May 2, 2022

News and notes

Before going on to a look at some of the marine life during the Triassic Period, here are some news items that I thought were interesting.

Geopolitics

The war in Ukraine continues. Remembering that all wars involve deception, here are a few sites to observe changes in the war:

- Daily updates at the Institute for the Study of War.
- Live Map; regular updates to the changes in the on ground situation.
- Oryx: Assessments of battlefield losses.
- How to End the War in Ukraine with Scott Ritter.

Research

- Long-term preservation of Hadean protocrust in Earth's mantle; ancient rocks and the early Earth; summary from Phys.org here.
- From Phys.org: Scientists study microorganisms on Earth to gain insight into life on other planets, research article here, includes a plain language summary.
- Pothole-like depressions in the chamber floor of the Sudbury Igneous Complex, Canada.
- Extremely rapid up-and-down motions of island arc crust during arc-continent collision; "Mountain building and the rock cycle often involve large vertical crustal motions".

Paleontology

- This relates to today's post on marine life during the Triassic: Giant marine reptiles at 2,800 meters above sea level; research article here.
- Also related to today's discussion on Triassic animals: Prehistoric plesiosaurs were penguins of their day.
- Early life: Eukaryogenesis and oxygen in Earth history, it's behind a pay wall, summary in Eureka Alerts here.
- Sask. research teams make rare find inside Scotty T. rex fossil.
- Evolution of sea urchins, heart urchins and sand dollars,: Phylogenomic analyses of echinoid diversification prompt a re-evaluation of their fossil record.

Hydrogeology

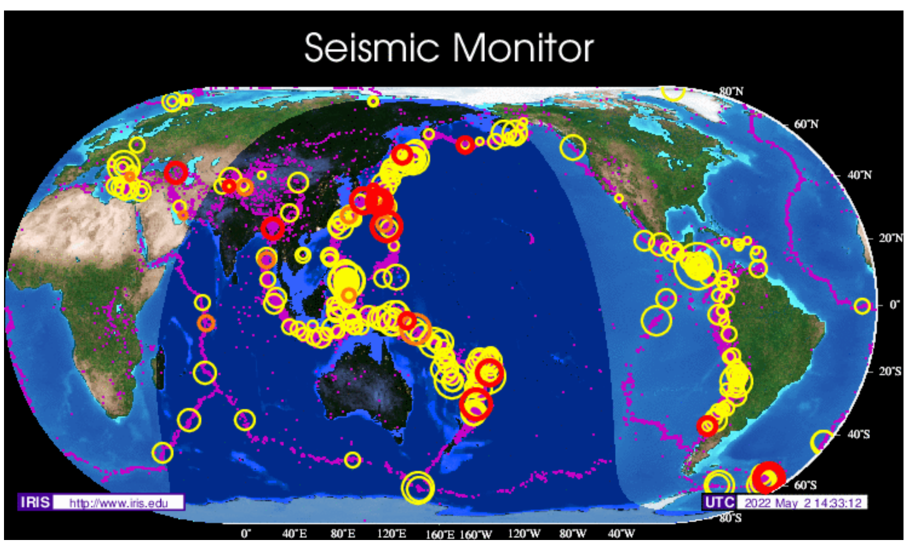
- Impact of groundwater extraction on hydrological process over the Beijing-Tianjin-Hebei region, China; behind a pay wall, summary from Phys.org here.

- Hydrogeology of fractured rock aquifers: From Fluid Flow to Coupled Processes in Fractured Rock: Recent Advances and New Frontiers; includes a plain language summary.

Climate Change

- What could go wrong? Chaos to control: Scientists use a 'butterfly attractor' to control and change the weather.
- Avoiding ocean mass extinction from climate warming; behind a pay wall, summary from Phys.org here.
- Build your storm shelters: A globally consistent local-scale assessment of future tropical cyclone risk; hat tip Phys.org.
- Modelling that shows which glaciers are vulnerable to climate change: Glacier geometry and flow speed determine how Arctic marine-terminating glaciers respond to lubricated beds; summary in Eureka Alerts here.
- Periodic climate change: Abrupt climate changes and the astronomical theory: are they related?
- Interaction between rainforests and the atmosphere: Tight Coupling of Surface and In-Plant Biochemistry and Convection Governs Key Fine Particulate Components over the Amazon Rainforest.

Volcanoes, Earthquakes and Geohazards



Daily Seismic Monitor

- Record-Breaking Earthquake Swarm Hits Antarctica as Sleeping Volcano Awakens.
- Plate boundary earthquakes: A strength inversion origin for non-volcanic tremor.
- Worldwide Volcano News and Updates.

Energy and Mining

- The future is in lithium: Europe's Green Deal requires massive amounts of battery metals – study; the study is here.
- Is wind power really the solution to our green energy needs? Related: U.S. Solar Industry Braces For Slump In New Capacity.
- Geophysics of coal bed methane: P-wave and S-wave response of coal rock containing gas-water with different saturation: an experimental perspective; it's behind a paywall, the Phys.org summary is here.
- Origin of a porphyry copper deposit: Petrogenesis and metallogenic implications of the Miocene granite porphyry in the Jiama Cu-polymetallic deposit, Gangdese belt, South Tibet; it's behind a paywall, the Phys.org summary is here.
- From the United States Energy Information Administration (USEIA): As of 2021, China imports more liquefied natural gas than any other country; related: Calcasieu Pass, the seventh U.S. liquefied natural gas export terminal, begins production.
- Also from the USEIA Three producing regions drove U.S. natural gas production in 2021.
- In a time of growing famine, burning corn in our cars is fundamentally wrong: Biofuel Blending Mandates Expected As Soon As Next Week.
- A Nigerian court orders oil companies to clean up their mess, it's a big one, so the oil companies bail out of Nigeria: TotalEnergies Looks To Divest Nigerian Asset, Joining Big Oil Exodus.
- Inquiry into a well-funded foreign campaign to defame the Alberta's energy industry: Public inquiry into anti-Alberta energy campaigns.

