

Abundance:



References: CK.

Specimen: NMV P161578.

Photo: JB.



†*Galeocerdo davisii* Chapman & Pritchard,
1904

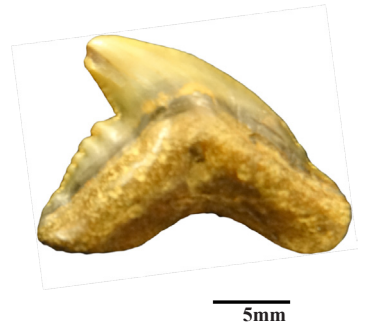
Synonyms Tiger shark,
Notidanus marginalis Davis, 1888.

Habitat: Upper shelf.

Description (dentition): Depressed cusp.

Distribution and range: Hamilton and the Beaumaris Sandstone, Beaumaris Victoria, Australia and New Zealand. U. Cretaceous - L. Pliocene.

Feeding: Carnivore.



Abundance: ■
References: CP.
Specimen: NMV P205571.
Photo: JB.



†*Notidanus jenningsi* Chapman & Pritchard, 1904

Synonym Cow shark.

Habitat: Shallow marine

Description (dentition): In the above nodule, two anterior medial teeth and traces of others are present. The anterior teeth are from the left side and are principal teeth, with an anterior fold located 1/3 length of tooth from the labial side. Very strong and broad cusp with fine serrations, which are coarser at the basal part of the crown. Anterior slope of adjacent tooth has finer regular serrations; posterior portion lacking.

Distribution and range: Type locality Beaumaris Sandstone, Beaumaris, Victoria. U. Miocene - L. Pliocene.

Feeding: Nektonic carnivore

Comment: These teeth appear to be from a single individual. Shark jaws are cartilaginous, and rarely fossilise.

Abundance: ■
References: CP, FW.
Specimen: NMV P5368. (holotype)
Photo: JB.





Lamniformes

Synonyms mackerel shark, lamnoid shark,

Habitat: Upper shelf.

Description (Articulated vertebrae): These fossil shark vertebrae were cartilaginous discs and fossilisation rarely occur, especially for articulated vertebrae.

Distribution and range: Cosmopolitan. Triassic - Recent.

Feeding: Nektonic carnivore.

Comment: Etymology of Lamniformes, it's from Greek lamna, es = shark and forma = shape.



20mm

Abundance:



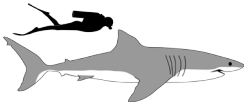
References: P, FW, FB.

Specimen: NMV P203454.

Photo: VK.



Extinct Threatened Least Concern
 (EX) (EW) (CR) (EN) (VU) (NT) (LC)



Carcharodon carcharius (Linnaeus, 1758)

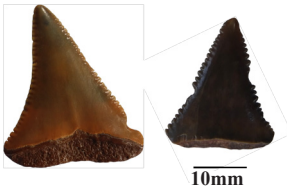
Synonyms *Squalus carcharias* Linnaeus, 1758, Great White Shark, White Pointer.

Habitat: Nektonic. Females are larger than males (sexual dimorphism) reaching up to 6m and living between 40-60 years, while males only reach about 3.5-4.5m at maturity. Lower depth limit 250m.

Description (dentition): These are juvenile teeth with lateral cusplets (which are absent in adults). The teeth are broad triangular; saw-tooth serrations occur at irregular intervals along the edge of the tooth.

Distribution and range: Global cosmopolitan, temperate coastal waters - continental shelf. Can be found in brackish estuaries. Mid Miocene - Recent.

Feeding: Fish, other sharks and rays; adults tend to feed on marine mammals such as seals and sea lions. The change in diet results in a change in tooth morphology with age.



10mm

Comment: *Carcharocles megalodon* is not a direct ancestor of the Great White Shark. The teeth of the *C. megalodon* have regular serrations unlike the great white, where the genus name for this animal *Carcharodon* comes from (Greek) "ragged tooth".

Abundance:



References: P, IUCN

Specimen: MO, JB.

Photo: JB.



†*Carcharodon hastalis* (Agassiz, 1843)

Synonyms *Isurus hastalis*, *Oxyrhina hastalis*, *Isurus xiphodon* Agassiz, 1843, *Cosmopolitodus hastalis*, *Cosmopolitodus xiphodon*, *Carcharodon plicatilis*.

Habitat: Nektonic. In temperate to tropical waters, especially shallow to mid-shelf.

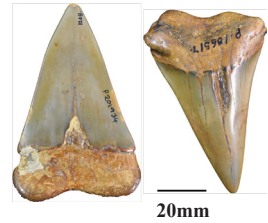
Description: Teeth single cusped typically range from 2.5-7.5cm in height; upper teeth of *C. hastalis* are broadly triangular with smooth, non-serrated cutting edges; lower teeth are narrower and have deeper root notches. Teeth of *Carcharodon* with teeth >254mm have gently arched basal margin of enamel on lingual; coarse to fine serrations with thick to massive root. Roots do not protrude lingually at midline of tooth; labial face without valley. Juvenile teeth with lateral cusplets, absent in adults.

Distribution and range: Cosmopolitan. Type location, Switzerland. L.Miocene - U.Pliocene.

Feeding: Carnivorous (fish, penguins, marine mammals).

Comment: Ancestral to the extant great white shark. The species name *hastalis* is possibly from the latin, *hasta* for "spear", a reference to the similarity of the tip of a spear and the shape of the tooth.

Abundance: ■ ■
References: FW, P, FL.
Specimen: NMV P18517,
 NMV P201934.
Photo: VK.



source <https://museumvictoria.com.au/treasures/collections.aspx?pid=11> NMV A 20038 (photo Benjamin Healley)



10mm

Carcharias taurus Rafinesque, 1810

Synonyms Sand tiger shark, yellow shark, spotted ragged-tooth shark, shovelnose shark, grey nurse shark.

Habitat: Inshore from the surf zone, and in shallow bays to mid shelf.

Description: Large primary tooth (cusp) and lateral cusps; cutting edge smooth and not notched. Lateral cusplets not prominent, strongly curved. Lateral cusplets adjacent to basal edge apex of crown. Cutting edge of crown complete. Juvenile teeth without lateral cusplets, present in adults.

Distribution and range: Circumtropical. Oligocene* - Recent. *Jan Juc Formation, Victoria (George Pritchard Collection).

Feeding: Fish, crabs and lobsters.

Comment: Etymology of *Carcharias* is from the Greek *karcharos* meaning 'sharpen'. The only shark known to gulp and store air in its stomach, so as to maintain neutral buoyancy while swimming.

Abundance: ■ ■
References: MS, P, FB.
Specimen: NMV P161577.
Photo: VK.



Isurus oxyrinchus Rafinesque, 1810

Synonyms Shortfin mako shark, blue pointer, mako shark.

Habitat: Nektonic - in coastal and oceanic water primarily in surface waters, down to about 150m.

Description (dentition): Single cusped teeth, cutting edge smooth and not notched; narrower and more curved crown (and roots more lobed) than that of *Carcharodon hastalis*. Roots not massive; central foramen present; lingual face of tooth smooth; transverse groove absent or incipient.

Distribution and range: Gulf of Mexico to southern Brazil. Eocene - Recent.

Feeding: Mackerel, swordfish and tuna are its main prey.

Comment: Mako teeth have hooked crowns; the upper teeth of adults tend to be wider and thinner than juveniles, can be strongly arched distally. Found also at Beaumaris were †*I. minutus* and †*I. desori*. Plus †*I. eocaenus* (NMV P13130) which is now called *Xiphodolamia eocaena* (family Lamniostomatidae).

Abundance:



References: MS, RWP, P, IUCN, FL, FW.

Specimen: MO.

Photo: FMcS.



20mm



10mm

†*Parotodus benedeni* (Le Hon, 1871)

Synonym False mako shark.

Habitat: Pelagic.

Description (dentition): Teeth single cusped, smooth cutting edge, not notched and massive globular root. Central foramen present, lingual face of root smooth; transverse groove absent or incipient. Crown curved distally; Mesial cutting edge convex with concave distal. Torus is salient; lacks nutrient groove.

Distribution and range: USA, Japan, New Zealand and Australia. Oligocene - Pliocene.

Feeding: Carnivore.

Comment: *Parotodus benedeni* from the Oligocene epoch generally have smaller teeth and less robust to *P. benedeni* of the Pliocene. It has been suggested that the change in size maybe attributed to the evolution of whales and a change of prey. Based on reconstructed dentition, this shark was 6-7.5m in length.

Abundance:



References: FW, P, KP.

Specimen: NMV P161582.

Photo: VK.



Myliobatis sp.

Synonym Eagle ray.

Habitat: Marine to brackish waters, brackish, depth range 1 - 300 m

Description (dentition): The teeth are arranged in upper and lower (crushing) plates of 7-files each; the files in the middle are hexagonal, = more than 5 times wider than side files, with a smooth marginally convex oral surface.

Distribution and range: Cosmopolitan. Palaeocene - Recent.

Feeding: They use their crushing crushing plates to break the shells of crabs, bivalves, they also eat annelid worms.

Comment: After death the plates disintergrate into individual files, as seen above. At Beaumaris both †*Myliobatis affinis* Chapman & Cudmore, 1924 (NMV P161513) and †*Myliobatis moorabbinensis* Chapman & Pritchard, 1907 (NMV P201938 - paratype) have also been found. *Myliobatis moorabbinensis* have teeth c. 5x wider than the length with c.10 denticles per 10mm in length. †*Myliobatis affinis* have c. 12-15 teeth per 10mm in length, and is smaller than *M. moorabbinensis*.

Abundance:

Myliobatis sp.



M. moorabbinensis



M. affinis



References:

MS, F, CP1, CC1.

Specimen:

MO.

Photos:

FMcS.



5mm





Heterodontus portusjacksoni (Meyer, 1793)

Synonyms *Squalus portusjacksoni* Meyer, 1793,
Cestracion heterodontus Sherrard, 1896,
Cestracion cainozoicus Chapman & Pritchard, 1904
Heterodontus cainozoicus Chapman & Pritchard, 1904,
Squalus philippi Bloch & Schneider, 1801,
Heterodontus philippi Bloch & Schneider, 1801,
 Port Jackson shark, horn shark, bullhead sharks, dogshark, oyster crusher.

Habitat: Littoral, temperate continental shelf and uppermost slopes; tend to be found in caves or gullies on rocky reefs down to c. 250m.

Description (dentition): Two types of teeth, spiky grasping front incisors for cutting, prying and holding prey, fused teeth plates for crushing are found at the back of the mouth (see above left).

Distribution and range: Southern Queensland down around southern Australia including Tasmania, right up to the central coast of Western Australia. Rarely in New Zealand. Miocene - Recent.

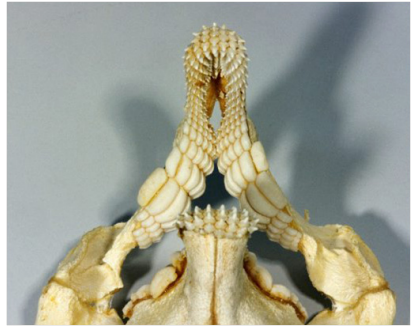
Feeding: Benthic invertebrates including molluscs, echinoderms, barnacles, small fish and crustaceans.

Comment: Named after Port Jackson in Sydney. They have two dorsal fins with a spine each that are venomous, these spines can be washed up on shore, and this probably gave rise to them being known as "horn sharks". *Heterodontus* means "different teeth" (see Description).

Abundance: ■ ■
References: A, MS.
Specimen: JB.
Photo: JB.



2mm



source: www.australianmuseum.net.au/image/teeth-of-port-jackson-shark (photo Paul Ovenden)



†*Odontaspis attenuata* (Davis, 1888)

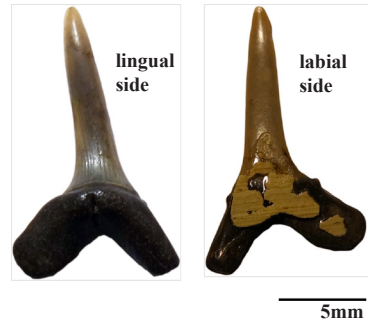
Synonyms *Lamna attenuata* Davis, 1888, mackerel shark, sand shark.

Habitat: Nektonic.

Description (dentition): Teeth have a prominent cusp and lateral cusplets (which can appear recurved if not worn); rounded cone with finely pointed apex, and striated inner lingual face. External surface curved inwards, with minute denticles on margins. Root lobes acute angle.

Distribution and range: Beaumaris Sandstone, Australia and Coleridge Gully in New Zealand (Oamaru formation). Cretaceous - U. Pliocene.

Feeding: Indiscriminate carnivore.



Abundance: ■
References: DV
Specimen: NMV P5377.
 (hypotype)
Photo: JB.



†*Odontaspis incurva* (Davis, 1888)

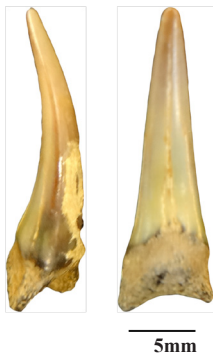
Synonyms *Lamna incurva* Davis, 1888, *Carcharias incurva*, tiger shark.

Habitat: Nektonic.

Description (teeth): Rounded, with minimal cutting edge. Surface smooth, lateral denticles absent; slightly convex. Root - 2 prongs, extend from lateral extremities to a great depth.

Distribution and range: Southern Australia including Beaumaris Sandstone and New Zealand (Cretaceous) and Denmark (Palaeocene). Cretaceous - L. Pliocene.

Feeding: Indiscriminate carnivore (based on extant species).



Comment: Oldest specimens were found in the Cretaceous-Tertiary formations of the Waireka series of New Zealand; with the youngest at Beaumaris. May be distinguished from †*O. attenuata* by an absence of longitudinal striae on the labial side. At Beaumaris numerous species of tiger shark have been found, including: †*O. macrota* (synonym: *O. elegans* and *Lamna elegans*), †*O. acutissima* and †*O. cuspidata*.

Abundance: ■
References: FW, DV.
Specimen: NMV P161580.
Photo: JB.



Orectolobus sp.

Synonyms *Crossorhinus* sp., carpet shark, nurse shark, wobbegong shark.

Habitat: Bottom sharks of warm-temperate to tropical continental waters of the western Pacific, occurring from intertidal down to at least 200 m, especially common in coral reefs and sandy bottomed sea floors.

Description (tooth): Small, sharp, presence of medial pit; labial flange extension (provides support akin to a buttress).

Distribution and range: Indo-Pacific. U. Jurassic - Recent.

Feeding: Carnivorous - small fish, cephalopods and other invertebrates.

