

CLASSROOM ON THE REEF

Unit 3: Marine systems - connections and change
Topic 1: The reef and beyond
Part 2: Coral biogeography



CORAL BIOGEOGRAPHY



Objective

Learn where coral reefs are distributed globally and why, by focusing on the factors that are important for coral growth and survival. Learn about coral history including when they appeared in the geologic record, and where and how they've changed over geologic time.

Background

The distribution of coral reefs is largely determined by a combination of abiotic factors. These factors include the geology and geography of the region, ocean temperature, ocean chemistry, surface currents, and more. Typically coral reefs can be found between the Tropics of Cancer and Capricorn across the Pacific, Indian and Atlantic Oceans, the Caribbean and Red Seas and the Gulf of Persia. Since we've learned how important sunlight and photosynthesis are for corals, we typically find coral reefs in clear oligotrophic (meaning nutrient poor) waters that are shallow and can receive plenty of sunlight. Due to light attenuation (meaning declining light) with increasing depth in the ocean, corals typically only grow in waters less than 45m deep. Since the waters are nutrient poor, corals usually grow in areas of high wave energy where water movement brings in food, nutrients and oxygen to the reef.

While modern day coral reefs have existed for ~485 million years, several other types of reefs have existed throughout the geological record, dating as far back as 3400 million years ago. The earliest reefs were comprised of different benthic, invertebrate animals that have many similarities to modern day reef builders: These include rugose reefs, stromatolite reefs, and Archeocyathid (sponge) reefs, and we will learn more about the organisms that formed these reefs. In this section we'll spend time learning about which abiotic factors are critical for coral survival, how these factors restrict where we find coral reefs globally, and how reefs have changed over geologic time. **Let's dive in!**

Notable words

Oligotrophic, salinity, species richness, species diversity, rugose reefs, stromatolite reefs, Archeocyathid reefs





Ancient Devonian Reefs



Images of Darngku (Geike Gorge) which is a part of Danggu George National Park in Western Australia - part of an ancient barrier reef system from the Devonian Period