Pretty, Shiny Rocks

- The highest price ever achieved for a diamond on the open market: De Beers Blue Sells for $57.5 Million at Sotheby's.
- Current Russian Diamond Sanction Rules "Murky," JVC Says.

Geologists in the News

- Jim Fitton: Nearly 100,000 back campaign to free British geologist facing death penalty in Iraq.
- Taking risks for science: NZ professor snorkels over Tonga volcano.

May 2, 2022

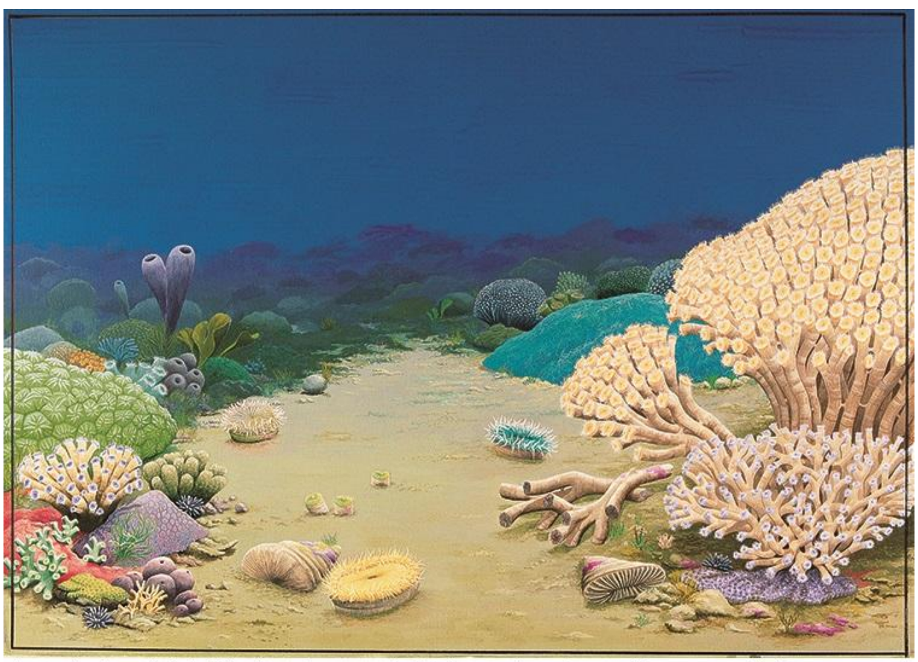
Marine life in the Triassic Period

Just as life on land took a big hit during the End Permian Mass Extinction, so did life in the seas and oceans. During the Triassic Period, the surviving life re-populated the seas and diversified into new, interesting forms. Among the form of life found in the Triassic seas and oceans were:

- The ancestors of modern Scleractinian corals;
- Molluscs such as ammonites;
- Sharks such as *Pseudodalatias*;
- Ray-finned fishes including *Australosomus*, *Birgeria*, *Parasemionotus*, and *Saurichthys*;
- Marine reptiles such as: nothosaurs, placodonts, plesiosaurs, thalattosaurs, and ichthyosaurs.

Let's look at some of these.

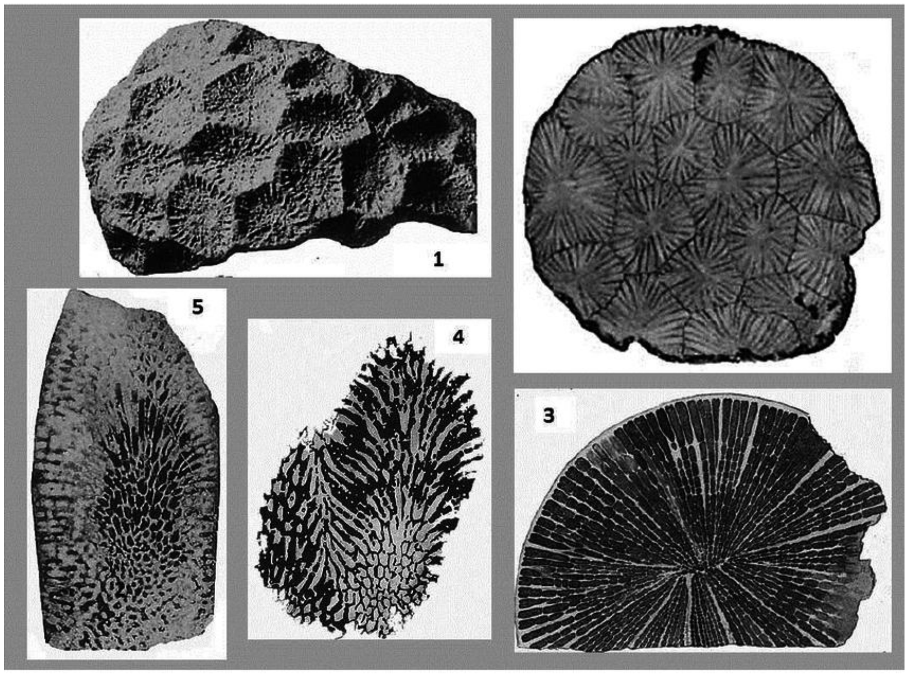
Scleractinian Corals



Reconstruction of a Late Triassic coral community. The taxa portrayed may not have occurred in the same geographic region at the same time. The dominant growth forms of the corals are massive and phacelloid. There were no intricately branching corals such are found today and most corals had large corallites.
Painting: Geoff Kelly