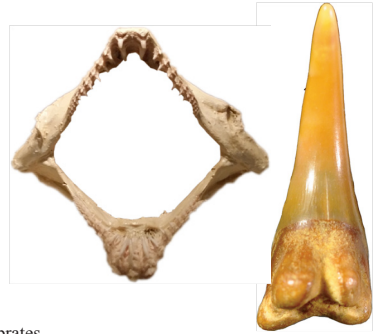
Comment: Etymology *Orectolobus* from Greek, *orektos* = 'stretch out' and *lobos* = 'lobe'. Can use its paired fins to "walk" along the bottom, and has been known to climb out of water in order to move between tidal pools.

Abundance: ■

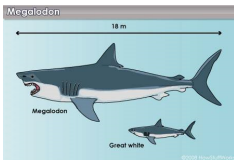
References: FB, DW, IUCN.

Specimen: NMV P160516.

Photo: VK & FMcS.



10mm



20mm

†*Carcharoles megalodon* (Agassiz, 1843)

Synonyms *Otodus megalodon* Agassiz, 1843, *Carcharodon megalodon* Agassiz, 1843, *Carcharodon rectus* Agassiz, 1856, *Carcharodon triangularis* Emmons, 1858, Giant white shark, Mega-tooth shark.

Habitat: Similar niche that Great White Sharks exploit today, in warmer waters.

Description (dentition): No side cusplets, almost 20mm symmetrical in shape, robust with serrated edges, the serrations evenly spaced. Chevron shaped scar visible just above the root. Compression fractures are common in specimens, these were caused when biting into bone.

Distribution and range: Cosmopolitan distribution in warm waters. Fossilised teeth are rare, and have been found at Beaumaris (Beaumaris Sandstone) and Hamilton in Victoria. M.Miocene - U.Pliocene.

Feeding: Carnivorous on whales, sea turtles, dolphins and dugongs.

Comment: *C. megalodon* may not have had the ability of raising its body temperature (gigantothermi), a possible contributing factor leading to its ultimate extinction, as oceans cooled it could not follow its prey into cooler waters. The largest known tooth of *C. megalodon* is 180mm long, representing a shark of more than 18m.

Abundance: ■

References: P, FW, FL.

Specimen: NMV P178131.

Photo: JB.



Pristis cudmorei Chapman, 1917

Synonyms Sawfish, longcomb sawfish, carpenter fish.

Habitat: Salt and freshwater environments (euryhaline).

Description (dentition): Sawfish rostral teeth were located on its snout (rostral blade). The tooth is somewhat triangular in shape; compressed dorsoventrally; faint striations lengthwise. Blunt apex with an inner concave edge and outer convex sharp margin. The base appears almost straight with some horizontal grooves; under magnification fine longitudinal striae can be seen.

Distribution and range: The genus *Pristis* is cosmopolitan. Eocene - Recent. †*Pristis cudmorei* Chapman, 1917 (Right) type location is the Beaumaris Sandstone, Beaumaris.

Feeding: Rostrum used to dig for crustaceans in sediment.

Comment: The mouth contains dome-shaped teeth for crushing fish and crustaceans. Skin of sawfish covered with dermal denticles (placoids) as in sharks and rays. The specimen on the left differs slightly from †*P. cudmorei* and may be either a new species or a variation.

Abundance: ■

References: IUCN, PNS, CH4.

Specimen: NMV P205577 & P13029 (holotype - *P. cudmorei*)

Photo: VK & JB



†*Pristiophorus lanceolatus* (Davis, 1888)

Synonyms Sawshark, *Lamna lanceolata* Davis, 1888.

Habitat: Upper shelf, may have been euryhaline.

Description (tooth): Distinctly large rostral teeth; elongate, lanceolate and tapering to apex from base, symmetrical. This specimen is worn, with missing cutting edges. Some rostral teeth are up to 20mm long. Teeth embedded in a rostrum, a chitinous spear-shaped structure which extended anteriorly from the head.

Distribution and range: Victoria, with the type location of the Beaumaris Sandstone, Beaumaris, also found in New Zealand and Antarctica. Eocene - Pliocene.

Feeding: Crustaceans.

Source: Bristol University from FAO



Comment: These teeth did not have sockets, but had cartilaginous attachments to the rostrum. It has been assumed that *P. lanceolatus* possessed rostral teeth arranged in an oscillating pattern i.e. long, intermediate, short, intermediate, long sequence of teeth. †*Megascyliorhinus cooperi* Cappetta & Ward, 1977 (NMV P160488) has been found in Beaumaris, according to Keyes. *M. cooperi* was a cosmopolitan shark (catshark), found mainly in New Zealand (L. Oligocene - U. Pleistocene). The anterior teeth were large (up to 7.5mm), asymmetrical with reflexed, and conical crown. Cutting edge limited to distal 1/3 of crown if present in lateral teeth. Lingual crown surface convex, with fine parallel striae at the base; labial surface less convex, with basal swelling over anterior root surface. Lateral teeth strongly striated, some with lateral cusplets which can also be striated. Nutritive foramen on lingual face.

Abundance: ■ ■

References: FW, K, K1.

Specimen: JB.

Photo: JB.



Sphyrna sp.

Synonyms Hammerhead shark, *Spyrna* (misspelling), *Zygaena* Curvier, 1816, *Cestracion* Klein, 1776, *Platysqualus* Swainson, 1839, *Reniceps* Gill, 1862.

Habitat: Marine coastal waters, bays and reefs.

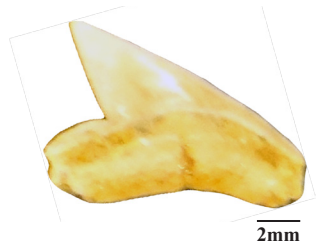
Description (dentition): Narrow cusped tooth; cutting edge with very fine uniform serrations to smooth cutting edge (juvenile teeth have no serrations present); teeth can be almost equilateral; no lateral cusplets present; basal margin of root almost sub-angular (straight); lingual face of root flat; convex enameloid should with notch above it on distal side; nutrient groove visible on lingual and labial side.

Distribution and range: Cosmopolitan including the Beaumaris Sandstone, Beaumaris. Eocene - Recent.

Feeding: Nektonic carnivore, such as feeding on fish, crustaceans and squid.

Comment: Two species of hammerhead shark have being so far identified in the Beaumaris Sandstone, †*Sphyrna prisca* Agassiz, 1843 and *Sphyrna lewini* Griffith and Smith, 1834. The name *Sphyrna* comes from the Greek for hammer.

Abundance: ■
References: MS, MV, RWP.
Specimen: NMV P249540.
Photo: FMcS.



†*Edaphodon mirabilis* Chapman and Cudmore, 1924

Synonym Ploughnose chimaera.

Habitat: Upper shelf.

Description: Palatine toothplate; strong, long and narrow in comparison to †*Edaphodon sweeti*. Three tritons are visible (the speckled areas) on this specimen; they were areas where grinding on the tooth plate occurred.

Distribution and range: Type location and the only known location for †*E. mirabilis* is the Beaumaris Sandstone, Beaumaris collected from the nodule bed at the base of the Beaumaris Sandstone.

Feeding: Nektonic carnivore.

Comment: The genus *Edaphodon* first appeared in the fossil record during the Cretaceous period in the northern hemisphere (USA, Russia, UK, Spain). It became extinct during the Pliocene, making Australia one of its last refuges. †*Ischyodus* cf. *dolloi* from the order Chimaeriformes and family Edaphodontidae has also been found in the Beaumaris Sandstone. The specimen (palatine dental plate) was originally misidentified by Woodward & White in 1930, as *Chimaera anomala*. But based on the arrangement and shape of its tritons it was later reidentified as †*Ischyodus* cf. *dolloi*.

Abundance: ■
References: FW, HB, SB, WG
Specimen: NMV P13418 (Holotype)
Photo: JB.



†*Edaphodon sweeti* Chapman and Pritchard, 1907

Synonyms Extinct giant chimaera, Plownose chimaera, ghost shark, ratfish.

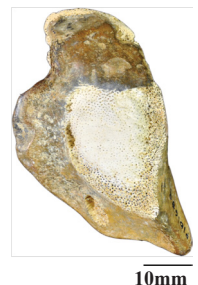
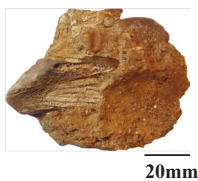
Habitat: Rivers and estuaries, but mainly very deep waters down to 2500m on the continental slope and abyssal plain.

Description: Tooth plate - the mouth was made up of three pairs of permanent tooth plates, one on the lower jaw (mandibular dental plate) and two plates on the upper jaw (vomarine and palatine dental plates). The specimen to the right shows a grinding surface (tritor) on the tooth plate.

Distribution and range: Chimaera have a worldwide distribution – temperate to cold waters. *E. sweeti* is restricted to the Beaumaris Sandstone and Forsyth's Bank to Fossil Rock Stack (near Hamilton). U. Miocene - L. Pliocene.

Feeding: Small fish and invertebrates such as molluscs probably using electroreception close to the ocean floor like modern chimaeras.

Comment: The primary difference to other chondrichthyans is that they have a single gill opening (with an operculum akin to Osteichthyes) and their upper jaw is fused with their skull.



Abundance: ■ ■

References: HB, SB.

Specimen: RC (left) & NMV P161689 (below).

Photo: FMcS & VK.

Class Actinopterygii

Infraclass Teleostei



Actinopterygii

Synonym Ray-finned bony fish.

Habitat: Marine, freshwater.

Description: (Above) Lower fish jaw (dentosplenial) of teleostean. The teleosts have pharyngeal jaws (unlike Holostei, which are made up of bowfins and garfish). It allows the maxilla (upper jaw and palate) and premaxilla (cranial bones at the tip of the upper jaw) greater movability. (Below) Tail bone of a fish. Both fossils are from the family Scombridae (includes mackerels, tunas etc.).

Distribution and range: Global. U. Silurian - Recent (Actinopterygii); L. Triassic - Recent (Teleostei).

Feeding: Teleosts can protrude their jaws forwards when feeding.

Comment: Actinopterygii are bony fish, the dominant class of fish and are called "ray-finned", as their fins are made up of bony/spiny structures which support skin in between. This differs from fleshy lobe-finned fish such as coelacanth and lungfish. Very few articulated fossil fish have been found in Victoria from the Tertiary, with most of our knowledge being gained from otoliths. They show much of what was present in Beaumaris during the U. Miocene - L. Pliocene is present today.



20mm

Abundance: ■ ■

Reference: V.

Specimen: NMV P161690.

Photo: VK & JB.



†*Lactarius tumulatus* Stinton, 1958

Synonym Perch-like fish.

Habitat: Nektonic.

Description (Otolith): Biconvex sagitta. Slightly scalloped dorsal rim, irregular tuberculations on outer face, inner face smooth. Slight rostrum present.

Distribution and range: Beaumaris, above the nodule bed in the Beaumaris Sandstone, also Balcombe bay Victoria, Australia. U.Miocene - L.Pliocene.

Feeding: Carnivore.

Comment: The otolith is a structure in the fish's inner ear that is involved in sensing movement.

Abundance:



References: SF.

Specimen: P16964.
(Balcombe Bay, Vic - Holotype).

Photo: JB.



1mm



†*Labrodon depressus* (Chapman & Pritchard, 1907)

Synonyms Wrasse, *Nummopalatus depressus* Chapman & Pritchard, 1907

Habitat: Nektonic, extant wrasse tend to be found in temperate waters and around coral reefs.

Description (dentition): Pharyngeal thin and almost equiangular outline. Teeth close closely packed, irregular distribution and lenticular in shape.

Distribution and range: Victoria near Danyo and Beaumaris (type location) in the Kalimnan. U. Oligocene - Pliocene.

Feeding: Nektonic omnivore.

Abundance:



References: CP1, MV, FW, AM.

Specimen: NMV P199998
(holotype)

Photo: FMcS.



5mm



†*Sillago pliocaenica* Stinton, 1952

Synonyms Perch-like fish, whiting.

Habitat: Subtidal, nektonic.

Description (Otolith): Dorsal rim with small, central point; rounded posterior with a smooth concave outer face.

Distribution and range: Beaumaris Sandstone (hypotype location); Muddy Creek, etc. in Victoria, and South Australia and Germany. Oligocene - Pliocene.

Feeding: Carnivore.

Comment: According to Stinton (1958), *Sillago pliocaenica* is the commonest otolith found in Tertiary rocks in Victoria.

Abundance:



References: SF.

Specimen: NMV P21789
(FA Cudmore Collection)

Photo: FMcS.



†*Diodon formosus* Chapman & Pritchard, 1907

Synonym Toadfish.

Habitat: Nektonic.

Description (dentition): Crushing tooth plate, shape of palate suboval, vermiculately crinkled surface, marginal denticles sometimes present

Distribution and range: Victoria, Australia. M. Miocene - L. Pliocene.

Feeding: Invertebrates, including small molluscs

Comment: Upper jaws more commonly found possibly due to lower jaw dislodging from fish soon after death and becoming disarticulated.

Abundance:



References: CP1.

Specimen: RC & MO.

Photos: FMcS & MO.



10mm



10mm



Cheloniidae

Synonym Sea turtle.

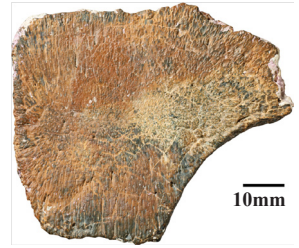
Habitat: Nektonic, coastal, terrestrial.

Description (shell bone): Isolated proximal end of costal bone; margins are abraded, with a conchoidal break down one side. Longitudinal margins are parallel to one another and perpendicular to the proximal margin. This specimen was part of the mid-region of the carapace. Dorsal surface finely vascular, with radiating pattern just visible. Below is the inner view showing a worn rib-head extension.

Distribution and range: Cosmopolitan. Cretaceous - Recent.

Feeding: Aquatic omnivore.

Comment: No scute sulci visible; vascularised bone indicative of a marine environment.



Abundance: ■
Reference: FK.
Specimen: NMV P232865
Photos: VK (right top) and FK (left)



†*Pacifichelys* sp.

Synonyms Sea turtle.

Habitat: Nektonic, marine, terrestrial.

Description (jaw): Left dentary medial view (NMV P240713); flattened dorsoventrally; the triturating surface is indicative of durophagous feeding. Low labial ridge curved dorsally, lacks serrations and cusps. Minimal development of

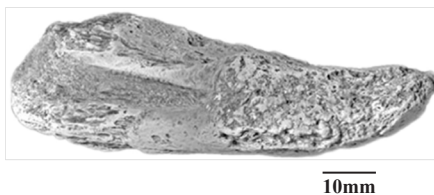
lingual ridge.

Distribution and range: Peru, California (USA) and Beaumaris, Victoria. M.Miocene - L.Pliocene.

Feeding: Aquatic omnivore.

Comment: The above specimen is similar in size to the mandibles of a juvenile †*Pacifichelys urbinai*.

Abundance: ■
References: FK, FW.
Specimen: NMV P240713.
Photo: FK.





†Dromornithidae indet.,

Synonyms Thunder bird, Mihiring bird.

Habitat: Terrestrial, open woodland.