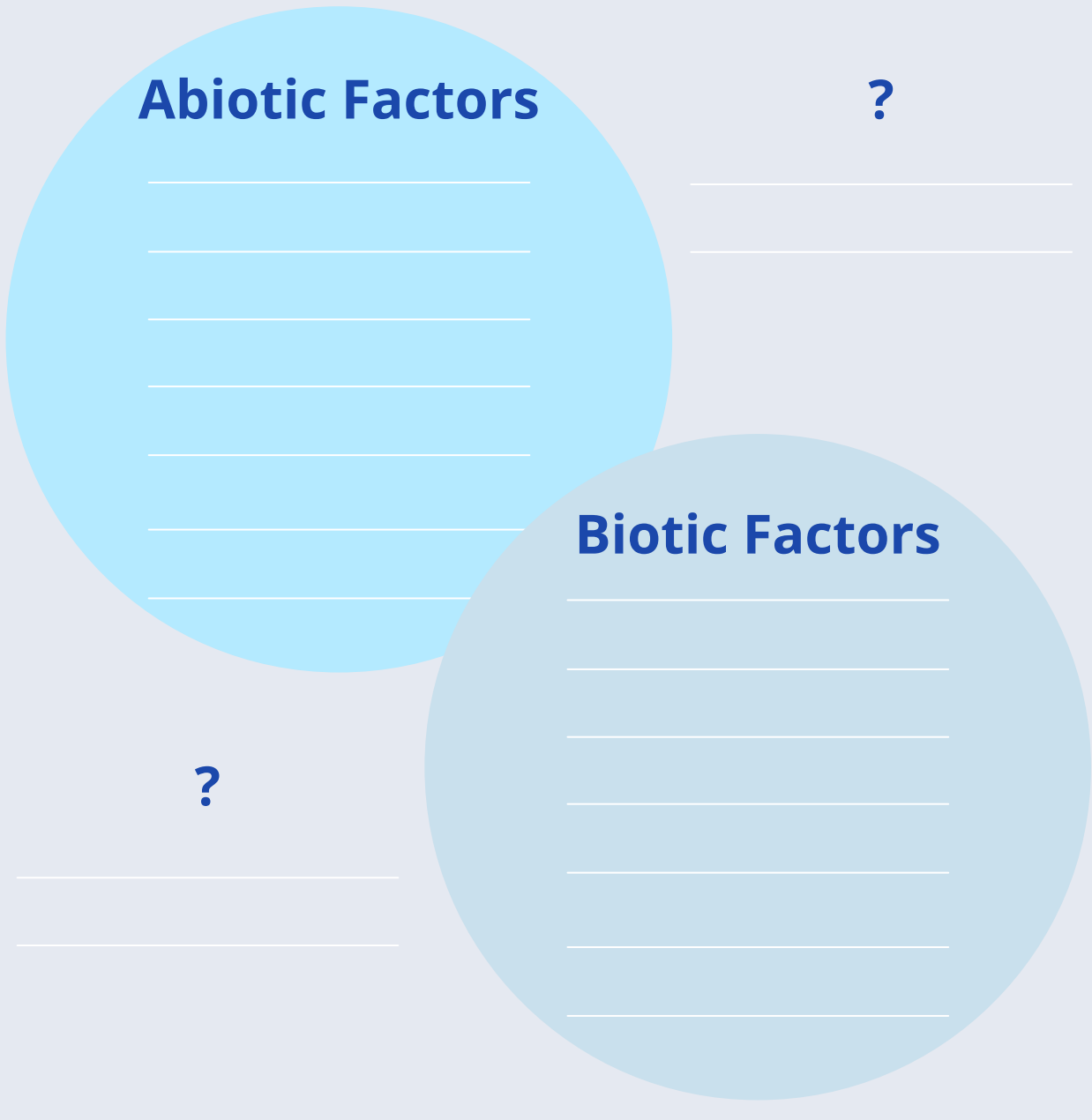


Your Task - Complete questions 1 - 10 + extension question (time permitting)

What do corals need to thrive?

1. As a class, watch **Abiotic and Biotic Factors** (02:40 duration)
(https://youtu.be/E1pp_7-yTN4)

Next – think about some factors you might observe on a coral reef and decide whether they are abiotic or biotic by classifying them using the diagram below. Share your ideas with your class in a discussion about some of the abiotic or biotic factors you expect to encounter on the reef:





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2. As a class, watch – Distribution of Coral Reefs (06:55 duration)

(<https://youtu.be/oCKx1MNqnu4>)

According to the video, which four ABIOTIC factors are most important for supporting stony coral growth? List these factors in the table below and define the ranges or limits that corals require of these factors where you can. Feel free to use words like “high” or “low” where numerical values cannot be determined. (Bonus points for extra factors and/or for including the correct units!)

	Abiotic Factor	General Preference	Optimal Value or Range
1		High / Low	
2		High / Low	
3		High / Low	
4		High / Low	
5		High / Low	
6		High / Low	

Extension – using the web, investigate whether corals are can be found living successfully outside of the optimal ranges of abiotic factors listed above. Demonstrate a species/genus and describe the habitat they live in and how it differs from a typical coral reef climate. (3 sentences) Hint: Explore ‘deep sea corals’ on the web!





Where do coral reefs exist?

Individually, read Patterns of Distribution on pages 84-85 in: Coral Reefs and Climate Change (Second Edition) text book and answer questions 3 and 4 below:

3. Based on your reading and using the two maps below (Figs. 1 & 2 below), describe where coral reefs are concentrated globally? Distinguish which region is considered the centre of biodiversity for coral reefs by explaining why species diversity (species richness and abundance) is highest in this region? (3-5 sentences)

4. Along the Great Barrier Reef species richness (the number of species) begins to decline as you move from North to South. Explain what abiotic factors contribute towards this pattern using examples. (3-5 sentences)





Fig. 1. Map of the coral triangle showing two different boundaries most commonly used to identify its extent. Source: WWF https://wwf.panda.org/discover/knowledge_hub/where_we_work/coraltriangle/coraltrianglefacts/



