CORALS - MODE OF LIFE

HOW DO MODERN CORALS LIVE?

Much of the evidence on how paleo-organisms lived is gained from analysis of similar organisms living today, corals pose no exception.

Some corals today have algae living within them, a dinoflagellate called **Zooxanthellae**.

- **Dinoflagellate** = a single-celled organism with two flagella, occurring in large numbers in marine plankton and also found in fresh water. Some produce toxins that can accumulate in shellfish, resulting in poisoning when eaten.
- **Zooxanthellae** = a type of algae (dinoflagellate) present inside modern-day corals.

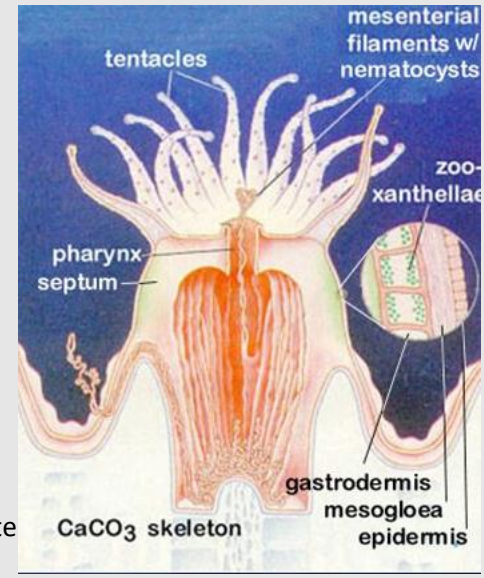
They live in large numbers in the cytoplasm of many marine **invertebrates.** The **Zooxanthellae** can **photosynthesize** as they have **chloroplasts** within their cells.

There is **a symbiotic relationship** between the coral and algae. This is to say that the organisms are d**ependent on one another.** The Zooxanthellae use the waste produced by the coral (**Carbon dioxide, phosphates and nitrates**) in order to produce **oxygen, water, amino acids** and **sugars**. Likewise, the coral uses the waste of Zooxanthellae and so the cycle continues. These organisms are dependent on the continuation of a **healthy reef structure.**

- **Symbiotic relationship** = describes two organisms living together for mutual benefit, neither of which can successfully live without the other.

Zooxanthellae are the dinoflagellates that live symbiotically within the corals. Polyps receive 40% of their nutrients from photosynthesis and 60% from filter feeding.

Corals take in O2 and give of CO2
Zooxanthellae take in CO2 and give off O2



The corals protect the zooxanthellae and in turn they are `farmed' for their nutrients. They change the internal chemistry of the animal making aragonite secretion easier.

SOFT TISSUE

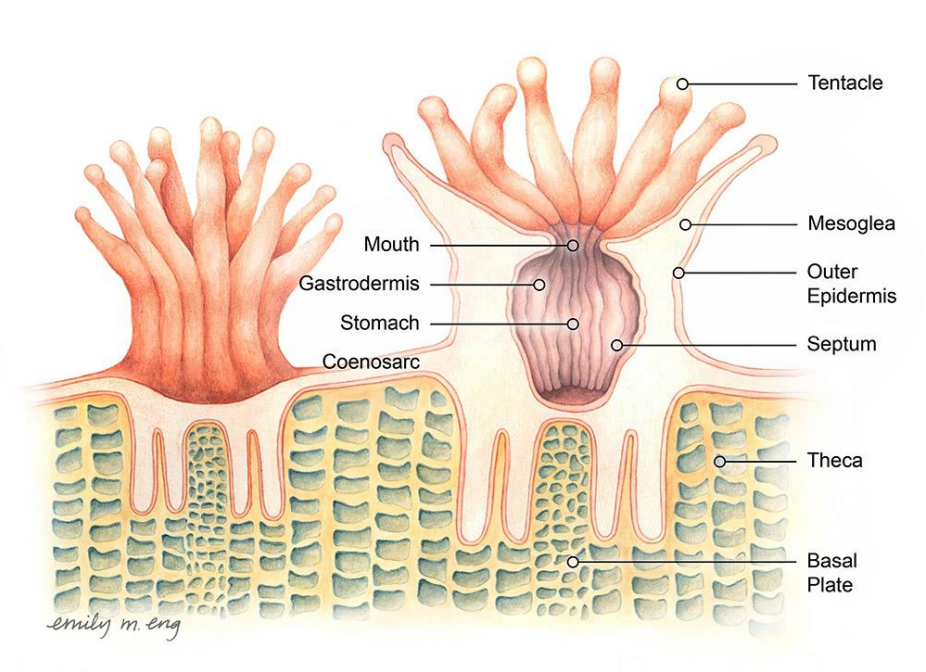
Soft tissue is not preserved so it must be assumed that paleo corals had similar soft tissue to **extant** (live) corals. Soft-bodied polyps sit in the depression, **the calice**, of the **corallite skeleton**.
The polyp uses calcium and carbonate ions from seawater to build itself a hard, cup-shaped skeleton made of calcium carbonate (**aragonite).** Most **tabulate and rugose** corals build their skeletons from **calcite** but **Scleractinian** corals build skeletons out of **aragonite.**