Figure 1 - Reconstruction of a Late Triassic Coral Community
Credit: Geoff Kelly, Corals of the World

Cnidarians (jellyfish, corals and sea anemones) have twice in the history of the Earth evolved hard parts. During the Paleozoic, tabulate and rugose corals evolved, flourished and were wiped out during the End Permian Mass Extinction. Reefs composed of other metazoans have been found in rocks from the Early Triassic, bur hard corals seem to have been absent in that time. However, beginning in the Middle Triassic and continuing into the Late Triassic, the ancestors of modern Scleractinian corals evolved.



Late Triassic corals and Lovcenipora from Timor and Seram. 1. Isastraea verbeeki and 2. Isastraea guembeli from Timor (Vinassa 1915); 3. Montlivaltia molukkana from Seram (Wanner, 1907), 4. Lovcenipora vinassai from East Seram (described as coral Pachypora intabulata by Wanner, 1907); 5. Lovcenipora vinassai from Timor (Vinassa 1915).

Figure 2 - Late Triassic corals and Lovcenipora from Timor and Seram
Credit: Han Van Gorsel, Jan. 2014

One of the features of modern Scleractinian corals is that they form a holobiont, that is, a creature that lives through the symbiosis of two separate species. In the case of Scleractinian corals, this relationship is between the coral and a species of dinoflagellate algae. The coral polyps provide a congenial environment for the algae to live and, in return. the algae provide glucose sugar for the coral polyp and aid it in secreting a calcium carbonate skeleton. This symbiotic relationship between corals and algae appears to have evolved during the Late Triassic and led to the great success of the corals.

Another interesting feature of Scleractinian corals is that calcium carbonate skeletons are made up of aragonite. If you recall from my discussion on carbonate minerals last May, aragonite is a metastable crystal form of calcium carbonate with calcite being the stable form. So, while a coral skeleton may have originally been aragonite, over time it will revert to calcite and most coral fossils are made up of calcite.

While all modern corals are descended from Scleractinians that evolved during the Triassic, most of the species of these corals died out during the End Triassic Mass Extinction with only a few lines surviving into later times.

Molluscs - Ammonites

Of all the various orders of ammonites that thrived during the Paleozoic, only the Ceratitida and Phylloceratina survived the End Permian Mass Extinction Event and almost all the ammonites found in the Triassic are Ceratitida. There are currently 18 recognized superfamilies of Ceratitida.

Ceratites

Figure 3 - Replica *Ceratites* fossil from the Middle Triassic
Credit: Fernando Losada Rodríguez, Creative Commons Attribution-Share Alike 4.0 International license

Ceratites ("Horn Stone") is known from fossils found in Middle Triassic marine habitats in Europe, Asia, and North America. An example of these habitats is the Upper Muschelkalk formations in the Germanic Basin. The Germanic Basin was a partially isolated shallow sea that extended across much of Europe from eastern France north of the future Alps and into Poland. The genus *Ceratites* was first described by Wilhem de Haan in 1825 and there are 11 species in the genus.

A distinguishing feature of *Ceratites* is the suture pattern on its shell with smooth lobes and frilly saddles. One speculation, is that the evolution of the frilly pattern would increase the strength of the shell and allow *Ceratites* to dive deeper in search of food.

Cladiscites

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Figure 4 - *Cladiscites*
Credit: Hectonichus, Creative Commons Attribution-Share Alike 3.0 Unported license

Cladiscites was a genera of ammonites that lived during the Triassic. Fossils of species within this genera have been found in the Triassic of Afghanistan, Hungary, Italy, Oman, Tajikistan, United States and the East Indies. This is another genera that was named by Wilhem de Haan in 1825.

Fishes - Sharks

Sharks are really interesting and there is one website devoted entirely to Triassic Sharks. *Pseudodalatias* is an example of a shark from the Triassic.

Figure 5 - *Pseudodalatias barnstonensis*
Credit: Creative Commons Attribution-Share Alike 4.0 International license

Pseudodalatias was a genus of squaliform shark that lived during the Triassic. Fossils of *Pseudodalatias* have been found in England, Italy and Spain . There are two identified species in the genus: *P. barnstonensis* and *P. henarejensis*. *Pseudodalatias* was first named by J. H. Sykes in 1971.

Fishes - Ray Finned

Ray finned fishes flourished and diversified during the Triassic although the details of the Early Triassic evolution are obscured by lack of fossils. Here are a few examples.

Australosomus

Figure 6 - *Australosomus*
Credit: Emőke Dénes, Credit: Creative Commons Attribution-Share Alike 4.0 International license

Fossils of *Australosomus* were found in Early Triassic formations in rocks from Africa, British Columbia, Greenland and Madagascar. The genera contains seven species and was described by Ferdinand Priem in 1924.

Birgeria

A fish from the Early Triassic with a worldwide distribution, *Birgeria* fossils have been found in Canada, China, Germany, Greenland, Italy, Slovenia, Madagascar, Russia, Spitsbergen, Switzerland, and the United States. The oldest fossils are from Griesbachian aged beds of the Wordie Creek Formation of East Greenland.

