Ancient Tiri Part 6: The first Metazoans (Multicellular Animals)
From the Seas to the Land.

We have been traveling through "deep time" in this series towards the present day, and now our journey is about 85% complete. We have arrived at a point between 650 and 420 million years ago (650-420Mya) when the plants have evolved from single celled individuals (or loose clusters of cells) into multicellular algae and bryophytes. At this time Tiri as we know it now does not strictly exist yet because "Proto-New Zealand" is underwater on the edge of the continental shelf of the supercontinent Gondwana. The oldest section of present day New Zealand's landmass was formed underwater some 540 to 360Mya and originally consisted of eroded Gondwana sediments deposited on the sea floor. These sediments built up offshore for millions of years, until movements of the sea floor carried them towards the land. There the sediments were added to the edge of the continent, creating new coastal mountains. The main part of the New Zealand landmass, sometimes called Greywacke 'basement' rock, was formed on the margins of Gondwana during several of these cycles of deposition and mountain building. Their age is known from the fossils they contain, including animals called trilobites which though now extinct, lived for an extraordinary quarter of a billion years between 520-260Mya.

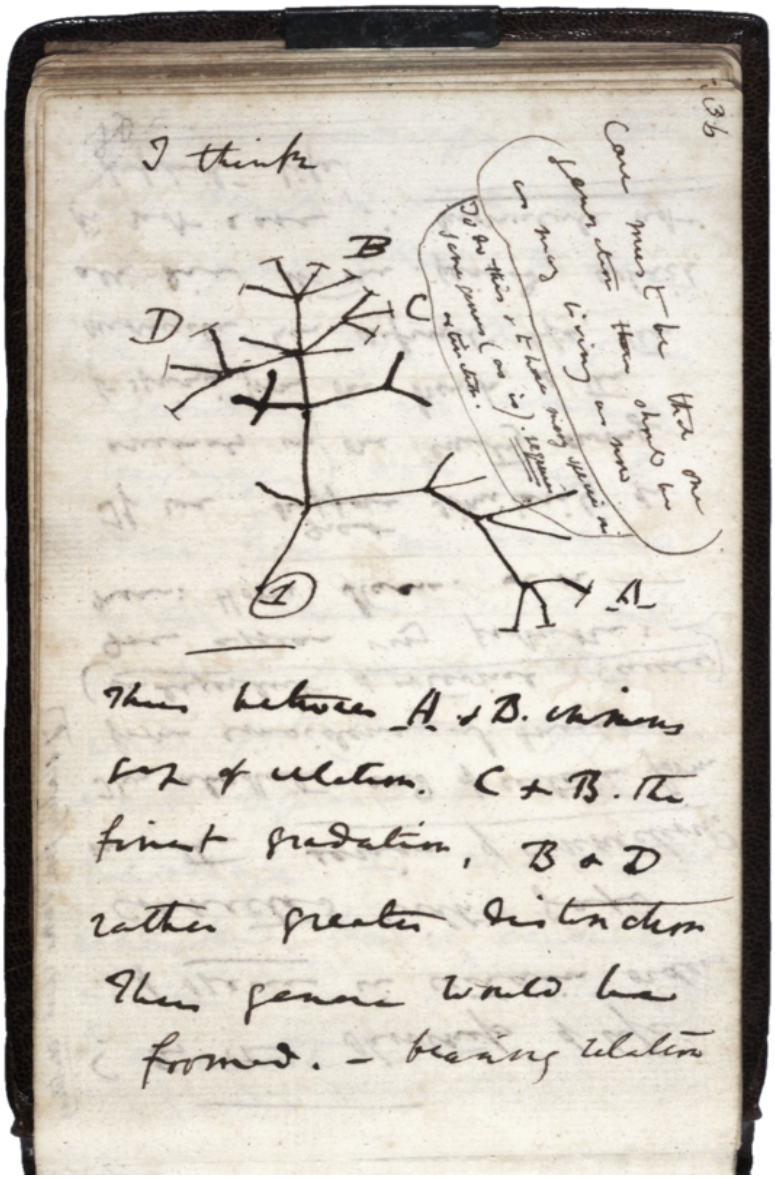
Marine Trilobite fossils. (Not in Tiri rocks) *Nat. History Museum*

In a future issue we will see how the much younger Greywacke and Argillite rocks of the Auckland area formed on top of this, 300-150Mya during a later underwater deposition phase. All of these rocks have been heated, squeezed and injected with veins of minerals over time, which accounts for the jagged fractured appearance of Tiri's foreshore rocks. There were two fascinating evolutionary bursts of "innovation" that occurred in the oceans at this time (650-420Ma) – almost evolutionary "experiments" you might say. The first was the Pre-Cambrian *Ediacaran period* (635-541Mya) which left many enigmatic and weird trace fossils of soft bodied animals with highly organised segmented bodies. Found in the Australian Ediacara hills in the Flinders Ranges, some of these marine fossils were so strange they could be interpreted as being either of plant or animal origin. Debates still rage regarding their relationships to modern groups of animals. One theory even suggests they might be primitive lichens or just bacterial mats.