Most coral polyps are actually white/ see through and it is **the zooxanthellae** living inside them which produce brilliant **colour pigments.**

The Polyp itself has tentacles, which extend for feeding purposes, usually at night. These **stinging tentacles** are called **nematocysts or cnidae** (and contain stinging cells called **nematoblasts).**

Filter feeding occurs nocturnally mainly and can be aided by stinging tentacles which **paralyses prey. Food particles** are extracted in the water or **zooplankton** are extracted. They may become trapped in **mucus secreted** by the polyp. Food is then passed into **the mouth** and into a **primitive gut** for digestion. This filter feeding occurs

in addition to the **nutrients gained from zooxanthellae**. Any undigested food is excreted **through the mouth** as polyps do not have an **anus.**



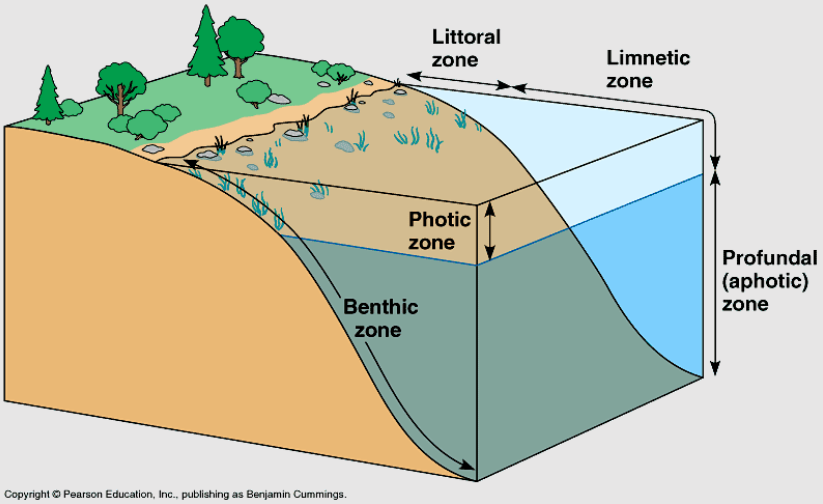
Corals grow a calcareous cap (corallite) surrounding the lower part of their soft tissue (polyp). As the polyp grows, more mineral is secreted to grow the corallite.

CONDITIONS NEEDED FOR GOOD CORAL GROWTH

Some corals are omnipresent in the ocean and are usually solitary corals, which usually survive in **temperate or tropical waters. Reef building** corals, however, are adapted to specific conditions that they need to **grow and survive.** Reef building corals will only occupy waters up to **+/- 30^0 of the equator** so are considered tropical.