Description (ankle bone): Partial right tarsometatarsus; lacks distal foramina vascularia (nutrient canal); much smaller in size than *Dromornis* spp. Broad hypotarsus and less pronounced sulcus extensorius. Differs from extant Casuariidae and other large flightless birds by being much larger; more robust

Distribution and range: Australia (Eastern states mainly). U. Oligocene* - U. Pleistocene; possibly back to L. Eocene, based on possible dromornithid foot impression in Queensland.

Feeding: Probably a plant eater, as their bill had no hook and feet lacked talons.

Comment: The Dromornithidae were giant flightless birds adapted to running, they were more closely related to water fowl than extant large flightless birds e.g. emus. The above specimen is the first pre-Pleistocene dromornithid from Victoria, extending their temporal range here by 4-million years. The name Mihiring comes from the Tjapwuring people of Western Victoria's name for a giant emu-like bird; at Pimba, Victoria, rock carvings of emu tracks along side grant-bird tracks can be found.

Abundance: ■

References: PF, MVR, VR.

Specimen: NMV P161489.

Photo: VK.



†*Pelagornis* sp. cf. *P. chilensis* Mayr & Rubilar 2010

Synonym Giant bony-toothed bird.

Habitat: Marine

Description: Incomplete right tibiotarsus (distal part of the shin bone shaft and extremitas distalis) was recovered as a float; similar in size to *Pelagornis chilensis*, suggesting that it was probably in the larger range of pelagornithids. It differs from previously described tibiotarsi in having a slightly wider pons supratendineus. The bone itself is quite thin, and only comparable to pelicans nowadays.

Distribution and range: Cosmopolitan - found on every continent worldwide. Beaumaris Sandstone, Australia. U.Palaeocene - U. Pliocene.

Feeding: Fish using their pseudoteeth.

Comment: Hollow tooth-like projections, called pseudoteeth, grew directly from jaw; it has been suggested that young birds did not have them and may have had to depend on their parents for food. Wingspan could in some species be >5m. The specimen recovered in Beaumaris is the only one that has so far been discovered in Australia. Extinction linked to climate change.

Abundance: ■

References: EF1, LV.

Specimen: NMV P218277.

Photo: VK.



Reconstruction of the head of *Pelagornis chilensis*. Digital reconstruction art © Peter Trusler



†*Diomedea thyridata* Wilkinson, 1969

Synonyms Albatross, tube-nosed seabirds.

Habitat: Open ocean.

Description: Described from a partial fossil bill, where the nasal sulci is identical to extant albatrosses. Pyramid shaped maxillary sinus, called the ‘Antrum of Highmore’ confirmed the bill as an albatross.

Distribution and range: Holotype from Beaumaris, and is the only known location of the species. U. Miocene- L. Pliocene.

Feeding: Probably ate crustaceans, cephalopods and fish.

Comment: *D. thyridata* was the first record of an albatross from the Tertiary in Australia. Linnaeus in 1758 took the name *Diomedea* from the Greek word for *Diomedes*, a Greek hero who took part in the Trojan war and according to legend, birds harassed him for his involvement in the war. The species name *thyridata* come from the words for “window or small door”, an allusion to the ‘antrum of highmore’, which has a small inner posterior aperture in this taxa.



20mm

Abundance: ■
Reference: W.
Specimen: NMV P24172.
Photo: VK.



†*Pseudapterodytes macraei* Simpson, 1970

Synonym Penguin.

Habitat: Coastal, ground-dwelling.

Description: Partial left (NMV P27055) and right (NMV P27056) carpometacarpus. Slight sigmoid shape to shaft with relatively small fossa pneumotricipitalis.

Distribution and range: Spring Creek (Minhamite) & Beaumaris Sandstone (south of Keefer’s Boatshed), Beaumaris, Victoria, Australia. U.Miocene - L.Pliocene.



10mm

Feeding: Based on extant species, cephalopods, plankton, crustaceans and fish.

Comment: The humerus of *P. macraei* is larger (both width and breadth) than *P. minor*. *P. macraei* is not ancestral to any modern penguins.

Abundance: ■
References: SG, PF1.
Specimen: NMV P27055-56.
Photo: PF.



†*Pseudaptenodytes minor* Simpson, 1970

Synonym Penguin.

Habitat: Coastal

Description: The genus *Pseudaptenodytes* have a unique tricripital fossa on the humerus.

Distribution and range: Beaumaris Sandstone (type location), Beaumaris, Victoria, Australia - the only known location for this species. Southern hemisphere, from the *Spheniscus mendiculus* (Galapagos penguin) which lives on the equator, to Antarctica, S. America and New Zealand. The fossil record in Australia is from the U. Eocene to the Holocene and is confined to Tasmania, Victoria and and South Australia. U. Miocene - L. Pliocene.

Feeding: Based on extant species, cephalopods, plankton, crustaceans and fish.

Comment: Early penguins had red-brown and grey feathers and elongate beaks, only recently in their evolution have there beaks reduced in size and their colouration changed to that of black and white. The oldest known fossil penguin, *Waimanu manneringi* from New Zealand is c. 60.5-61.6Ma.

Abundance: ■

References: PF1, V.

Specimen: NMV P26669.

Photo: FMcS.



10mm



Sphenisciformes indet.

Synonym Penguin.

Habitat: Nektonic.

Description: Partial left coracoid, missing both ends of the specimen.

Distribution and range: Beaumaris Sandstone, Beaumaris and Spring Creek (Type location) in Victoria, Australia. L. Palaeocene - Recent.

Feeding: Based on extant species, cephalopods, plankton, crustaceans and fish.

Comment: According to GG Simpson, this incomplete left coracoid may be a new genus.

Abundance: ■

References: PF1, V, SG1.

Specimen: NMV P24065.

Photo: FMcS.



10mm



Phocidae

Synonym Earless Seal, true seal, crawling seal.

Habitat: Marine, terrestrial, coastal.

Description (temporal bone): Right temporal bone with an inflated bulla; absence of rounded posterolaterally crest indicates that it belongs to the subfamily Monachinae (true seal).

Distribution and range: Cosmopolitan (primarily polar to temperate climates). M.Miocene - Recent.

Feeding: Piscivore.

Comment: The above specimen is the first record of a phocid in Australia older than the Pleistocene.



10mm

Abundance: ■
References: FFT.
Specimen: NMV P160399.
Photo: VK.



Tympanic bullae



involucrem

Periotic



20mm

Cetacea

Synonym Whale.

Habitat: Nektonic.

Distribution and range: Cosmopolitan. L. Eocene - Recent; †*Archaeocetes* are generally considered to be the first whales (L.Eocene); they evolved from the primarily terrestrial ancestor the artiodactyls.

Feeding: Carnivore, filter feeding of zooplankton through a baleen plate.

Description A (tympanic bullae): The above tympanic bullae and periotic were found separately, and probably belong to different baleen whales. In life the tympanic bullae and periotic would have been attached to one another via two bones: the anterior and posterior pedicile.

Abundance: ■ ■ ■
References: MS, EB, EF3, EF4.
Specimens: NMV;
 NMV P160438;
 Whale vertebrae RH,
 Whale disk MO,
 NMV P161709
Photos: VK, FMcS, EF3



Description B (vertebral disk and vertebrae): In life the intervertebral disk would have been between vertebrae.

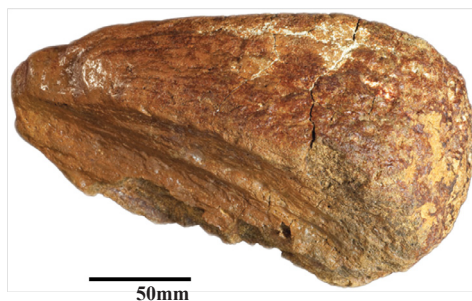


Above: Whale vertebrae recovered from the cliff face Ricketts Point.

Below: Whale disk, Rickett's Point.



Description C: Left composite posterior process (lateral view), made up of the tympanic bullae and periotic. Partially eroded on the dorsal and sides. The large size and lack of any trace of sutures (between the tympanic and periotic), suggests an adult, and that it probably belonged to the pygmy right whale family (Neobalaenidae). Pygmy right whales diverged from other Mysticetes prior to the end of the Miocene.



Comment: Cetacea (whales, porpoises and dolphins) are made up of two groups, Mysticeti (baleen whales) and Odontoceti (toothed whales). Like terrestrial mammals, they possess an outer, middle and inner ear but the outer ear lacks a connection to the surrounding environment. Odontocetes have ultrasonic (high frequency) hearing; while mysticetes have infrasonic (low frequency) hearing and are known for their “singing”.



Delphinidea sp.

Synonyms Earless Seal, true seal, crawling seal.

Habitat: Continental shelf.

Description (dentition): Conical undifferentiated teeth. In young dolphins they are slender, straight and sharp pointed.

Distribution and range: Cosmopolitan, Beaumaris. L.Eocene - Recent.

Feeding: Primarily fish and squid, sometimes eat other marine mammals.

Comment: *Delphinidae* (suborder Odontoceti) comes from the Greek for “womb”, a reference to dolphins mammalian class. Dolphins have rod shaped vestigial hind limbs as a reminder of their terrestrial past. Specimens recovered from Beaumaris include also lower jaws, periotics (inner ear bone), tympanic bullae (outer ear bone) and humeri (upper forelimb bone). †*Steno cudmorei* Chapman, 1917 (NMV P13033) type specimen was described from a worn tooth specimen recovered from Beaumaris. Since then other specimens were recovered. However, based on comparisons of the periotic with the extant *Steno bredanensis* (rough-toothed dolphin), it appears that the taxa do not have close affinities with delphinid species, and is thus *incertae sedis*.



Abundance: ■ ■
References: SF, V, FE, BDV.
Specimen: RC.
Photo: FMcS.



Physeteroidea sp.

Synonyms Cachalot, *Catodontidae*, giant sperm whale.

Habitat: Nektonic.

Description (lower jaw): These cone shaped teeth would have fitted into sockets into the upper jaw.

Distribution and range: Cosmopolitan, including the Beaumaris. Oligocene - Recent.

Feeding: Aquatic carnivore, extant species are known to eat squid and octopuses. However extinct giant predatory sperm whales would have eaten other whales.



Comment: The sperm whale is the largest of the toothed whales. The teeth can be used to tell the age of the whale, based on the amount of dentine and cementum layers. In February 2016 M. Orr found the above giant sperm whale tooth in Beaumaris. It is 30cm in length, making it the largest fossil tooth ever found in Australia. The whale would have been about 18m long and weighed some 40 tonnes (E. Fitzgerald 2016, pers. comm.).

Abundance: ■
References: MS, IUCN
Specimens: NMV P16205, MO.
Photos: VK & MO.



†*Physetodon baileyi* McCoy, 1879

Synonym Sperm whale.

Habitat: Nektonic.

Description (tooth): Teeth fusiform with a slight arch, tapering towards conical apex of the crown.

Distribution and range: It is only known from the Beaumaris Sandstone, Beaumaris (type location), Victoria, Australia. U. Miocene - L. Pliocene.

Feeding: Piscivore.

Abundance: ■

References: FW, MC1, EF2.

Specimen: NMV P5521.
(syntype)

Photo: DPK.



†*Scaldicetus macgeei* Chapman, 1912

Synonym Sperm whale.

Habitat: Nektonic.

Description (tooth): Cone stout with an enamel cap, with fine rugose surface; tapers to apex; no abrasive structures visible on tooth. No constriction visible below the enamel cap.

Distribution and range: Only known from the Beaumaris Sandstone (type location), Beaumaris, Victoria. U. Miocene - L. Pliocene.

Feeding: Piscivore.

Comment: It has been suggested by Hampe (2006), based on skull morphology and dentition of *Scaldicetus* spp., that this species occupied a similar niche to *Orcinus orca* (killer whale).

Abundance: ■

References: HO.

Specimen: NMV P12889.
(holotype)

Photos: JB.



*Mesoplodon* sp.

Synonyms *Aodon* sp., *Callidon* sp., *Diodon* sp., *Dioplodon* sp., Beaked whale.

Habitat: Marine.

Description: The illustration is a part of the upper jaw or beak (rostrum).

Distribution and range: Cosmopolitan. L. Miocene - Recent.

Feeding: Primarily squid and fish (based on extant species).

Comment: The density of the rostral bone has been found to be the highest density for any mammalian bone tissue known. Only mature males have this hyperossification, in which the premaxilla, maxilla, and vomer eventually fuse together, forming a massive rostral bone. The bone density is interpreted as strengthening for determination of male dominance.



50mm

Abundance: ■ ■
References: MS, IUCN, DVT.
Specimen: NMV P160428
Photo: VK.



10mm

†*Kolopsis* sp. cf. *K. torus* Woodburn, 1967

Synonym Diprotodon, wombat-like diprotodont.

Habitat: Terrestrial, forested.

Description (mandible): Teeth moderately worn, therefore probably a juvenile. The premolar tooth p3 is larger than the molar m1, indicating that this specimen was more primitive in morphology than *K. torus*.

Distribution and range: Alcoota and Ongeva, Northern Territory and the Beaumaris Sandstone, Beaumaris, Victoria. Miocene - L. Pliocene.

Feeding: Herbivore.

Comment: This specimen (NVM P16279) was bought for \$4 by Museum Victoria in 1910 from Albin Bishop; it was believed to be a lower jaw of a juvenile wallaby, from the Darling Downs, Queensland. In 1957, Stirton noted that it was in fact from the Diprotodontidae family. In 1977 a museum volunteer Timothy Flannery noticed under a microscope that a calcareous tube on the specimen was a marine polychaete worm and a foraminiferan *Rosline* sp. present; both of which were indicative of Beaumaris, in terms of age and palaeoenvironment. Darling Downs was a terrestrial site, this specimen has similar colouration and morphology to diprotodontid jaws (P15911a-b) discovered in Beaumaris, it was reclassified as from Beaumaris and not the Darling Downs in Queensland. *K. torus* was the smallest of the diprotodontids; weighing approximately 125-250kg.

Abundance: ■
References: RDV, PFR.
Specimen: NMV P16279.
Photo: VK.



†*Zygomaturus gilli* Stirton, 1967

Synonym Diprotodon.

Habitat: Forest to semi-forested areas, near waterways; its close relative †*Diprotodon optatum* inhabited arid inland areas.

Description (mandible): Curved tooth rows.

Distribution and range: *Zygomaturus gilli* (U.Miocene) is known only from the Beaumaris Sandstone. However *Zygomaturus* spp. have been found throughout Australia and Papua New Guinea (Miocene - Pleistocene).

Feeding: Omnivore, based on its hypsodont molars. These type of molars where the enamel extends below the gum line are also seen in cows and horses, and are adapted to eat abrasive diets (such as being able to withstand silica in grass).