Marine Ediacaran fossils 635-541Ma. (Too old for Tiri rocks) Wikimedia Commons

The majority of the animal fossils found in these rocks have no representatives living today, such as the strange half-worm half-arthropod, *Hallucigenia*. Immediately after this came the

appropriately named “Cambrian Explosion” (540Mya), a relatively “brief” period of approx. 25Ma when most of today’s major animal groups suddenly appeared in the fossil record.



Tree of Life from Darwin's notes. *Wikimedia Commons*

An encrusting white sponge on the Wharf legs. *John Sibley*

I have chosen three major animal groups dating from this ancient time period that are still living and commonly seen in the sea around Tiri.

200 years ago Charles Darwin wrote that living things today are descended down through countless generations from common ancestors, “branches” of what he called the “Tree of Life”. He said “blood lines” passed from parents to offspring in what we call today *vertical gene transfer* from one generation to the next within each species.

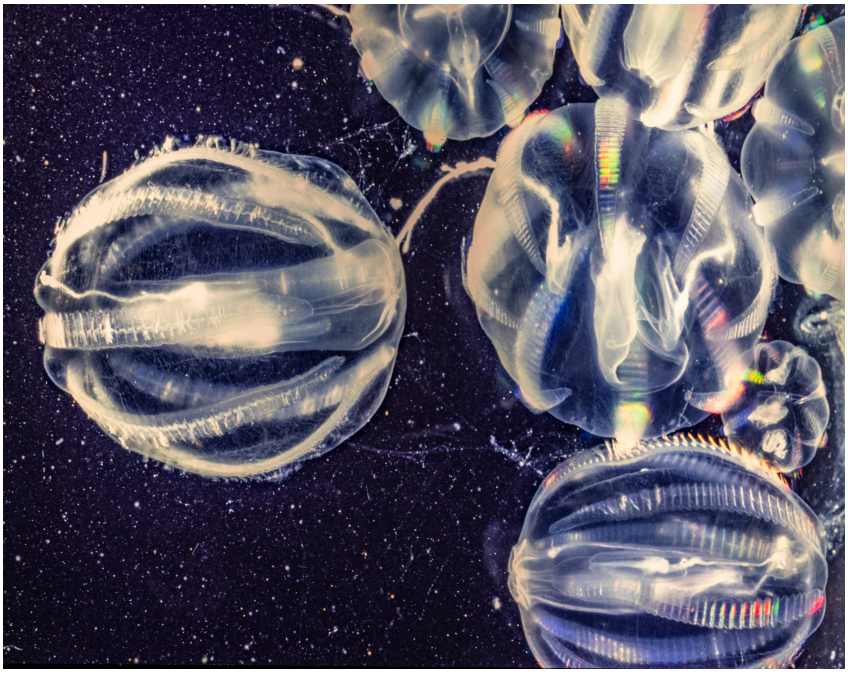
For much of the next two centuries scientists placed the *Sponges* right at the bottom of the tree as they are formed from loose aggregations of cells arranged in simple layers with jobs like water current generation and food absorption.

They are the only animals that can reconstruct themselves after being completely disrupted into scattered individual cells by squeezing them through a sieve! So traditionally sponges with their simple structures have always been placed near the bottom of the tree, below another strange group of animals called the “Comb jellies” or *Ctenophores* (with a silent “C”!) above them. (Cteno = “comb”, phore = “bearer”)

However with the advent of molecular biology tools such as DNA sequencing we have been able to go well beyond the traditional approach to classification which merely looked at physical features, to reveal origins with far greater precision and certainty.

Astonishingly it now appears that at the DNA level the “simple” sponges are really quite advanced. Although they do not have a central nervous system, they do have DNA sequences to code for it. It appears that over time they first developed, and then lost their nervous systems as they adapted to sedentary lifestyles where it was not needed.