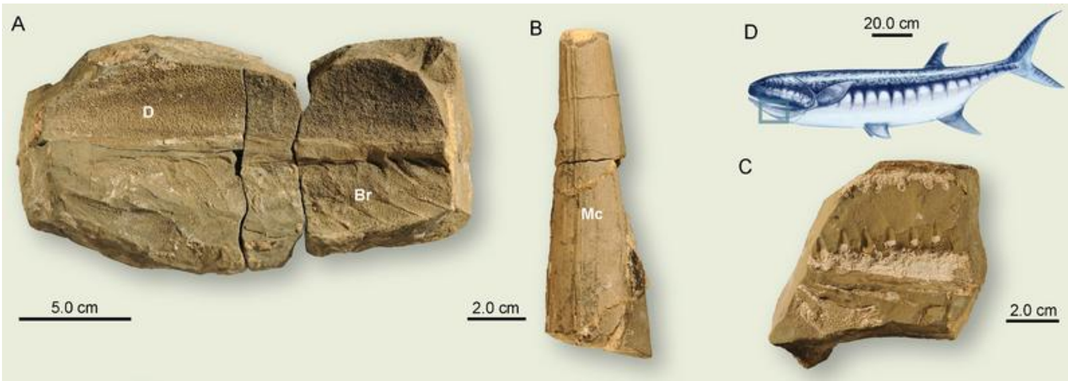


Figure 7 - *Birgeria*
Credit: Scheyer et al, 2014, Creative Commons, Attribution 2.5 Generic license

Birgeria was a carnivorous fish, and was probably an apex predator. It grew over 1 metre in length. Some of the largest species are the Early Triassic *Birgeria aldingeri* from Spitsbergen and *Birgeria americana* from Nevada.

There are 10 species in the *Birgeria*. The first species in *Birgeria* was first described by Louis Agassiz in 1844, although he initially named it *Saurichthys mougeoti*.

Parasemionotus

Another genera originally described by Ferdinand Priem in 1924, *Parasemionotus* was worldwide in distribution, fossils of Parasemionotus are found in Australia, Canada, China, Greenland, India, Madagascar, and United States.

Figure 8 - *Parasemionotus*
Credit: Ghedoghedo, Creative Commons Attribution-Share Alike 3.0 Unported license

Saurichthys

Figure 9 - *Saurichthys curionii*
Credit: Ghedoghedo, Creative Commons Attribution-Share Alike 4.0 International license

Resembling a modern barracuda, *Saurichthys* was another predatory fish from the Triassic. *Saurichthys* is related to Permian *Eosaurichthys* and also *Saurorhynchus* of the Jurassic.

Fossils of *Saurichthys* have been found on all continents except South America and Antarctica. Like *Birgeria,* the oldest fossils of are *Saurichthys* from the Wordie Creek Formation of East Greenland.

There are some 50 species in the genera *Saurichthys;* the type species *Saurichthys apicalis* was first described by Louis Agassiz in 1834.

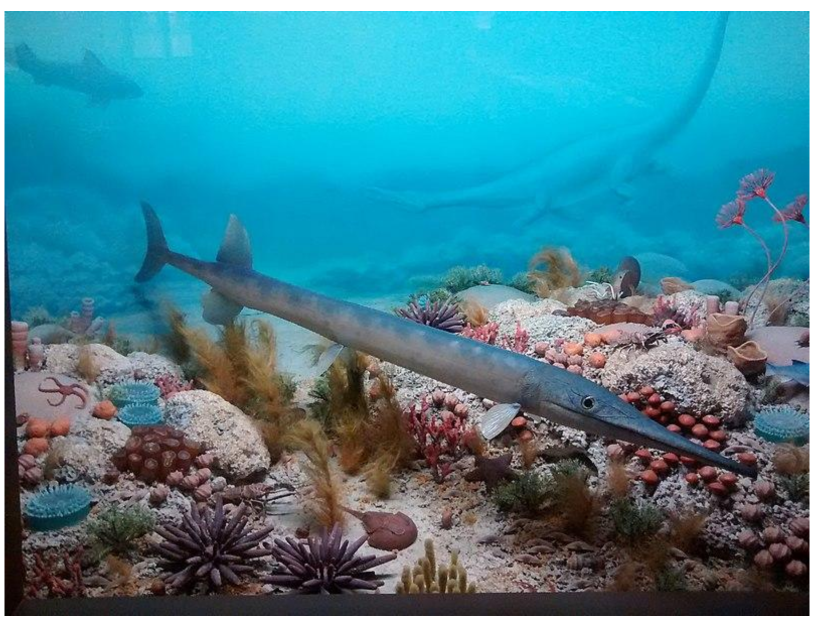


Figure 10 - Saurichthys from the Museum Mensch & Natur, München
Credit: Bildflut, Creative Commons CC0 1.0 Universal Public Domain Dedication