Comment: The name *Zygomaturus* comes from the Greek “zygomatic” for bolt or bar, a reference to the cheek bone, which displays a prominent arch. Some early records of *Zygomaturus* were incorrectly described as *Nototherium mitcheli* Owen, 1845. The above specimen was collected in two parts; part A by FA Cudmore in 1913 on a shingle bed and 54 years later part B was collected by Mr. Colin Macrae from a reef at low tide near Keefer's Boatshed; both are clearly from the same jaw. A further diprotodont, *Palorchestes* (NMV P150124 - not figured) has been found at Beaumaris (2016 E. Fitzgerald pers. comm.)

Abundance: ■

References: LAF, V, PFR.

Specimen: NMV P15911.(hypotype)

Photo: JB.



50mm

Subclass Theria

Order Sirenia



Sirenia, gen. et sp. indet.,

Synonyms Sea cow, dugong, manatee, sea pig, sea elephant, mermaid.

Habitat: Shallow marine waters that support sea-grass. Manatees are euryhaline and can live in marine, brackish or freshwater.

Description: Distal portion shaft of rib.



20mm

Distribution and range: Cosmopolitan, including Queenscliff (Holocene), Sundland and Beaumaris Sandstone, Beaumaris, Victoria and South Australia. Extant dugongs are limited to the Indo-Pacific distributions, including the northern coasts of Australia from Shark Bay to Brisbane. Middle Eocene - Recent.

Feeding: Aquatic herbivore of sea-grass and other vegetation.

Comment: The presence of sirenians during the U. Miocene and L. Pliocene in southeastern Australia may be indicative of more favourable warmer climatic conditions at the time.

Abundance: ■

References: MS, FV, PNS1, IUCN.

Specimen: NMV P160418.

Photo: JB.



Bergueria sp.

Synonyms Sea anemone, trace fossil.

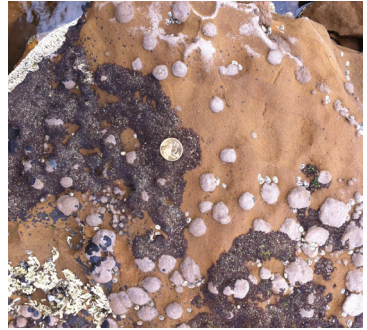
Habitat: Shallow to deep marine.

Description: Sea anemone trace fossil; Cylindrical to hemispherical structure, vertical mounds with smooth walls; has a circular to elliptical cross-section, with rounded bases; with or without a shallow, central depression and radial ridges; fill is structureless.

Distribution and range: Cosmopolitan. Precambrian - Recent.

Feeding: Suspension feeder.

Comment: These rather unusual fossils are mineralized remains of the spaces occupied by sea anemones. Although locally abundant, they are very rarely recognized in the fossil record.



Scale - coin (20.5mm in diameter)

Abundance: ■
References: IC.
Specimens: in situ.
Photo: JB.



Teredolites on fossilized driftwood at Beaumaris.

Scale – coin (41mm in diameter)

Abundance: ■ ■ ■
References: ES, TB.
Specimens: in situ
Photo: JB

Domichnia

Description: Dwelling structure, usually cylindrical in nature.

Distribution and range: Global. Pre-Cambrian - Recent.

Comment: Dwelling structures can include burrows in both hard (borings) and soft substrate (burrows). Dwellings are normally lined or reinforced and can be split into (i) *Skolithos* (Haldemann, 1840) - simple unpaired pipe structure (Precambrian - Recent) (ii) *Ophiomorpha* Lundgren, 1891 - burrows lined with pellets, resulting in a nodular outer surface on the burrow (Permian - Recent) (iii) *Teredolites* (Leymerie, 1842) - bivalve or worm borings in driftwood, which may have a calcareous lining within the tubes (Cretaceous - Recent) (iv) *Gastrochaenolites* (Leymerie, 1842) - borings into a hard substrate (Ordovician - Recent).



Ophiomorpha beaumarisensis Ter &

Buckeridge, 2012

Synonym Burrows.

Habitat: Marine intertidal to sub-littoral zones.

Description: Preserved in goethite (FeO.OH), thalassinoid (mud lobster) anatomizing burrows that are up to 3m long and c. 50mm diameter; finely nodose (pellet or wart like appearance) external surface; vertical shaft elipsoid; place of ramification pear or blister-shaped;

Distribution and range: Eastern coast of Port Phillip Bay from Mornington to Brighton. Rickett's Point in Beaumaris is the type location of this ichnospecies species. U.Miocene - L. Pliocene.

Feeding: May have 'farmed' sea grasses.

Comment: Pellets believed to have acted as support for the wall of the burrow. Burrows were once believed to have been casts of *Banksia integrifolia* and *Banksia serrata* or the spatangoid echinoid *Lovenia woodsii*, but disproven as cross-section reveals single large tube and is not cellular. The mud lobsters that produced the extensive array of burrows are believed to be similar to the extant mud lobster, *Thalassina anomala*.



Scale - coin (23.25mm in diameter)

Abundance:



Reference:

TB.

Specimen:

in situ

Photos:

JB.



Scale - coin (23.25mm in diameter)



Psilonichnus sp.

Habitat: Marginal marine environment, dune and lagoon environments

Description: Cylindrical burrows with bulbous nodes. The nodes may have been for brooding juveniles. U, J or Y-shaped; lateral branches can be different in size to parent trunk. The burrows are unlined; made possibly by a crustacean such as a brachyuran crabs.

Comment: Made by decapod crabs. Crabs can be divided into two main taxonomic group - Anomura (hermit crabs) and Brachyura (true crabs). Brachyura have adapted to a broad range of habits, and their lifestyles affect the type of burrow made.



Scale - coin (23.25mm in diameter)

Abundance:



References:

FCP, TB.

Specimen:

in situ

Photo:

JB.



Ironstone



Scale - coin (28.52mm in diameter)

Description (above ironstone): Iron oxide (goethite) deposited in an open fissure. It was produced when the region rose and groundwater rich in iron flowed through, depositing iron-rich minerals.

Phosphatic nodule

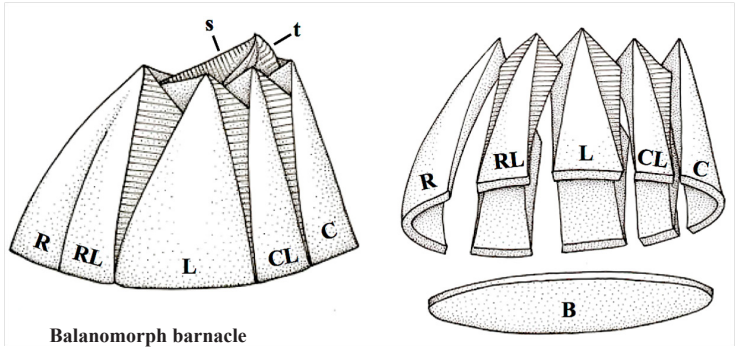


Description (above phosphatic nodule): Formed during periods of quiescence. Derived from phosphorus rich sources such as the bones of vertebrates.

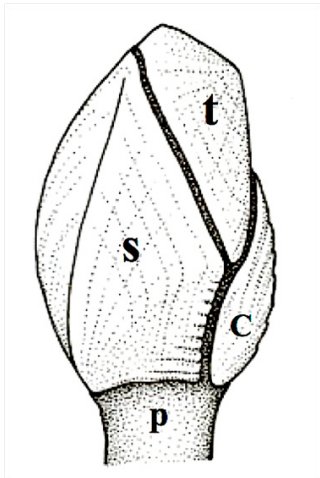
Comment: The phosphate basal nodules are associated with vertebrate remains, teeth and shells, and unconformably overlie the Gellibrand Marl. They occur in two horizons, made up of both phosphatic and goethite intraclasts in a quartz-rich sand matrix. Based on strontium isotope dating of the phosphate beds, the lower beds at Beaumaris were found to be 5.8-5.6 Ma.

Abundance (both):	
References:	MV, PC, WM, TB.
Specimen:	In situ, FMcS
Photo:	FMcS.

Barnacle Morphology



Balanomorph barnacle



Lepadomorph barnacle

Barnacle key

- C = Carina
- R = Rostrum
- CL = Carino-latus
- L = Latus
- RL = Rostro-latus
- P = Peduncle
- S = Scutum
- t = tergum
- B = base

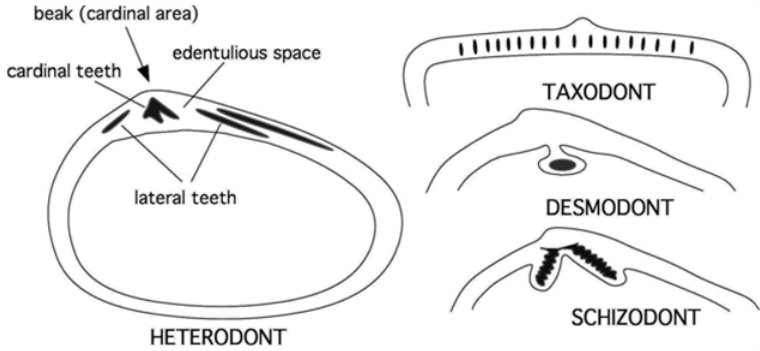
Balanomorph (acorn) barnacles would have been very common in the area when the Beaumaris Sandstone was deposited. Because they live in the high energy inter-tidal zone, they quickly disarticulate upon death.

Reference: JB
 Photo: JB.



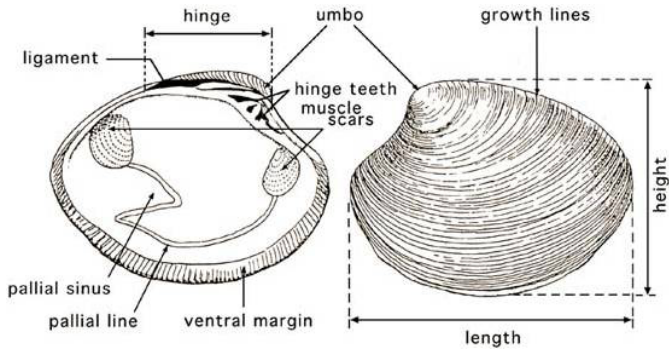
Living *Tetraclitella purpurascens* (Wood, 1851) a species found at Beaumaris today.

Bivalve Morphology



source: <http://paleo.cortland.edu/tutorial/Bivalves/bivalvemorph.htm>

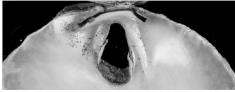
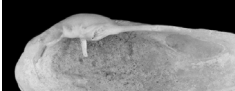
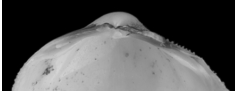
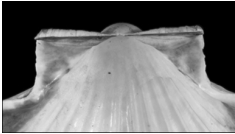
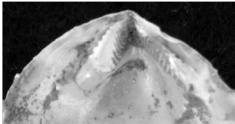
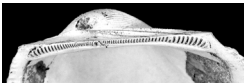
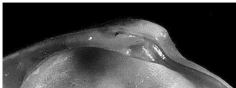
Some of the various types of bivalve hinge structures (dentition) shown above. Other forms include: dysodont, actinodont, isodont and pachyodont (see Glossary for explanation). These along with other morphological features such as the pallial line, muscle scars, ligament and overall shell shape, mineralogy and microstructure can be used in the classification of bivalves.



source: <http://www.fao.org/docrep/007/y5720e/y5720e07.htm>

Reference: RB

Dentition**Families**

Crurae		Lamellar ridges function as hinge teeth.	Anomiidae.
Desmodont		A large resilifer (chondrophore) function as the cardinal teeth.	Pholadidae.
Heterodont		A number of cardinal teeth are located close to the umbo and lateral teeth may also be present.	Carditidae, Crassatellidae, Mactridae, Veneridae.
Isodont		resilium.	Ostreidae, Pectinidae, Spondyliidae.
Schizodont		V-shaped scissurate teeth and sometimes elongated lateral teeth are present.	Trigoniidae.
Taxodont		Row of many parallel teeth.	Cucullaeidae, Glycymerididae, Limposidae.
Dysodont		Very small teeth close to the dorsal edge of the valves.	Corbulidae

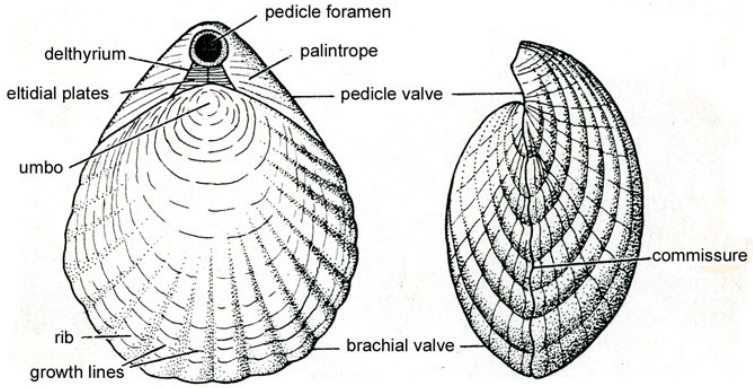
Reference:

RB

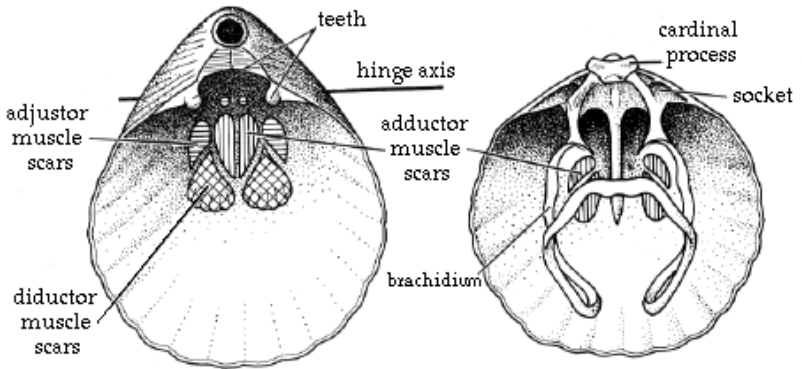
Photos:www.portphillipmarinelife.net.au

Brachiopod Morphology

External Features



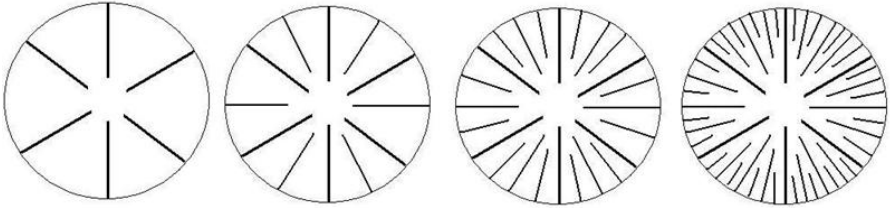
Internal Features



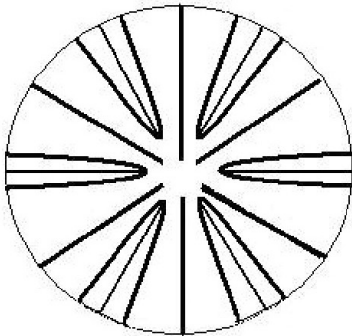
Source: <http://www.geo.arizona.edu/geo3xx/geo308/FoldersOnServer/2004%20LABS/Lab%205%20-%20brachiopods.pdf> (based on Davidson 1851)

Coral Morphology

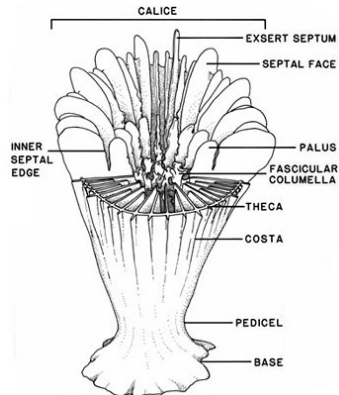
Corals are made up of three main groups. Rugosa and Tabulata are extinct (since the Permian mass extinction about 251Ma), with only Scleractinia remaining. Only scleractinians are found at Beaumaris. Scleractinia appeared around the Triassic period, and can be either solitary or colonial.