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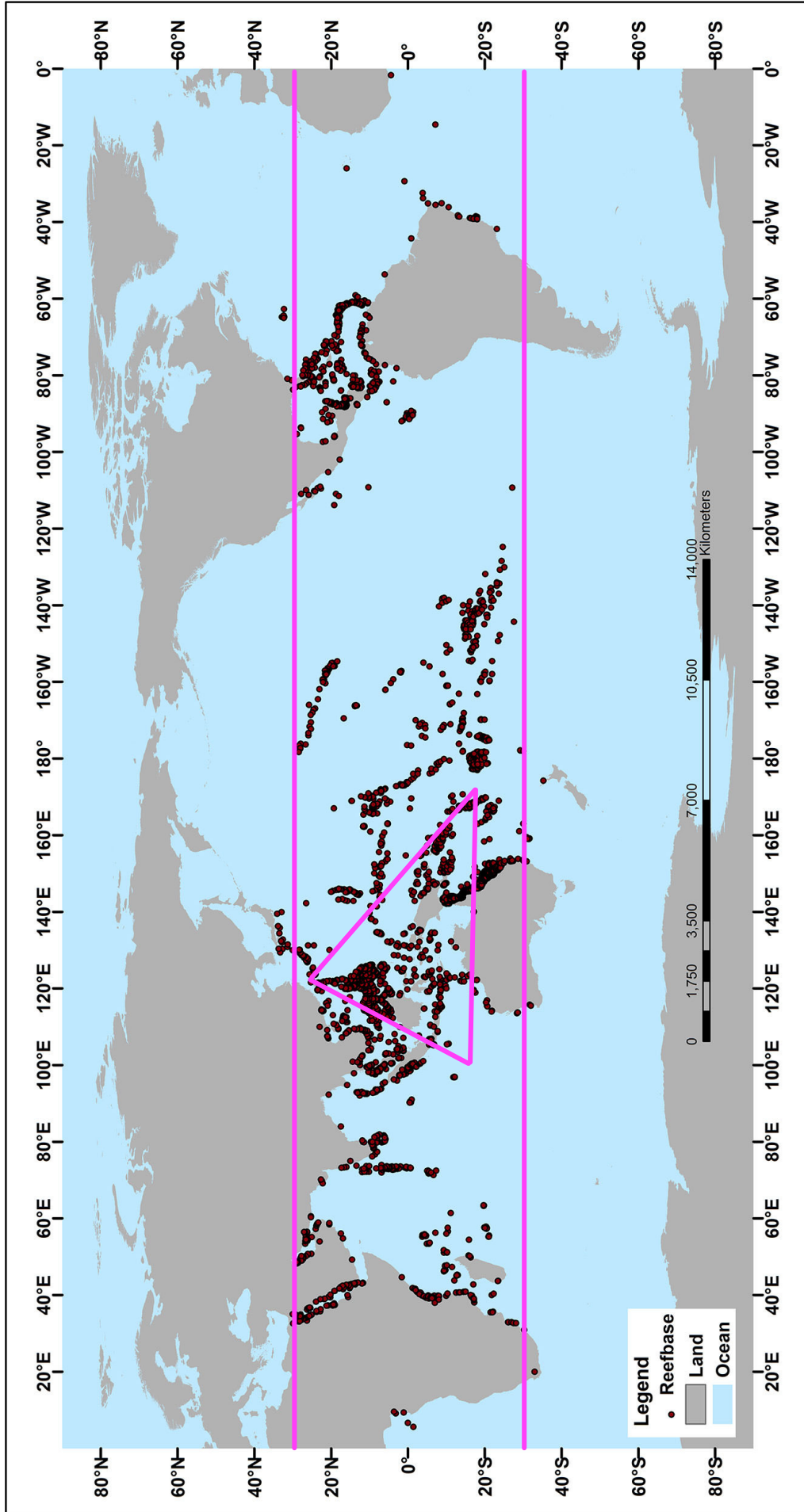


Fig. 2. Global distribution of coral reefs including approximate location of Coral Triangle – the epicentre of coral diversity. Source: NOAA <http://oceanservice.noaa.gov/facts/coralwaters.html>





When did coral reefs evolve?

5. As a class, watch – The history of coral reef building (07:50 duration)
(<https://youtu.be/4S2mUFGb2VI>)

Next : Individually, read about Palaeozoic reefs and Mesozoic and Coenozoic reef fossils at: <http://www.coralsoftheworld.org/page/reefs/> and go through the timelines showing the history of reef development (Figs. 3 & 4 below). Aside from coral reefs, what other types of reefs have existed in the geologic past? List these below including how long ago they existed and what region we've discovered them in today (1 sentence, each):

1.