Marine Reptiles

Nothosaurs - Nothosaurus

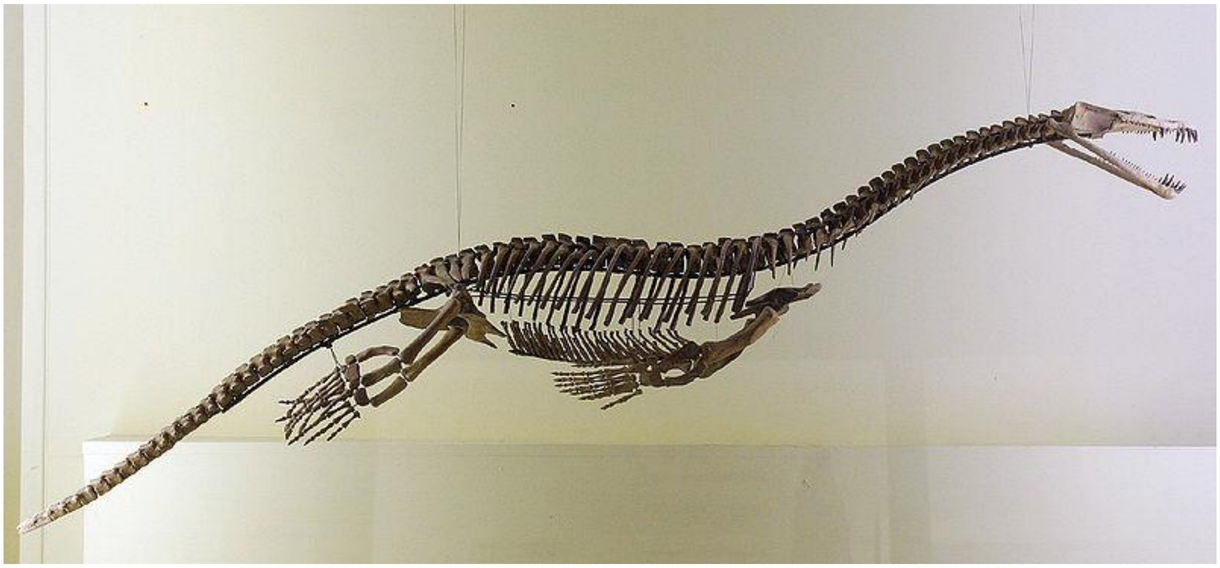


Figure 11 - *Nothosaurus*, Museum für Naturkunde, Berlin
Credit: Elke Wetzig, Creative Commons Attribution-Share Alike 3.0 Unported license

Nothosaurus ("false lizard") was a sauropterygian reptile that lived from the Middle to the Late Triassic between approximately 210 to 240 Mya. Fossils of *Nothosaurus* have been found in the Muschelkalk and Lower Keuper Formations of France, Germany, the Netherlands and Spain. *Nothosaurus* fossils have also been found in China, Israel, and North Africa. As well as fossil skeletons, Chinese geologists found trackway attributed to *Nothosaurus* in Yunnan.

Nothosaurus appears to have lived a semi-aquatic lifestyle, similar to modern seals. The fossils of *Nothosaurus* varied in size from 4 to 7 metres in length and they also appear to have had webbed feet and a fin on its tail. *Nothosaurus* has the teeth of a predator and probably ate fish and other marine animals, including other marine reptiles.

There are about a dozen species in the genus *Nothosaurus*. The type species, *Nothosaurus mirabilis*, was identified by Georg zu Münster in 1834 (not to be confused with Herman Munster).

Placodonts - Placodus

Placodus ("flat tooth") is the type genera of the Placodont order. Fossils of Placodus have been found in France, Germany, Poland and China.

About 2 metres long, *Placodus* had a short stocky body with a long tail and short neck attached to a heavy skull. Its teeth (chisel like incisors, broad and flattened in the back) suggest that

Placodus ate hard shelled creatures such as pelecypods and brachiopods.

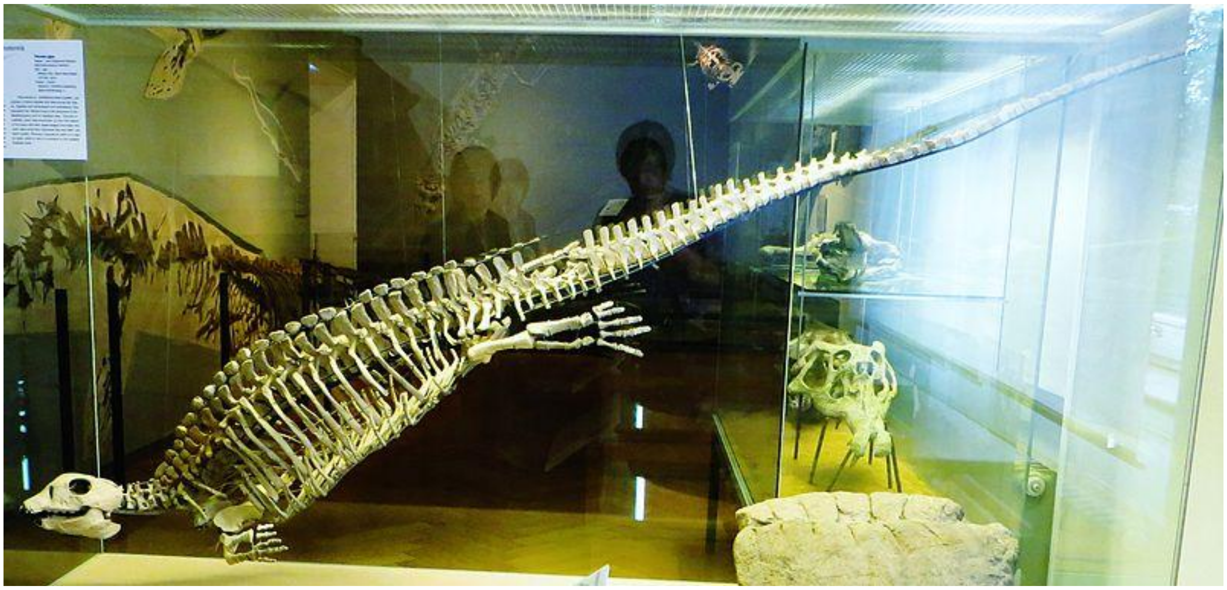


Figure 12 - *Placodus*, Museum of Paleontology, Tuebingen
Credit: Ghedoghedo, Creative Commons Attribution-Share Alike 3.0 Unported license

There are two identified species of *Placodus*: *P. gigas*, found mostly in Europe and *P. inexpectatus,* found mostly in China. The genius was first described by Louis Agassiz in 1833.