Septa from left to right: 1st (primary) Cycle; 1st and 2nd cycles; 1st, 2nd and 3rd cycles and 1st, 2nd, 3rd and 4th cycles. (Drawings Dana Riddle)



Septa where the 4th cycle seta are fused with the 3rd cycle septa (known as Pourtalès Plan) (Drawing Dana Riddle)



Morphological features of a solitary scleractinian (source: Cairns, 1994)

Sources: <http://www.advancedaquarist.com/2007/9/aafeature2>
 Cairns, S. D. 1994. Scleractinia of the temperate North Pacific. Smithsonian Contributions to Zoology., 557: 150 pp.

Echinoid Morphology

Irregular Echinoids

- Bilateral symmetry.
- Tend to be highly flattened.
- Periproct on the topside (dorsal).
- Peristome on the underside (ventral).

Comments: Spines if present, tend to be quite short, as irregular echinoids burrow (infauna). Sand dollars display secondary front to back bilateral symmetry; sand dollars originally were epifaunal, before evolving into infaunal echinoids, they still possess their Aristotle's lantern. eg. *Lovenia woodsii*, and sand dollars such as *Monostychia loveni*, *Clypeaster gippstandicus* and *Fellaster incisa*.

Regular Echinoids

pentamerous (5-part) radial symmetry – moving in any direction.

No front or back end.

Peristome (mouth) on the underside.

Periproct (anus) on the topside.

Comments: Mainly scavengers, eating detritus, sponges and molluscs; and thus possess a powerful mouth made up of 5-teeth in a circular arrangement (Aristotle's Lantern). Tend to stay on the bed surface (epifauna), and as a result generally have larger spines (for protection against predation), and in some cases for locomotion. Spines rarely remain attached to test (shell) during fossilisation. eg. †*Goniosigma singletoni*

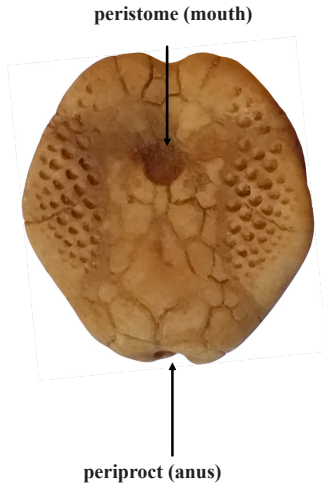
Beumaris Echinoid Key

1a	Test heart-shaped	2
1b	Test regular	3
1c	Test flattened	4
2a	Ambulacrum depressed	<i>Brissopsis tatei</i>
2b	Ambulacrum not depressed	<i>Lovenia woodsii</i>
3a	Ambulacrum with single large primary tubercle	<i>Phyllacanthus duncani</i> <i>duncani</i>
3b	Ambulacrum with primary tubercle and large secondary tubercles	<i>Evechinus palatus</i> ; <i>Ortholophus woodsii</i> ; <i>Goniosigma singletoni</i>
4a	Test with raised central part	<i>Clypeaster gippstandicus</i>
4b	Test with deep anterior sulcus	<i>Victoriaster gigas</i>
4c	Test pentamerous	<i>Monostychia loveni</i>
4d	Test round	<i>Fellaster incisa</i>

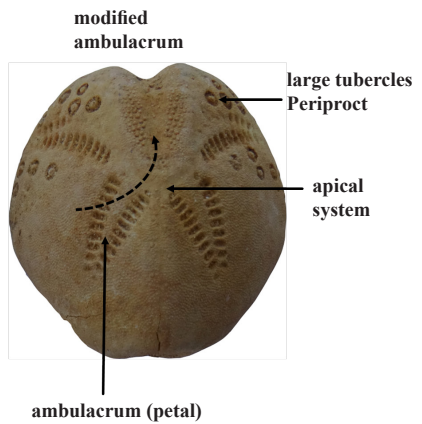
References: RB, JB

Echinoderm Morphology

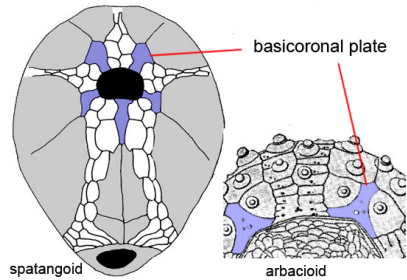
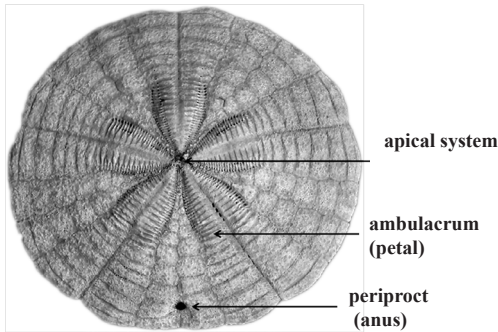
Lower (oral) surface



Upper (aboral) surface



Loveni woodsii (Etheridge, 1875) - the modified ambulacrum allows food to be directed towards the mouth on the oral side.

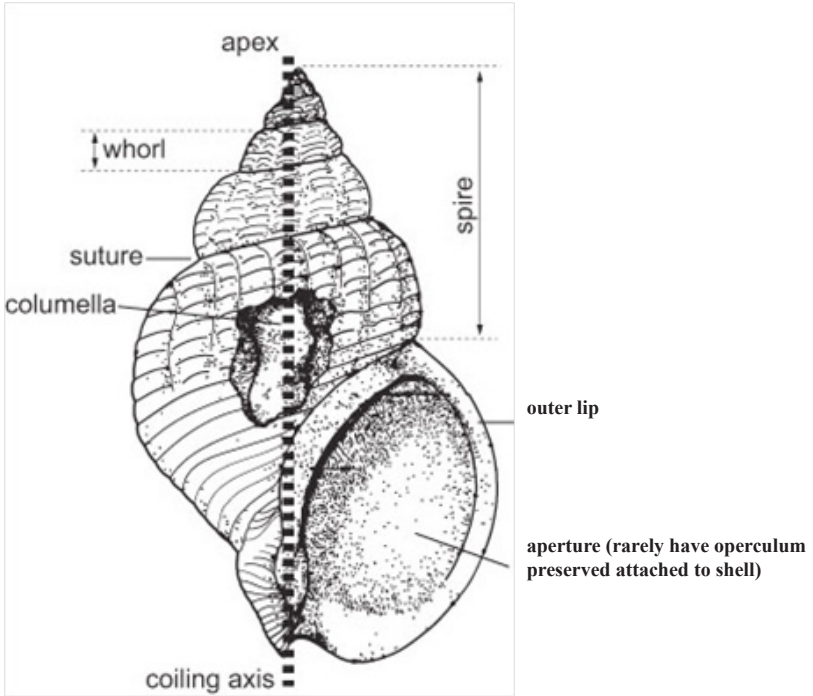


Fellaster incisa (Tate, 1893) NMV P27364 (Photo Frank Holmes) apical view, from the L. Pliocene of Jemmy's Point formation, Red Bluff, Victoria. Test length 41.3mm.

Spatangoid showing the location of the basicoronal plate (source: www.nhm.ac.uk by Smith, A. B. & Kroh, A. (editor) 2011)

References: RB, NHM
Photo: JB

Gastropod Morphology

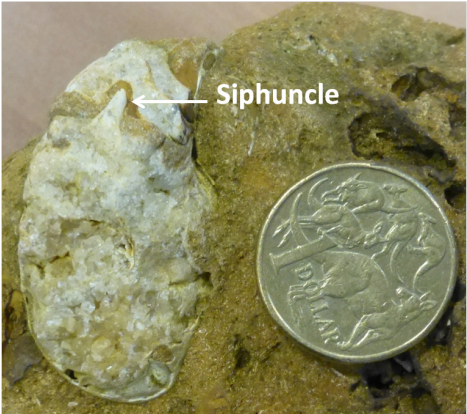
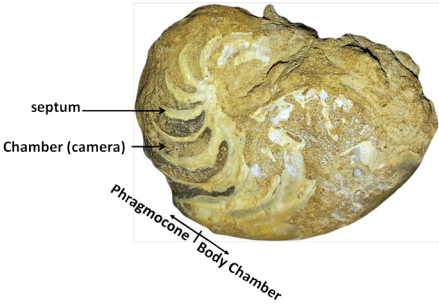


source: http://palaeo-electronica.org/2009_3/183/fig_1.htm

- The siphonal canal as seen above are an indicator of an inhalant siphon; it is used to push water over the gills. Species with siphonal canals tend to occur on soft sediment and are carnivores.
- Species with entire apertures tend to be herbivorous, and live on hard substrates. Exceptions include *Turritella* and *Natica*.

Reference: RB

Cephalopod Morphology



Scale - coin (25mm in diameter)



Nautilus pompilius source: www.nmfs.noaa.gov/ia/species/Nautilus/nautilus.html (photo Gregory Barord)

Photos:

MO

Shark tooth Morphology

Shark tooth orientation

- labial: lip side of the tooth, usually the flatter of the sides.
- lingual: tongue side of the tooth; tends to be rounded and may have a central foramen or transverse groove present.
- mesial: side of the tooth nearest the midline of the jaw.
- distal: side of tooth furthest from the midline of the jaw.
- basal: lowest part of the tooth.
- apical: Uppermost part of the tooth.

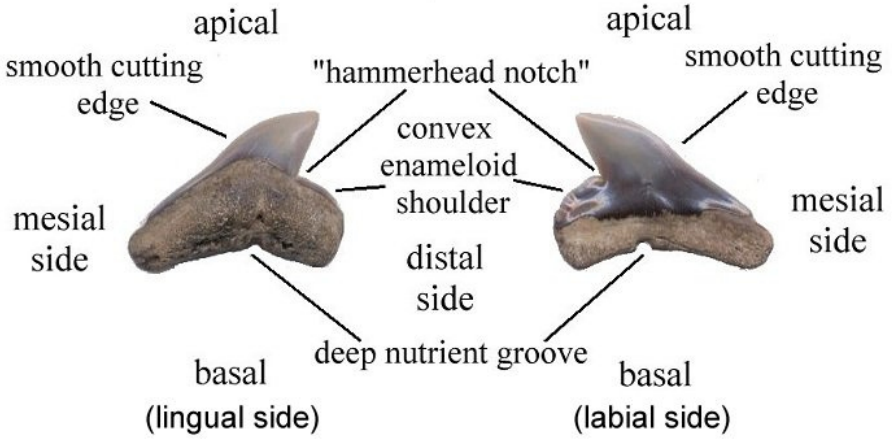
Ontogeny (relates to the growth of shark teeth with age)

- Juvenile teeth without lateral cusplets, but present in adults include: *Carcharias* and *Odontaspis*.
- Juvenile teeth with lateral cusplet but absent in adults: *Carcharodon*.
- Juvenile teeth without serrations, but present in adults: *Carcharodon* and *Sphyrna*.
- Teeth with robust crowns in cross-section and incomplete cutting edges in juveniles but thinner with complete cutting edges in adults: *Isurus oxyrinchus*.

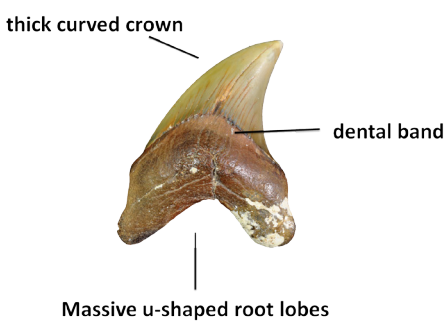
Sexual dimorphism occurs in some species, e.g. upper teeth incurved near tips in males only: *Carcharhinus brachyurus*.

Reference: RWP

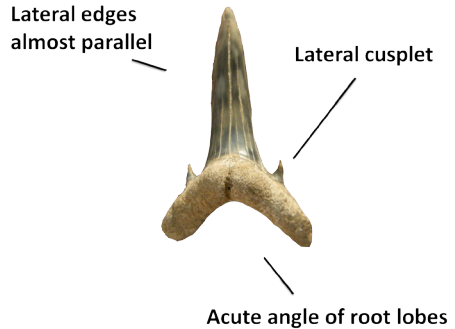
Shark tooth Morphology



1. *Sphyrna zygaena*¹



2. *Parotodus benedeni*



3. *Carcharias taurus*

Reference:

RWP

Photos:

¹<http://www.fossilguy.com/gallery/vert/fish-shark/sphyrna/sphyrna.htm>

Key to phyla at Beaumaris

Key to the major groups found at Rickett's Point, Beaumaris. If you work through the key, you should be able to identify the organism to phylum level or below; from there you can look at the species descriptions in the relevant section of the book to further identify the organism.

Invertebrates

- 1a** Burrows, tracks and dwellings - often as tubular structures (ichnofossils)... pp. 66-67.
- 1b** Single arcuate calcareous tube, open both ends. Mollusca: Scaphopoda... pp. 31
- 2a** Delicate pore network (colonial); known to encrust other fossils.
Phylum Bryozoa pp. 7.
- 2b** Skeleton colonial or solitary. One or many calices which are divided by radial plates (septa)...
Phylum Cnidaria, (corals) pp. 3-6.
- 3a** Shells with dissimilar valves, symmetrical. One valve has a hole (pedicle foramen)
Phylum Brachiopoda pp. 8-9.
- 4a** Coiled shell, chambers connected by a siphuncle (tube) ..
Phylum Mollusca: Nautilida pp. 32.
- 4b** Coiled shell, unchambered .. **Phylum Mollusca**: Gastropoda pp. 24-30.
- 4c** Two valves, similar in shape, except in oysters .. **Phylum Mollusca**: Bivalvia pp. 11-23.
- 5** Shell is made up of calcite plates. Heart-shaped or compressed spherical; bilateral or five-rayed symmetry. Spines unlikely to be attached on fossilised specimens. ...
Phylum Echinodermata pp. 33-38.
- 6** Segmented, calcareous plates, sometimes limbs present ..
Phylum Arthropoda (Barnacles and crabs) pp. 39-41.
- 7** Tiny unicellular organism; test made up of chambers connected by openings or foramina...
Phylum Retaria pp. 1

Vertebrates (Chordata)

- 10a** Skeleton (cartilaginous) rarely preserved – teeth with enameloid crowns common, fin spines, placoid scales and calcified vertebrae can also be found...
Class Chondrichthyes: **Elasmobranchii** (sharks, skates and rays) .. pp. 42-52.
- 10b** Tooth plates - Class Chondrichthyes: **Holocephali** (chimaeras) pp. 52-53.
- 11a** Teeth, bones, scales, otoliths (ear bones) and fin spines ...
Class Actinopterygii (fish) pp. 53-55.
- 12a** Bones light and hollow, teeth absent (or may have pseudo-teeth), fused ankle bones, keeled sternum, vertebrae saddle shaped with neural canal... **Class Aves** (birds) pp. 57-59.
- 13a** Reptiles are divided into 3 subclasses (Anapsida, Diapsida and Synapsida) based on the number of openings in the skull. Anapsids are the only subclass present at Beaumaris. Bones solid, bony shell plates ...**Class Reptilia** pp. 56.
- 14a** Bones can be gracile; lower jaw as single bone; limb bones often hollow (except for seals and manatees). Teeth often multi-faceted and enamel covered...
Class Mammalia pp. 60-65.