2.

3.

4.

Extension – Explain how stromatolite reefs formed: (2-3 sentences)

6. List the 4 most recent living coral groups that modern day stony corals have evolved from:

1.

2.

3.

4.





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Extension – Interpret the information in the two timelines showing the history of reef development below (Figs. 3 & 4), by answering the following questions:

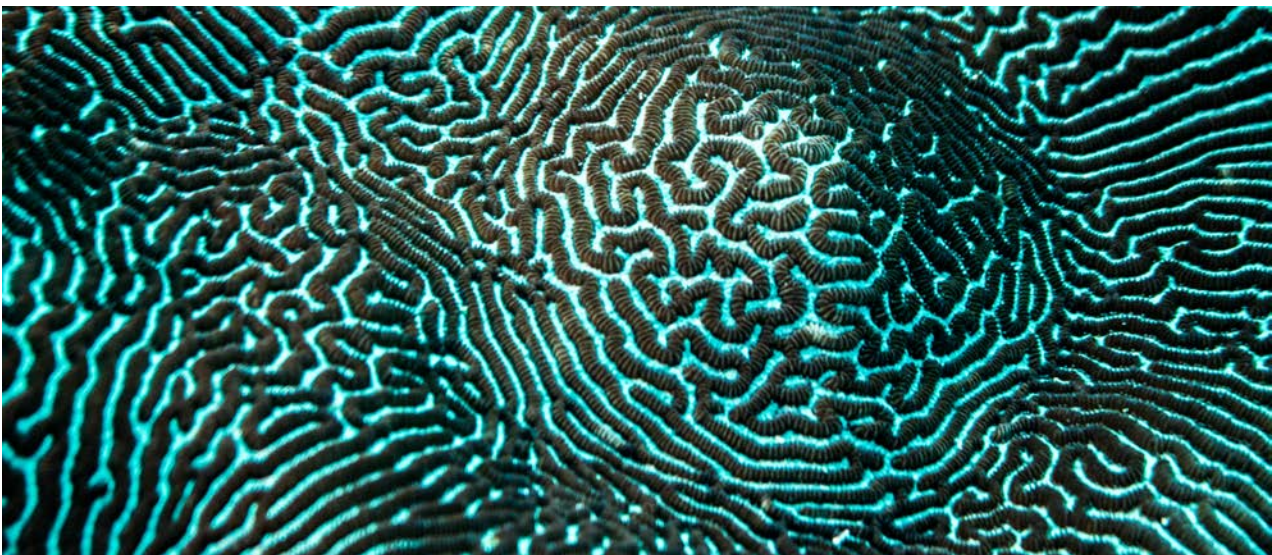
a. In both timelines, what do the numbers represent?

b. What Era are we currently living in?

c. What Epoch are we currently living in?

d. What Era and Period did Scleractinian corals FIRST emerge?

e. What type of reef was present throughout the Palaeozoic, Mesozoic, and Cenozoic Eras (and STILL exists today)?