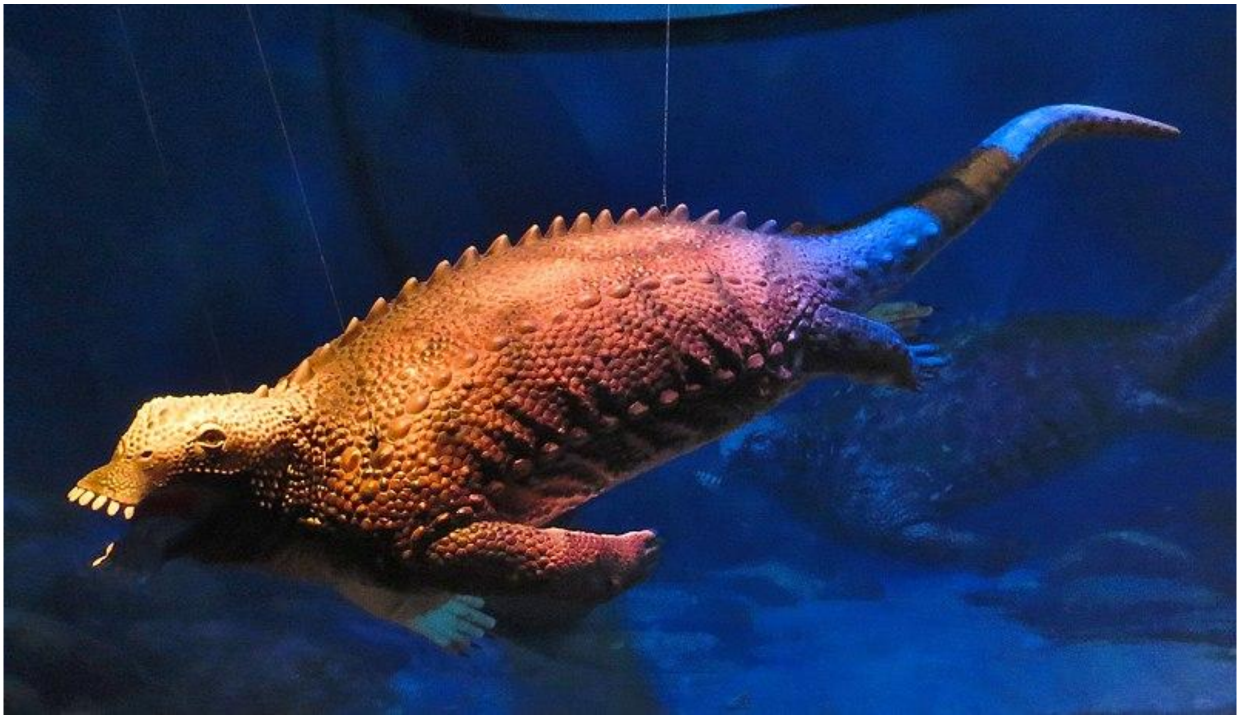
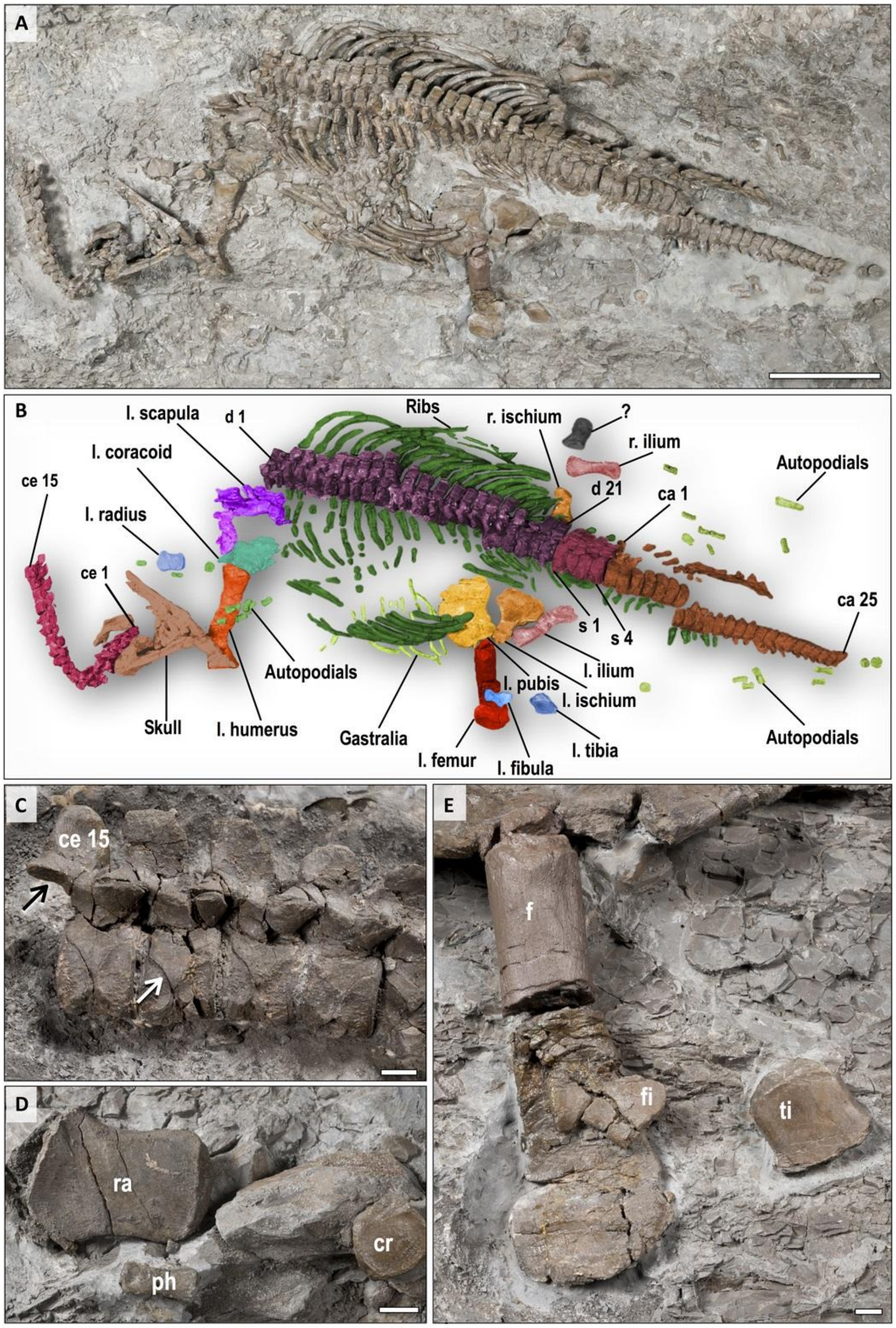