Plantae

15a Wood (roots and branches), leaves (radiating network of veins) or narrow parallel veins and palynomorphs (spores, seeds and pollen) ..**Class Plantae** pp. 2

Pseudofossils

16a Inorganic objects (non-biological structure) that resemble a fossil; at Beaumaris these may have a mammillary or nodular appearance.. pp. 68

Glossary

Sources: C, RB, UB, MSI, NHM, PHK, JP.

acorn barnacle: sessile barnacles, lack a stalk, attached directly to substrate.

actinodont: numerous teeth arranged in a radial pattern fanning out and downwards (bivalves).

adductor muscles: (i) in barnacles they are the main muscles for closing the operculum and is attached to each scutum (ii) in bivalves they are represented by their two scars, one on the anterior and the other on the posterior, used to close the valves - scars of equal size in isomyarian shells; one scar in the posterior of monomyarian shells and the posterior larger than the anterior scar on anisomyarian shells.

adjustor muscles: two pairs of muscles associated with articulate brachiopods, used to adjust the valves relative to the pedicle (brachiopods).

ambitus: the widest circumference of a test (echinoids).

ambulacrum(-a): plates associated with tube-feet; usually biserially arranged (echinoids).

anterior: near the front of the body (higher animals) and near the head (lower animals).

anthocaulus: coral that develops asexually on the skeletons of some coral species.

apical: towards the top of the spire in gastropods.

apical disc: consists of the ocular and genital plates and is found at the top of the aboral surface of the test (echinoids).

aragonite: a polymorph of calcium carbonate, chemically identical to calcite, but different crystallization, higher specific gravity and less marked cleavage.

Aristotle's lantern: jaw apparatus, made up of 5-teeth found in regular echinoids

arcuate: forming an arc.

azooxanthellate: a coral which doesn't have a symbiotic zooxanthellae in its tissue.

basicoronal plate: first formed plate adjacent to peristome. Usually resorbed in regular echinoids and present in irregular echinoids.

beak: pointed tip of a valve at its posterior end; initial location of growth (brachiopods)

benthic: of or relating to the bottom of a water body.

biserial: the layout of pore-pairs (tube-feet) which form a double series along the ambulacrum.

bourlette: flattened chevron shaped enamel just above the root on the lingual side.

buccal: lying within the mouth.

byssal foramen: Opening for fibrous threads (byssus) in the right valve, used to anchor to substrate (bivalves).

calice: a cup-shaped depression on the corallite, in which the polyp sat in life.

Cainozoic (= Cenozoic): the latest geological era (66Ma - Recent).

Cambrian Period: is the period of time 541-485 million years ago, and is the first part of the Palaeozoic Era.

carapace: bony plates beneath horny scutes of the chelonian dorsal skin (tortoises, turtles); dorsal skin fold of many crustaceans arising from posterior border of head. Can be chitinous.

cardinal process: located on the dorsal valve in brachiopods; a postero-median area for the diductor muscle attachment.

cardinal teeth: the central teeth situated just below the umbo in bivalves, usually larger than to lateral teeth.

cartilage (adjective: cartilaginous): flexible tough elastic connective tissue that provides support.

chelipeds: in decapod crustaceans, claw, nipper or pincher, which terminates certain limbs of some arthropods. Latin from *chela* 'claw' and *pod* meaning 'foot'.

Cheltenhamian: refers to an Australian time stage that occurred 6.8-5.5 million years ago. Preceded by the Mitchellian Stage and followed by the Kalimnan Stage.

chitin: semitransparent, tough long-chain polymer of N-acetylglucosamine, a derivative of glucose; a major component of arthropods, also found in the cell walls of fungi.

cleavage: whereby a mineral breaks along a specific plane(s) as determined by its crystal lattice.

colonial (e.g. coral): where many individual animals (polyps) are grouped together.

columella: axial structure such as a vertical rod or plate, as seen in corals.

commissure: juncture of growth between the pedicle and brachial valves (brachiopods).

compartmental plates: forming the wall of the shell in barnacles.

conchoidal: curved surface, similar to interior surface of a bivalve shell.

coracoid: is a hook-like structure on the scapula (shoulder blade) bone; used in muscle attachment.

corallite: skeleton of an individual polyp (corals).

corallum: calcareous skeleton of corals.

cosmopolitan: worldwide distribution.

costal: of or relating to a rib.

Cretaceous Period: was the last period of the Mesozoic Era, 145-65 million years ago.

cusp: a point/projection on a tooth.

cycle: circular arrangement (e.g. of septa in a coral).

denticles: placoid scales which act as skin (in sharks, ray and chimaeras); made up of a pulp cavity surrounded by dentine.

desmodont: reduced teeth in bivalves.

diagenesis: occurs after sediments are deposited and involves the physical and chemical processes on the sediment before lithification.

dicyclic: made up of two whorls.

discoid: flat and circular like a disc.

dissepiments: thin structures that form between corallites.

distal (teeth): the side of the tooth away from the midline of the jaw.

dorsal: relates to the back of an animal.

durophagous feeding: animals that consume hard shells/bones with strong crushing blunt teeth.

dysodont: small teeth located near the edge of the valve in bivalves.

encrusting: to cover or overlay.

Eocene: an epoch occurring 56-33.9 million years ago.

epifaunal: animals living on the surface of the seafloor, river or lake.

epoch: the third order geological time unit. It comes below period (second order) and era (first order).

escutcheon: a small curved area on the dorsal margin, posterior to the beak.

etymology: study of the source and make up of a word.

euryhaline: an organism that is able to tolerate a wide range of salinities.

exsert: to protrude.

exuviation: moulting in barnacles, whereby the membranes covering the body and appendages are shed.

facultatively: occurring possibly in response to a situation or not being restricted to a particular mode of life.

file: a labio-lingual group of teeth, including functional and replacement teeth.

filter-feeder: suspension-feeder, straining of suspended material from water so as to obtain food.

float: specimen not in situ, found loose.

foraminifera (informally called “forams”): class of amoeboid protista which are single celled, made up of a shell called a test; important in relative dating in palaeontology.

fossa: shallow depression, hollow, pit or groove.

fracture: a joint or fault in structural geology; and in mineralogy it relates to the breaking of minerals but not along crystallographic planes e.g. conchoidal, fibrous fractures.

genital plate and pores: located in the apical system, consists of pores for the discharge of eggs or spermatozoa (echinoids).

goethite: Iron oxyhydroxide (Fe.OH) a secondary mineral.

gonopore: perforation through a genital plate to the gonads.

heterodont dentition: more than one type of tooth morphology, such as cardinal and lateral teeth (occurs in some bivalves).

hinge: location of the junction of the two shells of a bivalve.

Holocene: the epoch extending from 11,300 BP to 1950.

holotype: the main specimen used in defining a species.

hypotype: a specimen that was not used in the original description of a species, but from a subsequent work (used as a reference for comparison).

ichnofossil: a trace fossil is a structure produced as a result of activity of an organism.

inequilateral: unequal sides.

infaunal: relates to animals that live beneath the substrate.

insular shelf: refers to the shelf surrounding an island.

intertidal (littoral): an area on the shore that occurs between the low and high tide marks.

involute: closely coiled.

isodont: large teeth on either side of the internal ligament pit in bivalves.

Jan Juc Marl Formation: Oligocene in age, part of the Torquay Group, it consists of glauconitic marl and sand calcarenite.

keel: prominent longitudinal ridge (bivalvia).

lingual: of, relating to, or situated near the tongue.

lunule: (Latin) crescent moon, anatomical feature on exterior of the shells surface.

labial: relates to the side where the lips are located.

lectotype: a specimen which is designated as type of a species when no holotype was selected by the original author.

maxillary sinus: located under the eyes and is the largest of the paranasal sinuses, that surround the nasal cavity.

mesial: the side of the tooth toward the midline of the jaw, where left and right jaws meet.

metacarpus: long bones within the hand/forelimb, that are connected to the carpals (wrist bones) and phalanges (finger bones).

Mohs' scale: a ten point scale used to denote hardness. e.g. calcite = 3; quartz = 7; diamond = 10.

mysticetes: the division of Cetacea that includes baleen whales; they filter feed using baleen plates from the upper jaw.

nacreous: iridescent pearly appearance (mother of pearl)

nektonic: aquatic animals able to swim and move independently of water currents.

oceanodromous: organisms that migrate within oceans.

neritic: relates to the shallow near from the mean low mark down to 200m.

odontoceti: refers to toothed cetaceans such as dolphins, porpoises, beaked and sperm whales.

ontogeny: relates to the origin and development history of an organism.

operculum: movable plates, scuta and terga and the membrane connecting them; acts as a cover of the opening through which cirri protrude in barnacles.

oral: the side of the test bearing the peristome (echinoids).

otolith: are structures from the inner ear involved in balance, sound-detection and orientation.

Oligocene: an epoch that occurred 33.9-23 million years ago.

pali: rise from the inner end of septal plates as vertical rods (pali) or plates (paliform lobes).

pallial sinus: found on interior of the posterior part of the valves and if deflected would indicate the bivalve was a burrower, it was for the attachment of the mantle muscles.

palynology: the study of pollen grains and spores, both living and fossil.

papillose: small nipple-like projection.

paratype: a specimen used to show additional features to that of a holotype.

paries: part of the wall plates of barnacles.

pedicle: stalk like structure (brachiopods).

perciopods: in crustaceans, legs attached to the thorax.

perignathic girdle: inside the test, from the peristome margin to which the jaw muscles are attached. Jaws are mainly found in regular echinoderms, and in some irregular echinoderms.

periotic bone: surrounds the inner ear of mammals.

periproct: opening in test for the anus (echinoids).

peristome: area of test (shell) which has the mouth in echinoids.

Permian period: the last period of the Palaeozoic Era, 299-251 million years ago. At the end of the Permian Period a massive extinction wiped out approximately 95% of all life on earth.

photosymbiotic: a symbiotic relationship between two organisms, in which one of the organisms is capable of photosynthesis.

phylogeny: the sequence of events in the evolutionary development of a species or group.

piscivore: fish eater.

placoid (dermal denticles): scales that cover the skin of elasmobranchs. They can be viewed through an electron microscope, and are similar to vertebrate teeth having an inner pulp core.

Pleistocene: an epoch that occurred between 2.588 million years ago and 11,700 years. During this epoch there were periods of repeated glaciations.

pores (ambulacral): perforation through the ambulacral plate for the tube-foot (echinoids).

Precambrian (abbrev. pЄ): is the time prior to the Phanerozoic Eon; 4.6 billion years ago to 541 million years ago.

prosocline: to slant forwards (anteriorly).

prosoyral: relates to the umbo of bivalves, which are curved, so as to point towards the anterior.

pseudomorph: a secondary mineral which has replaced another mineral but maintains the shape of that original mineral.

radiole: spine of an echinoid. They are made up of calcite - each spine moves to a tubercle. They are attached by soft tissue, and so are readily lost after death. They can be used to identify species if preserved.

Recent: refers to the present time. post 1950 (Anthropocene).

regression (marine): is when the sea levels relative to the surface of the exposed land drops, exposing previously submerged seafloor. It can occur due to glacial events (water locked up in ice) or as a result of plate tectonics (movement of the lithosphere). The opposite to regression is marine transgression.

resilium: an internal ligament of a bivalve that is situated in a depression known as the resilifer; it helps hold the two valves together.

rhombic: resembling a rhombus, which is an oblique-angled parallelogram with 4-equal sides.

rostrum: a beak or snout-like projection.

schizodont: relates to a type of hinge dentition (Bivalvia), in which the teeth are large, and possess parallel ridges at right angles to the axis of the teeth. The left valve bears a single tooth.

scleractinian: stony/hard corals, made up of polyps that build a hard skeleton, with a six-ray pattern of septa (sometimes called 'hexacorals'); they filled the niche of the extinct tabulate and rugose corals. Appeared first in the M. Triassic.

sagittal: a vertical plane which passes from the anterior to the posterior; dividing the body into left and right.

scansorial: to climb.

scutum: the two triangular opercular plates in the aperture of a barnacle (pl. scuta). Each paired with a tergum (terga).

septa (singular septum): radial plates extending vertically through the corallite. The longer septa are called major (primary) septa and the shorter ones minor (secondary) septa.

siphon: a tube-like extension of the mantle, that draws water in for respiration and feeding; it can result in a siphonal canal or ridge on the shell of the gastropod.

siphuncle: a slender tube that extends from the protoconch to the body chamber.

spatulate: having a broad rounded apex with a narrow base.

sulcus (sulcate): downfold (furrow or groove) of the anterior region of one valve opposite a complementary up fold, in the other valve (brachiopods); furrow in the anterior ambulacrum (echinoids).

symbiotic: organisms that live together, usually beneficial to both.

symphyseal (tooth): a tooth located on the midline of a jaw.

syndepositional: is a geological term for being deposited at the same time.

syntype: type specimen of equal status to the other descriptive specimens used when describing the original description of a taxon.

taxodont dentition: where the hinge-teeth are of equal size arranged in a pattern, fanning outwards; which occurs in some bivalves.

taxa (singular taxon): organisms making up a particular taxonomic group, e.g. members of a certain species form a taxon.

tergum: In barnacles. Paired thickened dorsal plates that articulate with the scuta, and occupy the opercular opening (pl. terga).

test: the mineralised plates that make up the 'shell' of the sea urchin, or a barnacle.

tibiotarsus: relates to the main longest bone in the leg of a bird, located between the femur and tarsometatarsus.

tritator: grinding surface on a tooth.

torus: a donut shape.

tympanic bone: part of the middle ear, which supports the tympanic membrane - which vibrates (when it detects sound) transmitting the external air pressure changes to ear ossicles of the middle ear cavity.

theca: a cup-like or tubular sheath-like structure.

trapezoidal: quadrilateral (4 sides), with two parallel sides.