Palaeozoic Reefs

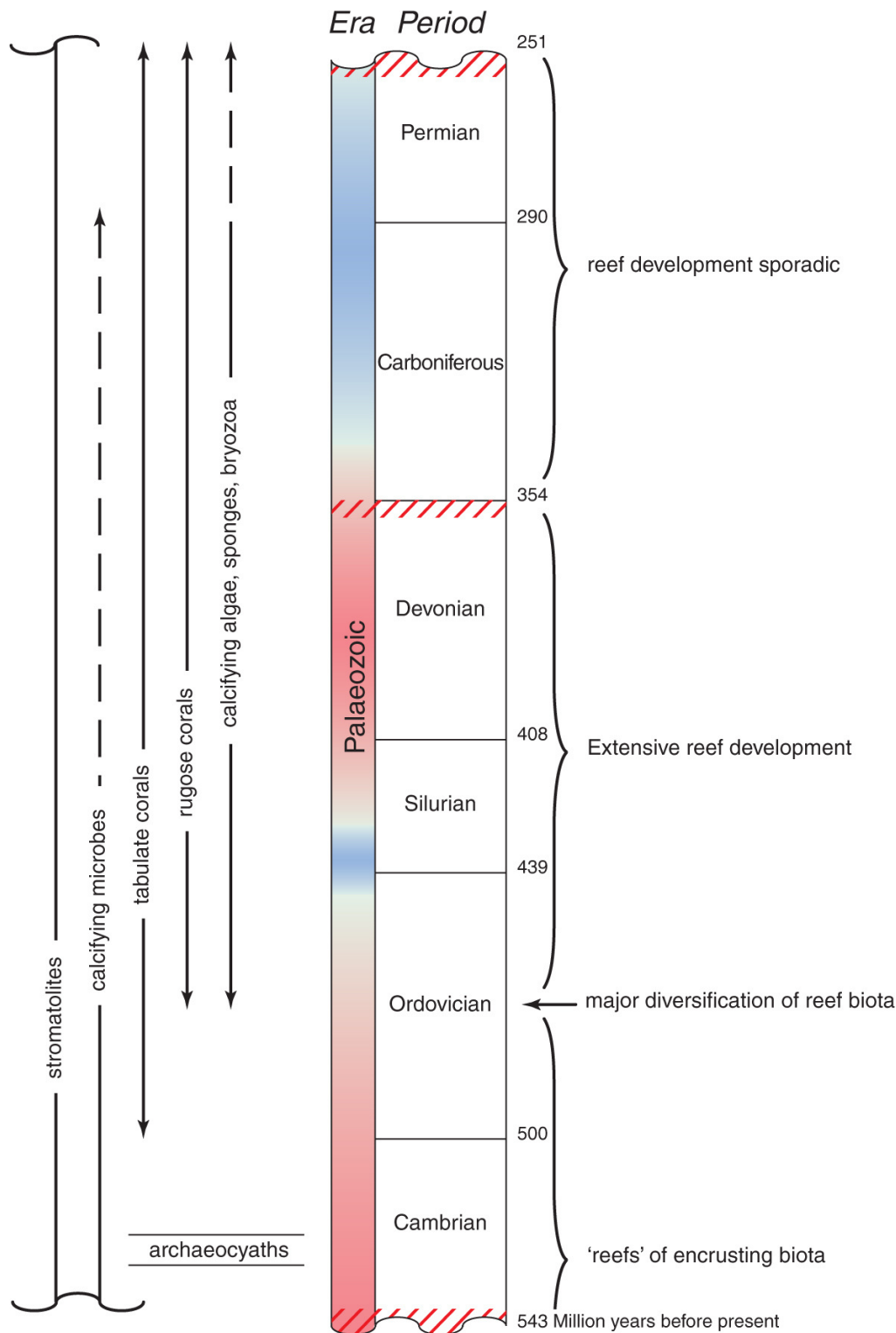


Fig. 3. The Palaeozoic Era. Summary of reef development before the evolution of the Scleractinia (modern day stony corals). Colours of the column indicate major cycles of global warming (red) and cooling (blue). Major mass extinctions are indicated by red cross-hatches. Source: Corals of the World <http://www.coralsoftheworld.org/page/reefs/>