The *Ctenophores* on the other hand have recently been found to have never developed typical Metazoan nervous or muscle systems in the first place. In fact the current theory is that their



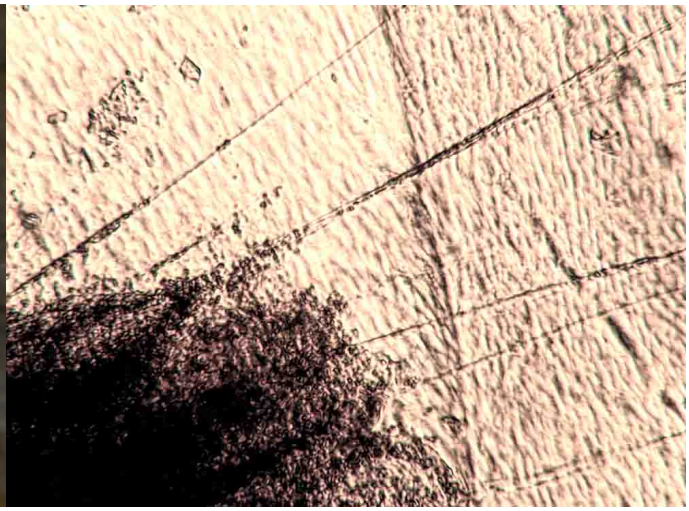
Tiri Ctenophores approx 20mm long *John Sibley*

nervous and muscle systems evolved *independently* of the rest of the Metazoans. They have also recently been found to possess just one neurotransmitter (chemicals which relay nerve messages across nerve junctions) as opposed to several for all the rest of the Animal Kingdom. So now it's the Ctenophores that seem to occupy that lowest, most basic branch on the "Tree of Life". We will see later how this "Tree of Life" is in reality more a thorny tangled "bush" due to *horizontal gene transfer* (a form of cross species hybridisation) which Darwin knew nothing about. Look out for these jellyfish-like Ctenophores drifting past the Wharf.

At least two species of comb jelly can be seen off Tiri, one grape sized (*Pleurobrachia sp*) and the other lemon sized (*Lesueuria sp*.). They occur often in huge numbers, the smaller ones sometimes become stranded on Tiri's beaches looking for all the world like little transparent glass marbles sitting glistening on the sand. The larger ones are so fragile that a mere touch against a solid object shreds them to pieces. They display bilateral symmetry (Left/right sidedness with a front mouth and rear anus), and are propelled through the water by rows of fused beating "hairs" called "combs" (for that is what they resemble) that beat and propel them along. As the sunlight catches these combs it is split up into stunning rainbow colours, a process called diffraction. If this beauty wasn't enough, consider with awe that they have remained virtually unchanged for over half a billion years! They do not possess the cnidaria or stinging cells of the jellyfish and are completely harmless to humans. Their secret weapon consists of sticky "lasso" tentacles with which they catch their prey. Using these they are capable of decimating newly hatched fish fry. Together with human overfishing, they were responsible for the virtual extermination of North Sea herring stocks in the 1920's.

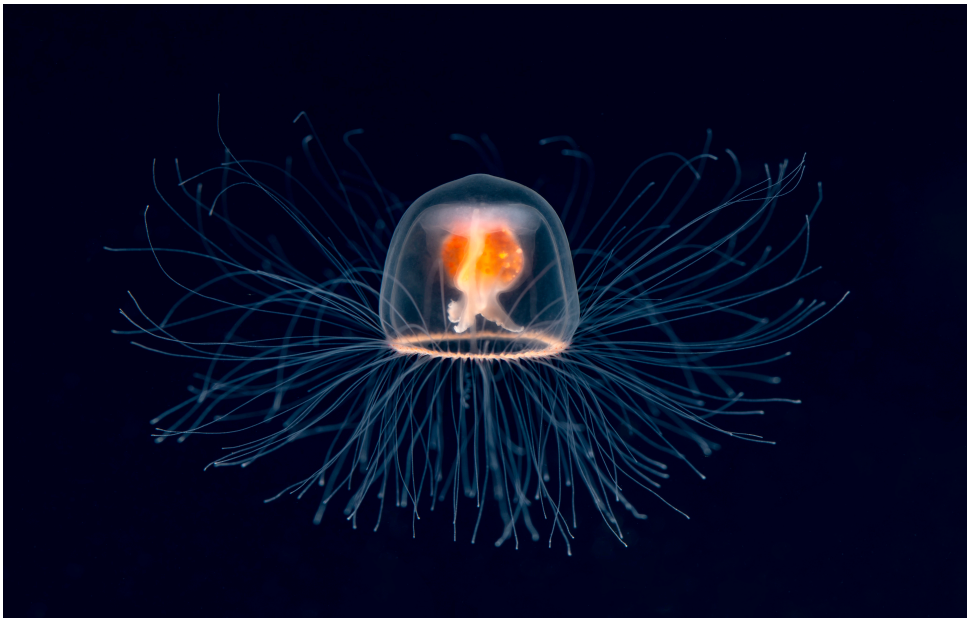
The *Cnidaria* (with another silent "C"!) are another group of marine animals (better known as the jellyfish and sea anemones) that appeared at this time 580Mya. Like the Ctenophores they have never developed adaptations to live on land.