Triassic Period: was the first period of the Mesozoic Era, 251-199 million years ago.

triserial: arrangement of pore-pairs (tube-feet) that form 3 separate pairs in the ambulacrum (echinoids).

trituration: to pulverize, crush to a fine powder.

tubercle: rounded knob-like projection (mamelon) on the test; it is associated with the spine (echinoids).

umbilicus: depression or hole found in molluscs, at the centre of the shell whorl.

umbo: the earliest formed part of a valve; usually rounded and projecting above the hinge line (e.g. in bivalves).

ventral: underside of an animal or plant.

zooid: an organism from a colony such as Bryozoa, Hydroidea and Anthozoa.

zooxanthellae: are dinoflagellates that live endosymbiotically with corals (and other invertebrates); providing carbohydrates to the host via photosynthesis, it also gives the coral its colouration.

Nomenclature

aff. indicates that the specimen may be a new species that has ‘affinities’ with a known species.

cf. indicates uncertainty or reserve. “cf” is Latin for confer, to “compare with”

Incertae sedis classification uncertain.

isp ichnospecies (trace fossil).

igen ichnogenus (trace fossil).

v is shorthand for *vidimus*, meaning “we have seen”, in this case the author is indicating that they have seen the original type specimen.

MA *mega annum*; millions of years.

sp. (spp. for plural) indicates a possible new species, but identification has not been fully completed yet due to lack of evidence.

c. - *circa* (approximately)

cv. - cultivar

f. - form/ forma

fam. - family

gen. nov. - *genus novus* – a newly described genus

indet. indeterminatus, -a, -um cannot be, or has not been, determined

ined. - *ineditus* (unpublished)

ms. - manuscript (unpublished manuscript name - generally follows an author name)

p.p. - *pro parte* (in part)

sect. - section/sectio

s. lat. - *sensu lato* (in the broad sense)

s. str. - *sensu stricto* (in the narrow or strict sense)

sp. aff. - species with affinity to ..., or close to ... (NB. ‘*aff. sp.*’ should not be used)

sp. nov. - *species novus* – a newly described species (NB. ‘*nov. sp.*’ should not be used)

ssp. - (not preferred - see *subsp.*)

subg. - subgenus

subsp. - subspecies

U. - upper (towards the end of that particular geological unit of time)

L. lower (near the start of that particular geological unit of time)

References

- A** Aitken, K (2003). *Green Guide - Sharks & Rays of Australia*. New Holland Publishers (Australia) Pty Ltd, Sydney. 96pp. ISBN 1-86436 318 5.
- AM** Australian Museum (2016). <www.australianmuseum.net.au> *Australian Museum NSW* 2016 [viewed Jan-Aug 2016].
- AS** Australian Stratigraphic Units (2016). <<http://dbforms.ga.gov.au>> Australian Government, Geoscience Australia 2016.
- BA** Bartholomai, A (2008). Lower Cretaceous Chimaeroids (Chondrichthyes: Holocephali) from the Great Artesian Basin, Australia. *Memoirs-Queensland Museum* 52(2): 49.
- BCS** Beaumaris Conservation Society Inc (2016). <<http://www.bcs.asn.au/bibliofoss.htm>> Bibliography of the Beaumaris Bay Fossil Site. [viewed Dec 2015].
- BD** Beu, AG & Darragh, TA (2001). Revision of Southern Australian Cenozoic fossil Pectinidae (Mollusca: Bivalvia). *Proceedings of the Royal Society of Victoria* 113(1): 163-167.
- BDV** Biodiversity Heritage Library (2016). <<http://www.biodiversitylibrary.org/>> [viewed Jan-Aug 2016].
- BE** Bird, E (1990). *Structure and surface: the geology and geomorphology of the Sandringham district*. City of Bayside, Victoria. 14pp.
- BU** Boreham, AUE (1965). A revision of F. W. Hutton's pelecypod species described in the Catalogue of Tertiary Mollusca and Echinodermata (1873). *New Zealand Geological Survey Paleontological Bulletin* 37: 1-125.
- C** Cornwall, IE (1995). The barnacles of British Columbia. Royal British Columbia Museum. *Australian Museum* vol. 25: 369-377.
- CC** Chapman, F & Cudmore, FA (1934). The Cainozoic Cidariae of Australia. *Memoirs of the National Museum Melbourne* 8: 126-149.
- CC1** Chapman, F & Cudmore, FA (1924). New or little known fossils in the National Museum - some Cainozoic fish remains, with a revision of the group. *Proceedings of the Royal Society of Victoria* 36 (2): 107-162.
- CH** Chapman, F (1911). A revision of the species *Limopsis* in Tertiary beds of Southern Australia. *Proceedings of the Royal Society of Victoria* 23: 419-432.
- CK** Cicimurri, DJ & Knight, JL (2009). Late Oligocene sharks and rays from the Chandler Bridge formation, Dorchester County, South Carolina, USA. *Acta Palaeontologica Polonica* 54(4): 627-647.
- CP** Chapman, F & Pritchard, GB (1904). ART. VIII - Fossil fish remains from the tertiaries of Australia - Part I. *Proceedings of the Royal Society of Victoria* 17: 267-297.
- CP1** Chapman, F & Pritchard, GB (1907). Fossil fish remains from the Tertiaries of Australia- Part 2. *Proceedings of the Royal Society of Victoria* 20: 59-75.
- CP2** Chapman, F (1922). New or Little-known Fossils in the National Museum. *Proceedings of the Royal Society of Victoria* 35(1).
- CP3** Chapman, F (1928). The Sorrento Bore, Mornington Peninsula - with a description of new or little-known fossils. *Department of mines records of the Geological Survey of Victoria* 5(1).
- CP4** Chapman, F (1917). New or Little-known Victorian fossils in the National Museum (Part XX - Some Tertiary fish-teeth). *Proceedings of the Royal Society of Victoria* 24 (1-2): 134-141.

- CW** Cotton, BC & Woods, NH (1935). The correlation of recent and fossil Turritellidae of Southern Australia. *Records of the South Australian Museum* 5(3): 369-387.
- D** Darragh, TA (1965). Revision of the species of Eucrassatella and Spissatella in the Tertiary of Victoria and Tasmania. *Proceedings of the Royal Society of Victoria* 78(1): 95-144.
- D1** Darragh, TA (2010). A new species of the genus Proxichione (Bivalvia: Veneridae) from Western Australia with notes on the Late Tertiary species. *Records of the Western Australian Museum* 25: 369-377.
- D2** Darragh, TA (1986). The Cainozoic Trigoniidae of Australia. *Alcheringa: An Australasian Journal of Palaeontology* 10: 1-34.
- D3** Gill, ED & Darragh, TA (1963). Evolution of the Zenatiinae (Mactridae: Lammellibranchiata). *Proceedings of the Royal Society of Victoria* (77): 177-190.
- D4** Darragh, TA (1965). **Proxichione** (Pelecypoda: Veneridae) from the Tertiary of South-Eastern Australia. *Proceedings of the Royal Society of Victoria* 79: 165-173.
- D5** Darragh, TA (1970). Catalogue of Australian Tertiary Mollusca (except chitons). *Memoirs of the National Museum of Victoria* 31: 125-212.
- D6** Darragh, TA (2002). A revision of the Australian genus Umbilia (Gastropoda: Cypraeidae). *Memoirs of the National Museum Victoria* 59(2): 355-392.
- D7** Darragh, TA (1991). A revision of the Australian genus Tylospira Harris, 1897 (Gastropoda: Scuthioliariidae). *Alcheringa: An Australasian Journal of Palaeontology* 15(2):151-175.
- D8** Darragh, TA (1985). Molluscan biogeography and biostratigraphy of Tertiary of southeastern Australia. *Alcheringa: An Australasian Journal of Palaeontology* 9(2): 83-116.
- DJ** Dennant, J (1904). Descriptions of new species of corals from the Australian Tertiaries, Part 7. *Transactions of the Royal Society of South Australia* 28: 52-76.
- DJa** Dennant, J (1899). Descriptions of new species of corals from the Australian Tertiaries, Part 1. *Transactions of the Royal Society of South Australia* 23:112-122.
- DK** Darragh, TA & Kendrick, GW (2010). Eocene molluscs from the Merlinleigh Sandstone, Carnarvon Basin, Western Australia. *Records of the Western Australian Museum* 26: 23-41.
- DK1** Darragh, TA & Kendrick, GW (2008). Silicified Eocene molluscs from the Lower Murchison Southern Carnarvon Basin, Western Australia. *Records of the Western Australian Museum* 24: 217-246.
- DP** Duncan, PM (1877). On the Echinodermata of the Australian Cainozoic (Tertiary) deposits. *The Quarterly Journal of the Geological Society of London* 33: 42-73.
- DP1** Duncan, PM (1864). A description of some fossil corals and echinoderms from the South Australian Tertiaries. *The annals and magazine of natural history: zoology, botany, and geology* 14(3): 161-168.
- DV** Davis, JW (1888). On fossil-fish remains from the Tertiary and Cretaceo-Tertiary formations of New Zealand. *Scientific Transactions of the Royal Dublin Society* 4(2):1-48.
- DVT** De Buffrenil, V, Zylberberg, L, Traub, W & Casinos, A (2000). Structural and mechanical characteristics of the hyperdense bone of the rostrum of Mesoplodon densirostris (Cetacea, Ziphiidae): summary of recent observations. *Historical Biology: An International Journal of Palaeobiology* 14(1-2): 57-65.
- DW** Duffin, CJ & Ward, DJ (1983). Neoselachian sharks teeth from the Lower Carboniferous of Britain and the Lower Permian of the USA. *Palaeontology* 26: 93-110.

- E** Etheridge, R (18 75). Description of a new species of the genus *Hemipatagus*. *Quarterly Journal of the Geological Society*, Geological Society of London: 444-450.
- EB** Ekdale, EG, Berta, A & Deméré, TA (2011). The Comparative Osteology of the Petrotympic Complex (Ear Region) of Extant Baleen Whales (Cetacea: Mysticeti). Iwaniuk A, ed. PLoS ONE. 2011;6(6):e21311. doi:10.1371/journal.pone.0021311.
- EF1** Fitzgerald, EMG, Park, T & Worthy, TH (2012). First giant bony-toothed bird (Pelagornithidae) from Australia. *Journal of Vertebrate Palaeontology* 32(4): 971-974.
- EF2** Fitzgerald, EMG (2004). A review of the Tertiary fossil Cetacea (Mammalia) localities in Australia. *Memoirs of the Museum of Victoria* 61(2): 182-208.
- EF3** Fitzgerald, EMG (2012). Possible neobalaenid from the Miocene of Australia implies a long evolutionary history for the pygmy right whale *Caperea marginata* (Cetacea, Mysticeti). *Journal of Vertebrate Paleontology* 32(4): 976-980.
- EF4** Fitzgerald, EMG (2004). The fossil record of cetaceans (Mammalia) on the Australian continent. *Fossil Collector Bulletin* 72: 5-32.
- EG** Edgar, GJ (2008). *Australian Marine Life - The plants and animals of temperate waters*, 2nd edn, New Holland Publishers, Sydney, NSW, Australia. 624pp. ISBN 9781921517174.
- ES** Earth Sciences <<http://www.es.ucl.ac.uk/tf/ichno.htm>> Types of Ichnofacies, UCL Earth Sciences 2016. [viewed June 2016].
- F** Walker, C & Ward, D (2000). *Fossils*, Dorling Kindersley Ltd, London, UK. 320pp. ISBN 9781405359870.
- FB** Fish Base (2016). <<http://www.fishbase.org>> Froese, R. and Pauly, D (Editors) 2016. [viewed Jan-Aug 2016].
- FCP** Frey, RW, Curran, HA & Pemberton, SG (1984). Tracemaking activities of crabs and their environmental significance: the ichnogenus *Psilonichnus*. *Journal of Paleontology* 58 (2): 333-250.
- FE** Fordyce, MS (1981). A review of Australian Fossil Cetacea. *Memoirs of the National Museum of Victoria* 43(1): 43-58.
- FFT** Fordyce, RE & Flannery, TF (1983). Fossil phocid seals from the late Tertiary of Victoria. *Proceedings of the Royal Society of Victoria* 95: 99-100.
- FK** Fitzgerald, EMG & Kool, L (2015). The first fossil sea turtles (Testudines: Cheloniidae) from the Cenozoic of Australia. *Alcheringa: An Australasian Journal of Palaeontology* 39:142-148.
- FL** Florida Museum of Natural History (2016). <<http://flmnh.ufl.edu>> *University of Florida*. [viewed Jan 2016].
- FP** Foster, RJ & Philip, GM (1980). Some Australian Late Cainozoic Echinoids. *Proceedings of the Royal Society of Victoria* 91: 155-160.
- FS** Fitzgerald, EMG & Schmidt, R (2015). Fossils of Beaumaris. <www.marinecare.org.au/images/Fossils_of_Beaumaris_Feb_2015.pdf> *Museum Victoria*. [viewed Dec 2015].
- FV** Fitzgerald, EMG, Velez-Juarbe, J & Roderick, TW (2013). Miocene sea cow (Sirenia) from Papua New Guinea sheds light on sirenian evolution in the Indo-Pacific. *Journal of Vertebrate Paleontology* 33(4): 956-963.
- FW** Fossilworks (2015). <<http://fossilworks.org>> Palaeobiology database, Macquarie University, Alroy, J (Editor) 2005. [viewed Jan-Aug 2016].
- GE** Gill, ED (1963). The age and ecology of fossil Mollusca from Red Bluff Sandringham Victoria. *Journal of the Malacological Society of Victoria* 1(7): 7-11.