Mesozoic and Coenozoic Fossil Reefs

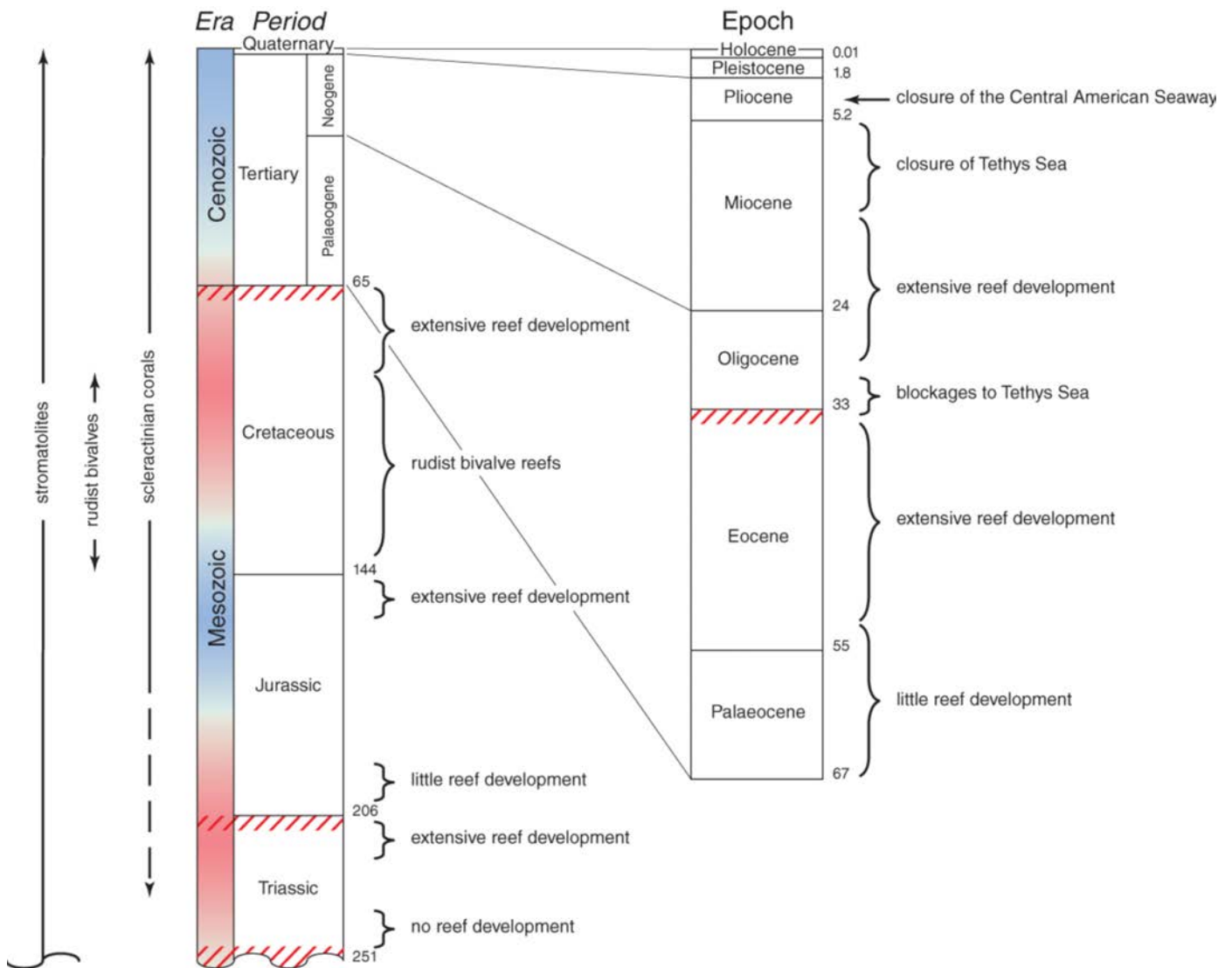


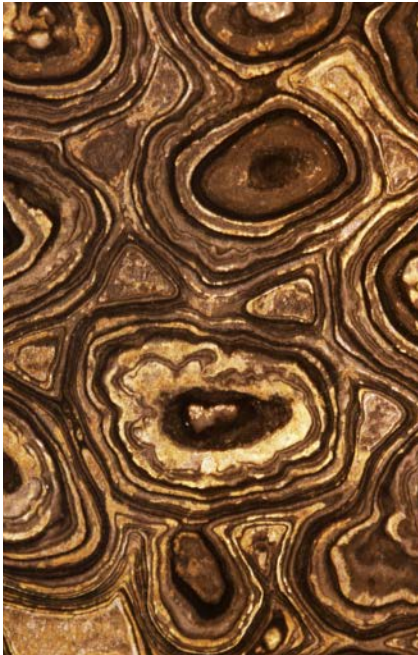
Fig. 4. Mesozoic and Coenozoic Eras. Summary of reef development during the evolution of the Scleractinia (modern day stony corals). Colours of the column indicate major cycles of global warming (red) and cooling (blue). Major mass extinction are indicated by red cross-hatches.