Figure 13 - *Placodus gigas,* Reconstruction
Credit: Ghedo, Creative Commons Attribution-Share Alike 4.0 International license

Plesiosaurs - Rhaeticosaurus



The holotype of Rhaeticosaurus mertensi gen. et sp. nov.
(A) Photograph. (B) Color overlay. (C) Cervical vertebrae 10 to 15 in right lateral view showing medially inclined zygapophyses (black arrow) and the autapomorphic ventrally concave V-shaped neurocentral sutures (white arrow). (D) Left radius, a phalanx, and a carpal element. (E) Left femur, tibia, and fibula. The proximal femur is a cast because the original was sectioned for histology. ca, caudal vertebra; ce, cervical vertebra; cr, carpal bone; d, dorsal vertebra; f, femur; fi, fibula; l., left; ph, phalange; r., right; ra, radius; s, sacral vertebra; ti, tibia; ?, unidentified bone. Scale bars, 20 cm (A) and 1 cm (C to E).

Figure 14 - *Rhaeticosaurus mertensi*
Credit: [Tanja Wintrich], [Figure 2 of Wintrich *et al*, 2017]

Plesiosaurs are mostly known from the Jurassic and Cretaceous Periods. However, in 2017, the paleontologist Tanja Wintrich and her team named the earliest known plesiosaur, *Rhaeticosaurus mertensi*. A private collector, Michael Mertens, found the original specimen in a clay pit within the Exter Formation near Bonenburg, Germany. The species is named after the Rhaetian age of the Triassic Period, the last age of that period.

Figure 15 - Tanja Wintrich (left) and Michael Mertens (right)
Credit: Professor Martin Sander (University of Bonn)

Rhaeticosaurus mertensi was of a small-bodied plesiosaur, about 237 cm long. The skeleton showed that *Rhaeticosaurus* had a stiff neck attached to a short trunk with a short tail and four broad flippers. These flippers could act as hydrofoils, essentially allowing it to "fly underwater" much like modern day penguins. *Rhaeticosaurus* also appears to have been a creature of the open ocean.

Thalattosaurs - Endennasaurus

Figure 16 - *Endennasaurus*
Credit: Tommy from Arad, Creative Commons Attribution 2.0 Generic license

Found in the Endenna cave within the upper strata of the Calcari di Zorzino Formation near the Village of Endenna in northern Italy, *Endennasaurus* was a thalattosaurian marine reptile. The name means "Reptile from Endenna".

There are only two specimens so *Endennasaurus,* both found in the Bergamo Museum of Natural Sciences. The skeleton suggests that it was adapted to preying on small animals that did not have a strong shell or exoskelton like some crustaceans and small vertebrates.

There is only one species in the genus, *Endennasaurus acutirostris*, first described by Silvio Renesto in 1984.