Brown anemone - a Cnidarian polyp off Hobbs Bay. *J Sibley*

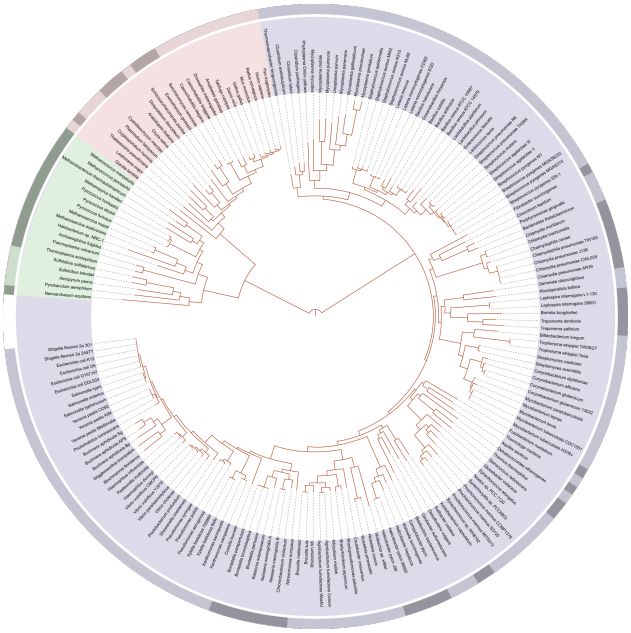


Nematocysts shooting out into my finger! *J. Sibley*

Their jelly like bodies bear a superficial resemblance to the Ctenophores. But there the similarity ends. They have radial symmetry and powerful stinging tentacles studded with microscopic oval stinging cells (nematocysts) that shoot dart-like poisoned hypodermic needles into their prey (or your flesh) rather like an everted finger of a rubber glove pushed out suddenly under pressure. They occur as either mobile free swimming Medusae (Jellyfish) or sedentary Polyps (anemones and corals) anchored to the seabed. The free swimming medusa forms also go through a sedentary phase as a polyp at one point in their life cycle. The Medusae can be as large as 2m across in the case of the blue jellyfish *Cyanea lamarcki*, often seen off Tiri, or as small as 10mm across in the case of *Turritopsis rubra* the small red jellyfish we see in swarms when boarding the ferry. These Cnidarians are very significant predators of fish fry. The Bluebottle *Physalia* is a really odd Cnidarian. It isn't actually a single animal, rather it is formed from a *colony* of animals. Some members of the colony may specialise forming stinging tentacles, others as "mouths" capable of ingesting prey (many may cooperate to digest a large fish). Yet others form the skin of a large air bladder needed for buoyancy. They twist the whole gas bladder over periodically to "dunk" it in the seawater to wet the upper surface to prevent it drying out. The venom in the stinging cells is ferocious, "dissolving" the skin everywhere the nematocyst laden tentacles make contact. The aftermath is excruciating, looking (and feeling) like red hot wires have cut deep into the skin. Multiple stings have been known to be fatal, and even detached tentacles are still capable of stinging the unwary swimmer on Tiri.



Turritopsis - a small red cnidarian medusa. *J. Sibley*



So given their primitive natures, it is entirely appropriate that we start our survey of these early Tiri Metazoans – with the Sponges Ctenophores and Cnidarians, and to remember that although they remain marine to this day, they would have been swimming in unimaginable swarms above the sediments that were destined to become the rocks of future New Zealand at the bottom of the ocean just off the coast of the Gondwana supercontinent all those millions of years ago.

If you go to the following weblink you will find an example (left) of an interesting abbreviated "Tree of Life" based on representatives from most of the living groups today whose genomes have been sequenced. Note that over 80% of all living things are bacteria!

https://en.wikipedia.org/wiki/Phylogenetic_tree#/media/File:Tree_of_life_SVG.svg

In the next issue of *Ancient Tiri* we will look at the Metazoans that evolved the adaptations needed to emerge from the oceans and occupy the land.