- HB** Helfman, G & Burgess, GH (2014). *Sharks: The animal book*. Johns Hopkins University Press, Baltimore, USA. 288pp. ISBN 9781421413099.
- HO** Hampe, O (2006). Middle/Late Miocene hoplocetine sperm whale remains (Odontoceti: Physteridae) of North Germany with an emended classification of the Hoplocetinae. *Fossil Record* 9(1): 61-86.
- IC** KU Ichnology (2016). <<http://ichnology.ku.edu>> Studying the traces of life, University of Kansas, IchnoBioGeoScience Research Group, Hasiotis, S 2014. [viewed June 2016].
- IUCN** International Union for Conservation of Nature and Natural Resources (2016). <<http://www.iucnredlist.org>>. *The IUCN Red List of Threatened Species*, 2016. [viewed Jan-Aug 2016].
- JB** Buckeridge, JS (1983). Fossil barnacles (Cirripedia: Thoracica) of New Zealand and Australia 50. *New Zealand Geological Survey Palaeontological Bulletin*: 1- 151.
- JB1** Buckeridge, JS (2013). A part, not apart from nature: The IUBS Ethics Commission – an overview of a journey from 2000-2012. *Biology International* 52: 5-13. (2012).
- JE** Jeffery, CH & Emlet, RB (2003). Macroevolutionary consequences of developmental mode in Temnopleurid Echinoids from the Tertiary of Southern Australia. *Evolution* 57(5): 1031-1048.
- JK** Jenkins, RJF (1975). The fossil crab *Ommatocarcinus corioensis* (Creswell) and a review of related Austrasian species. *Memoirs of the National Museum of Victoria* (36): 33-62.
- JP** Jackson, PNW (2010). *Introducing Palaeontology: A guide to ancient life*. Dunedin Academic Press Ltd, Scotland. 152pp. ISBN 9781906716158.
- K** Keyes, IW (1984). New records of fossil Elasmobranch genera *Megascyliorhinus*, *Centrophorus* and *Dalatias* (Order Selachii) in New Zealand. *New Zealand Journal of Geology and Geophysics* 27(2).
- K1** Keyes, IW (1982). The Cenozoic sawshark *Pristiophorus lanceolatus* (Davis) (Order Selachii) of New Zealand and Australia, with a review of the phylogeny and distribution of world fossil and extant Pristiophoridae. *New Zealand Journal of Geology and Geophysics* (25): 459-474.
- KC** Kitahara, MV & Cairns, SD (2009). A revision of the genus *Deltocyathus* Milne-Edwards & Haime, 1848 (Scleractinia, Caryophylliidae) from New Caledonia, with the description of a new species. *Zoosystema* 31(2): 233-248.
- KP** Kent, BW & Powell, GW (1999). Reconstructed dentition of the rare lamnoid shark *Parotodus benedenti* (Le Hon) from the Yorktown formation (Early Pliocene) at Lee Creek Mine, North Carolina. *The Mosasaur* (6): 1-10.
- LAF** Long, JA, Archer, M & Flannery, T (2002). *Prehistoric mammals of Australia and New Guinea - one hundred million years of evolution*, UNSW Press, Australia.
- LH** Lamprell, KL & Healy, JM (1998). A Revision of the Scaphopoda from Australian Waters (Mollusca). *Records of the Australian Museum*, Supplement 24.
- LNH** Ludbrook, NH (1956). The molluscan fauna of the Pliocene strata underlying the Adelaide Plains, Part 3. *Transactions of the Royal Society of South Australia* 79: 1-36.
- LNHI** Ludbrook, NH (1955). The Molluscan fauna of the Pliocene strata underlying the Adelaide Plains, Part 2. *Transactions of the Royal Society of South Australia* 78: 18-87.
- LV** Louchart, A & Viriot, L (2011). From snout to beak: the loss of teeth in birds. *Trends in Ecology & Evolution* 26(12): 663-673.
- MC** McCoy, F (1877). Prodrromus of the Palaeontology of Victoria; or, figures and description of Victorian Organic Remains - Decade V, *Geological Survey of Victoria* 5.

- MC1** McCoy, F (1879). Prodomus of the Palaeontology of Victoria; or, figures and descriptions of Victorian Organic Remains - Decade VI. *Geological Survey of Victoria* 6.
- MCa** McCoy, F (1876). Prodomus of the Palaeontology of Victoria; or, figures and descriptions of Victorian Organic Remains - Decade III, *Geological Survey of Victoria* 3.
- MK** MacKinnon, DI, Stanley, SB & Lee, DE (1993). Brachiopod fauna of the Kokoamu Greensand (Oligocene), New Zealand. *New Zealand Journal of Geology & Geophysics* 36(3): 327-347.
- MP** McNamara, KJ & Philip, GM (1984). A revision of the spatangoid echinoid *Pericosmus* from the Tertiary of Australia. *Records of the Western Australia Museum* 11, 319-356
- MPK** McNamara, KJ, Philip, GM & Kruse, PD (1986). Tertiary brissid echinoids of southern Australia. *Alcheringa* 10: 55-84.
- MR** Milson, C & Rigby, S (2009). *Fossils at a glance*, 2nd edn, Wiley-Blackwell, UK.
- MS** WoRMS (2016). World Register of Marine Species, <<http://www.marine-species.org/index.php>> WoRMS Editorial Board, 2016. [viewed Jan-Aug 2016].
- MSI** Marine Species Identification Portal (2016). <<http://species-identification.org>> ETI Bioinformatics, 2016. [viewed Jan-Aug 2016].
- MV** Melbourne Victoria Collections (2016). <<http://collections.museumvictoria.com.au/>> Museum Victoria. [viewed Jan-Aug 2016].
- MVR** Murray, PF & Vickers-Rich, P (2004). *Magnificent Mihirungs: The colossal flightless birds of the Australian dreamtime*. Indiana University Press, USA.
- NHM** Natural History Museum (2016). <<http://www.nhm.ac.uk/our-science/data/echinoid-directory>> The Echinoid Directory, Smith, AB and Kroh, A. 2011. [viewed Jan-Aug 2016].
- P** Purdy, RW, Schneider, VP, Applegate, SP, McLellan, JH, Meyre, RL & Slaughter, BH (2001). The Neogene sharks, rays, and bony fishes from Lee Creek Mine, Aurora, North Carolina. *Contributions to Paleobiology* 90: 71-202.
- PB** Nautiloidea (2005). <<http://palaeo.gly.bris.ac.uk/palaeofiles/fossilgroups/cephalopoda/nautiloidea.html>> Fossil Groups, University of Bristol. [viewed March 2016].
- PC** Pellant, C (2000). *Rocks and Minerals*. 2nd edn. Dorling Kindersley Ltd, London, UK.
- PEB** Bryozoan net (2016). <http://www.bryozoa.net/library/1982/bock_1982.pdf> Recent and Fossil Bryozoa, Bock, PE. 1982. [viewed Feb 2016].
- PF** Park, T & Fitzgerald, EMG (2012). A late Miocene - early Pliocene Mihirung bird (Aves: Dromornitidae) from Victoria, southeast Australia. *Alcheringa: An Australasian Journal of palaeontology* 36(3): 419 - 422.
- PF1** Park, T & Fitzgerald, EMG (2012). A review of Australian fossil penguins (Aves: Sphenisciformes). *Memoirs of Museum Victoria* 69: 309-325.
- PG** Pritchard, GB (1904). Contributions to the palaeontology of the older Tertiary of Victoria - Gastropoda Part II. *Proceedings of the Royal Society of Victoria* 17(1): 320-338.
- PG1** Pritchard, GB (1903). Contributions to the palaeontology of the older Tertiary of Victoria - Lamellibranchs Part III. *Proceedings of the Royal Society of Victoria* 15(1): 87-103.
- PFR** Piper, KJ, Fitzgerald, EMG & Rich, TH (2005). Mesozoic to early Quaternary mammal faunas of Victoria, South-East Australia. *Palaeontology* 49 (6): 1237-1262.
- Ph** Philip, GM (1969). The Tertiary Echinoids of South-Eastern Australia IV. Camarodonta (2). *Proceedings of the Royal Society of Victoria* 82(16): 227-228.

- Ph1** Philip, GM (1963). The Tertiary echinoids of South-Eastern Australia I. Introduction and Cidaridae. *Proceedings of the Royal Society of Victoria* 76(1-2): 181-226.
- PHK** Kearney, P (2001). *Dictionary of Geology*. 2nd Edn, Penguin Books, UK.
- PNS** Pledge, NS (1967). Fossil Elasmobranch teeth of South Australia and their stratigraphic distribution. *Transactions of the Royal Society of South Australia* 91.
- PNS1** Pledge, NS (2006). Sirenians in southern Australia - first fossil record. *Alcheringa: An Australasian Journal of Palaeontology* 30(1): 295-305.
- PY** Ponder, WF & Yoo, EK (1976). A revision of the Australian and tropical Indo-Pacific Tertiary and Recent species of *Pisinna* (= *Estea*) (Mollusca: Gastropoda: Rissoidae). *Records of the Australian Museum* 30: 150-247.
- RB** Black, RM (1995). *The Elements of Palaeontology*, 2nd edn, Cambridge University Press, UK. 404pp. ISBN 0521343466.
- RBK** Reeves, J & Buckeridge, J (2012). *The urban sanctuary: Algae and marine invertebrates of Ricketts Point marine sanctuary*. Greypath Productions, Melbourne, Australia. 140pp. ISBN 978-0-9804483-5-1. <http://www.iubs.org/pdf/publi/otherpubli/243.%20The%20Urban%20Sanctuary.pdf>.
- RDV** Rich, TH, Darragh, TA & Vickers-Rich, P (2003). The Strange Case of the Wandering Fossil. *Bulletin of the American Museum of Natural History* 279: 556-567.
- RJ** Richardson, JR (1991). Australian Tertiary Brachiopoda. the subfamily Anakineticae. *Proceedings of the Royal Society of Victoria* 103: 29-45.
- RWP** Purdy, RW (1990). A Key to Common Genera of Neogene Shark. *Paleobiology*, viewed 2 Sep 2015, <<http://paleobiology.si.edu/pdfs/sharktoothKey.pdf>>.
- S** Schmidt, R (2003). Eocene bryozoa of the St. Vincent Basin, south Australia. *Lethaia* 36: 1-343.
- SB** Stahl, BJ (1999). Chondrichthyes III (Holocephali). Volume 4 of Schultze, HP. (ed). *Handbook of Paleoichthyology*. F. Pfeil Verlag, Munich, 164pp.
- SC** Cairns, SD (2016). A key to the genera and species of the transversely-dividing Flabellidae (Anthozoa, Scleractinia, Flabellidae), with a guide to the literature, and description of two new species. *ZooKeys* 562: 1-48.
- SF** Stinton, FC (1958). Fish otoliths from the Tertiary strata of Victoria, Australia. *Proceedings of the Royal Society of Australia* 70: 81-93.
- SG** Simpson, GG (1970). Miocene penguins from Victoria, Australia, and Chubut, Argentina. *Memoirs of the National Museum, Victoria* 31: 17-24.
- SG1** Simpson, GG (1965). New record of a fossil penguin from Australia. *Proc. Royal Society of Australia* 71: 113-119.
- SH** Steeman, ME, Hebsgaard, MB, Fordyce, RE, Ho, SYW, Rabosky, DL, Nielsen, R, Rahbek, C, Glenner, H, Sørensen, MV, & Willerslev, E (2009). Radiation of extant cetaceans driven by restructuring of the oceans. *Systematic Biology* 58: 573-585.
- SN** Sadler, T & Neville, SP (1985). The fossil sea urchin *Fellaster incisa* - an extension of range. *Transactions and Proceedings of the Royal Society of South Australia* 109.
- SR** Squires, RL (1993). Earliest records of the Anomiid Bivalve *Pododesmus*: A new species from the Lower Eocene of Western Washington. *The Veliger* 36(3): 270-275.
- T** Tate, R (1887). The Lamellibranchs of the Older Tertiary of Australia (Part 2). *Transactions and Proceedings of the Royal Society of South Australia* 9: 142-200.
- T1** Tate, R (1899). A Revision of the Older Tertiary Mollusca of Australia - part 1. *Transactions of the Royal Society of South Victoria* 23: 249-277.

- T2** Tate, R (1891). Descriptions of new species of Australian Mollusca, Recent and fossil. *Transactions of the Royal Society of South Victoria* 14: 261.
- T4** Tate, R (1890). The stratigraphical relations of the Tertiary formations about Adelaide, with special reference to the Croydon Bore. *Transactions of the Royal Society of South Victoria* 13(2): 180-184.
- T5** Tate, R (1893). The gastropods of the Older Tertiary of Australia (Part 4). *Transactions of the Royal Society of South Victoria* 17: 316-345.
- T6** Tate, R (1888). The gastropods of the Older Tertiary of Australia (Part 1). *Transactions of the Royal Society of South Victoria* 10: 91-171.
- T7** Tate, R (1885). Description of new species of Mollusca of the Upper Eocene beds at Table Cape. Pap. *Proceedings of the Royal Society of Tasmania for 1884*: 226-231.
- T8** Tate, R (1891). Descriptions of new species of Australian Mollusca, Recent and Fossil *Transactions of the Royal Society of South Victoria* 14: 257-269.
- TB** Ter, PC & Buckeridge, JS (2012). *Ophiomorpha Beaumarisensis* isp. Nov., A Trace Fossil from the late Neogene Beaumaris Sandstone is the burrow of a Thalassinidean lobster. *Proceedings of the Royal Society of Victoria* 78: 95-144.
- TJ** Talent, JA (2012). *Earth and Life: Global biodiversity, extinction intervals and biogeographic perturbations through time*. Springer Science & Business Media, EU. 1400pp. ISBN 9048134285, 9789048134281.
- VR** Vickers-Rich, P (1979). The Dromornithidae, a family of large, extinct ground birds endemic to Australia. *Bureau of Mineral Resources, Geology and Geophysics. Bulletin*. 184, Canberra. 196pp.
- TP** Taylor, J & Poore, GCB (2011). Taxonomic Toolkit for marine life of Port Phillip Bay, <<http://portphillipmarinelife.net.au>> Museum Victoria [viewed 22 Aug 2016].
- UB** University of California Museum of Paleontology (2016). <www.ucmp.berkeley.edu> UCMP, 2016. [viewed April 2016].
- V** Vickers-Rich, P, Monaghan, JM, Baird, RF & Rich, TH eds. (1991). *Vertebrate Palaeontology of Australasia*. Pioneer Design Studio for Monash University Publications Committee, Lilydale, Victoria. 1437pp. ISBN 0909674361.
- W** Wilkinson, HE (1969). Description of an upper Miocene albatross from Beaumaris, Victoria, Australia. *Memoirs of the Museum of Victoria* 29: 41-51.
- WA** Williams, A, Brunton, CHC, Carlson, SJ, Baker, PG, Carter, JL, Curry, GB, Dagys, AS, Gourvennec, R, Hou, HF, Jin, YG, Johnson, JG, Lee, DE, MacKinnon, DI, Racheboeuf, PR, Smirnova, TN & Sun, DL (2006). *Treatise on Invertebrate Paleontology* Part H, Brachiopoda 5: Rhynchonelliformea 5:1689-2320.
- WG** Ward, DJ & Grandez, L (1991). Chimaeroid fish remains from Seymour Island, Antarctic Peninsula. *Antarctic Science* 3(3): 323-330.
- WM** Wallace, MW, Dickinson, JA, Moore, DH & Sandiford, M (2005). Late Neogene strandlines of southern Victoria: a unique record of eustasy and tectonics in southeast Australia. *Australian Journal of Earth Sciences* 52: 277-295.
- WMT** Warne, MT (2005). The global Mio-Pliocene climate equability and coastal ostracod faunas of southeast Australia. *Palaeogeography, Palaeoclimatology, Palaeoecology* 225: 248-265.
- WR** Wallace, MT (2010). Review of *Alataleberis* McKenzie and Warne, 1986 and description of *Alatapacifica* gen. nov. (Ostracoda, Crustacea) from the Cenozoic of Australasia. *Alcheringa: An Australasian Journal of Palaeontology* 34(1): 37-60.

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