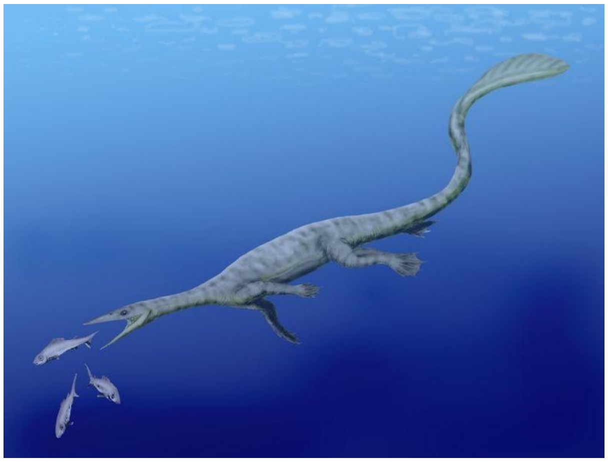


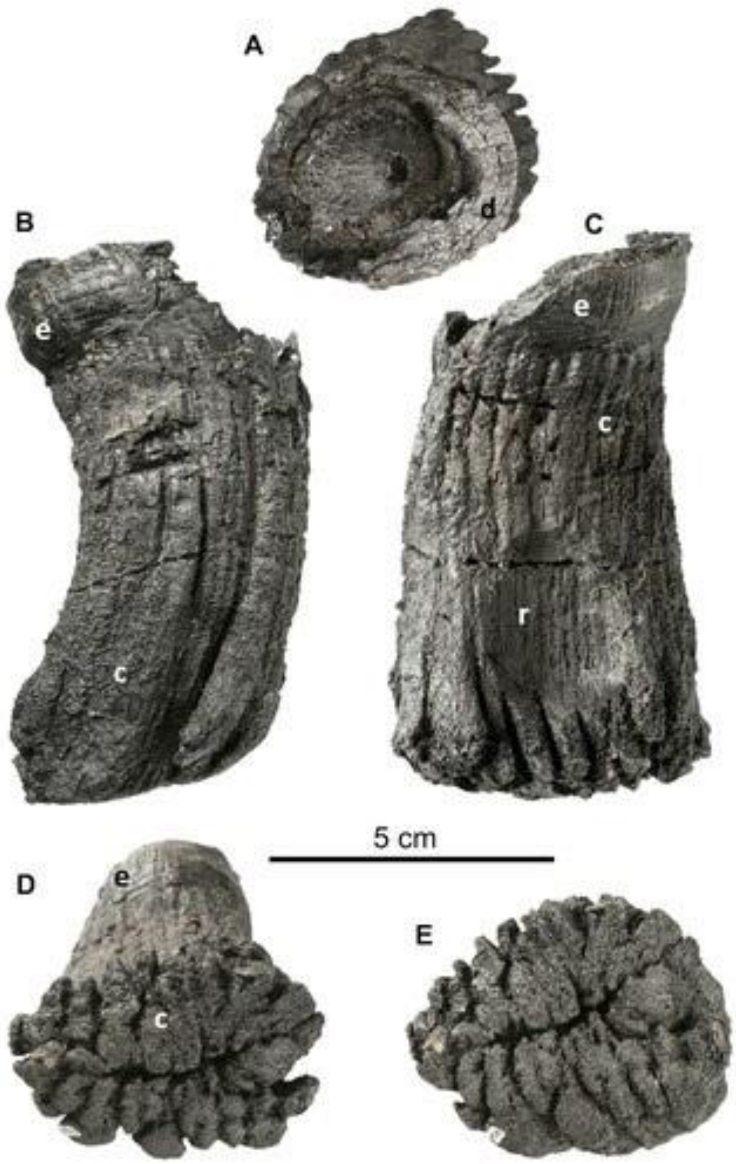
Figure 17 - *Endennasaurus*
Credit: Nobu Tamura, Creative Commons Attribution-Share Alike 3.0 Unported license

New find of Huge Ichthyosaurs

Recent research by P. Martin Sander, Pablo Romero Pérez de Villar, Heinz Furrer and Tanja Wintrich (noted in the News and notes**,** above) found some huge examples of ichthyosaurs from the Late Triassic Kössen Formation in the eastern Swiss Alps. These specimens appear to be related to two ichthyosaurs from North America, *Shonisaurus popularis* and *Shastasaurus sikkanniensis*.

One implication of the fossil finds is that ichthyosaurs related to *Shonisaurus* and *Shastasaurus* lived in the ancient Tethys Sea where the Kössen Formation was deposited. The fossil teeth appear to be the largest teeth for ichthyosaurs and possible represent an upper limit for the size of ichthyosaur teeth. The researchers suggest that there was a diversity of giant tooth-bearing ichthyosaurs in the Late Triassic and that the finds reinforce the idea that Late Triassic ichthyosaurs were distinctly larger than the later Jurassic forms.

Let's look at some of the fossils they found.



Ichthyosauria indet., tooth lacking most of the crown, PIMUZ A/III 670, Rhaetian Schesaplana Member, Kössen Formation, Crachenhorn Mountain, Davos-Monstein, Grisons, Switzerland. A, apical view; B, mesial or distal view; C, lingual view; D, oblique basal; E, basal view. Abbreviations: c, cementum; d, dentin; e, enamel; r, resorption pit.

Figure 18 - Ichthyosaur Teeth From the Kössen Formation
Credit: P. Martin Sander, Figure 2 of Sander *et al, 2022*

An accumulation of ichthyosaurian bones and teeth of moderate size, late Norian-early Rhaetian Alplihorn Member, Kössen Formation, Schesaplana Mountain, Grisons, Switzerland. B, PIMUZ A/III 751, late Norian to early Rhaetian Alplihorn Member, Kössen Formation. Fil da Stidier, Grisons, Switzerland. The specimen may represent a sacral rib or unusually large dorsal ribs or an element of the shoulder girdle.

Figure 19 - Ichthyosaurian bones and teeth from the Kössen Formation
Credit: P. Martin Sander, Figure 2 of Sander *et al, 2022*

Winding it Up

There is a lot more that I could say about marine animals of the Triassic, but I try not to test the patience of the few readers that follow this blog.

If you like YouTube, check out these videos:

- By Paleo Analysis: Why Were Triassic Animals so Weird? and Top 5 Weirdest Triassic Animals!
- By PBS Eons: Why Triassic Animals Were Just the Weirdest.
- By Moth Light Media: Why do Animals Look so Strange After Mass Extinctions.

Standard Caveat

The purpose of my weblog postings is to spark people's curiosity in geology. Don't entirely believe me until you've done your own research and checked the evidence. If I have sparked your curiosity in the subject of this posting, follow up with some of the links provided here. If you want to, go out into the field and examine some rocks on your own with the help of a good field guide. Follow the evidence and make up your own mind.

In science, the only authority is the evidence.