Source: Corals of the World <http://www.coralsoftheworld.org/page/reefs/>





Stromatolite Reefs



Cross section through stromatolite fossil



'Stromatolite' - Greek for 'layered rock'



Stromatolites of cyanobacteria in Shark Bay, Western Australia, one of only a few locations with remaining stromatolite reefs



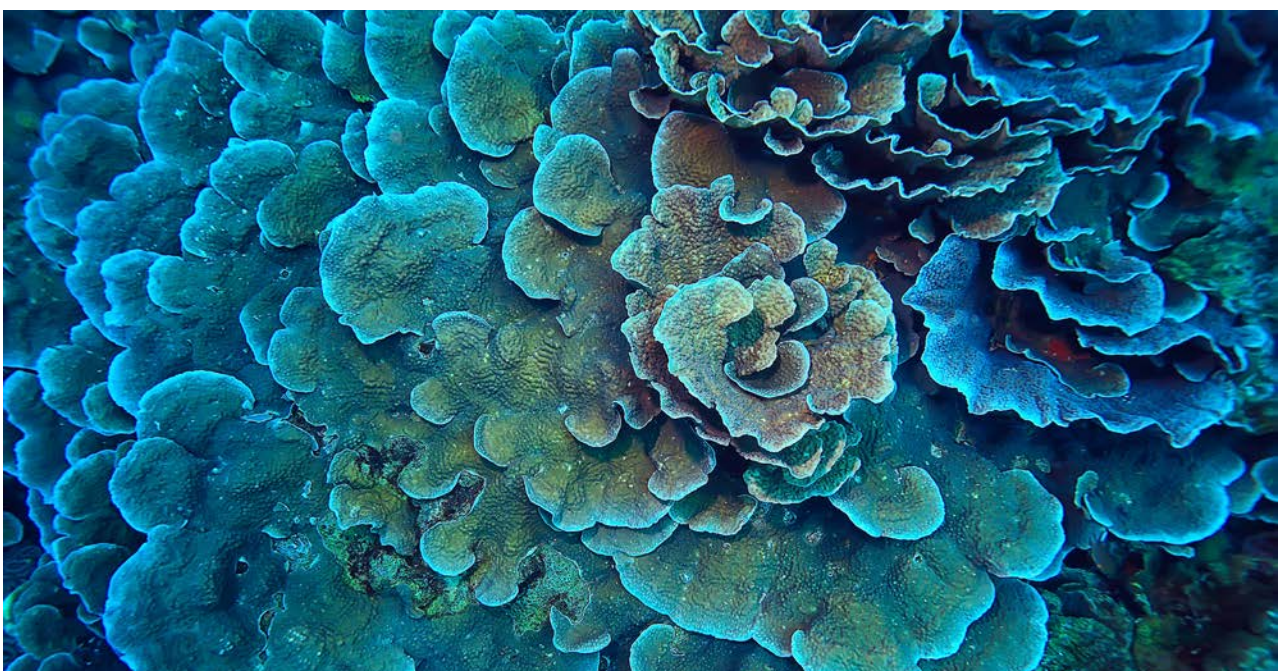


When did the GBR form?

7. As a class, watch – Geological history of the Great Barrier Reef (03:39 duration) (<https://youtu.be/BZ1BiT8sRyY>)

Describe how the position of the Great Barrier Reef has changed as sea level has moved up and down over geologic history. How old is the Great Barrier Reef estimated to be, and what factor is this based on? (3 sentences)

8. What does the recent discovery of ancient reef platforms found preserved at depth under the Great Barrier Reef today, tell us about sea level during the reef's history? (1 sentence)





Fossilised Coral



Section from a slab of fossil coral with corallites similar to modern corals



Devonian fossil coral



Fossil coral - radial imprint reminiscent of modern day Fungioid coral



Lublinophyllum thailandicum - fossil coral





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Studying coral reefs of the past

9. Individually, read Tracking Change on pages 168-170 in: Coral Reefs and Climate Change (Second Edition) text book.

Next, as a class, watch – Tracking Change – Climate Change (07:16 duration) (<https://youtu.be/59Dz-GCw4uc>)

What can coral cores tell us about coral reef communities in the past? (2-3 sentences)

10. Briefly describe how ice cores can tell us about past climates. How are the rings of a tree similar to that of the deposits of coral skeleton? What information can we learn by examining coral cores under X-ray and UV light? (3-4 sentences)

Extension – Historically, glacial periods alternate with warmer periods. Describe why the time period for these shifts matters in terms of an ecosystem’s ability to acclimate and/or adapt to new climate conditions (e.g. acclimating to warmer or cooler temperatures). (3-4 sentences)