Reef building corals must be:

1. **Below the sea level**. Water depth is important as **light is filtered out as depth** increases. **Few** reef building corals are found **below 30m depth**. We say they live in the **photic zone.**
2. **Clear waters** are required since again, the **zooxanthellae dinoflagellates** living inside them need to p**hotosynthesize** to produce energy and nutrients.
3. **Mud or particles can clog up polyps** and so they tend to be **located offshore** where there is **less sediment** of terrestiral origin. They must be far form **rivers** and other sources of sediment.
4. **T**hey are only found in **marine** environments nautrually because the **salinity** must fall within **30-40 ppm.**



5. The **temperature n**eeds to be in the range **23^{0}C to 27^{0}C.**

Today there are many global threats to coral such as: dredging, overfishing, pollution, El Nino and La Nina. El Niño and La Niña are complex weather patterns resulting from variations in ocean temperatures in the Equatorial Pacific.
https://oceanservice.noaa.gov/facts/ninonina.html
Another important issue is coral bleaching. This can occur from small changes in ocean temperature or pollutants in waters.

- **Coral bleaching** = where a small increase in ocean temperature or pollution causes coral polyps to die.

If corals experience long-term rises in temperature (of even 1^{0}C) then the algal symbionts are lost and the corals change colour or bleach.

Corals are generally found on the **continental shelf, close to land** or as **coral islands or atolls** in the oceans. Good examples of modern coral reefs are: the **Great Barrier Reef**, Australia; many of the islands in the Caribbean, such as **the Bahamas**; and **the Maldives** in the Indian Ocean.

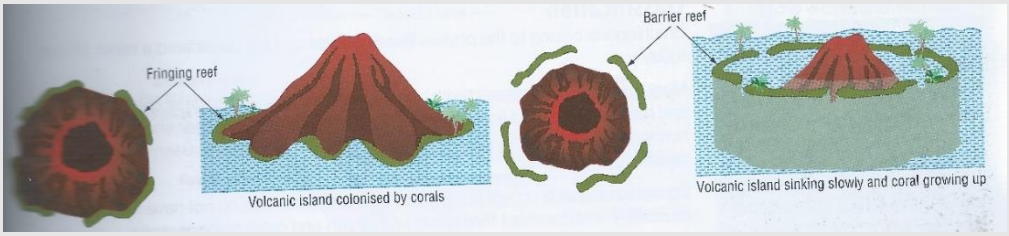
TYPES OF MODERN REEF

Fringing reefs meet the land and may be exposed above sea level at low tide.

Barrier reefs are further out to sea, with a lagoon separating the reef from land.

Atolls or coral islands are found far offshore and are ring-shaped. They form due to the presence of a hot spot, as the volcanoes create a shallow region of sea. However, over time, the weight of the volcano means that the crust gradually sinks and the Moho sags below the shield volcano. The growth of a coral island/atoll must be equal or greater than the rate of subsidence in order to prevent deep submergence. Modern-day reefs tend to grow at a rate of 1cm-10cm per year with the thickness of the reef increasing too.

It grows up to form a massive, unbedded, reef limestone.



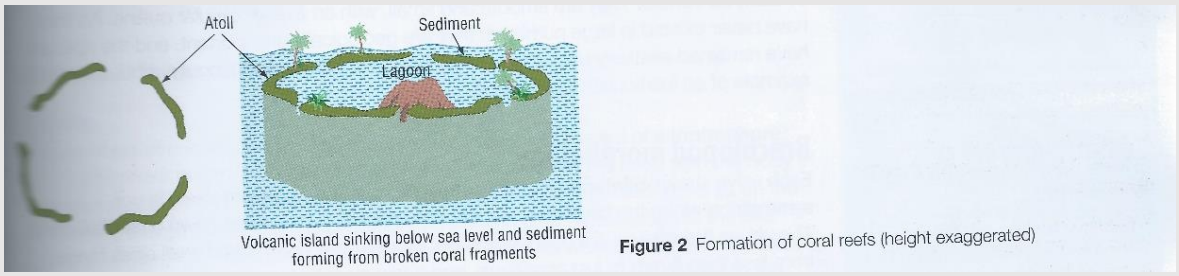


Figure 2 Formation of coral reefs (height exaggerated)

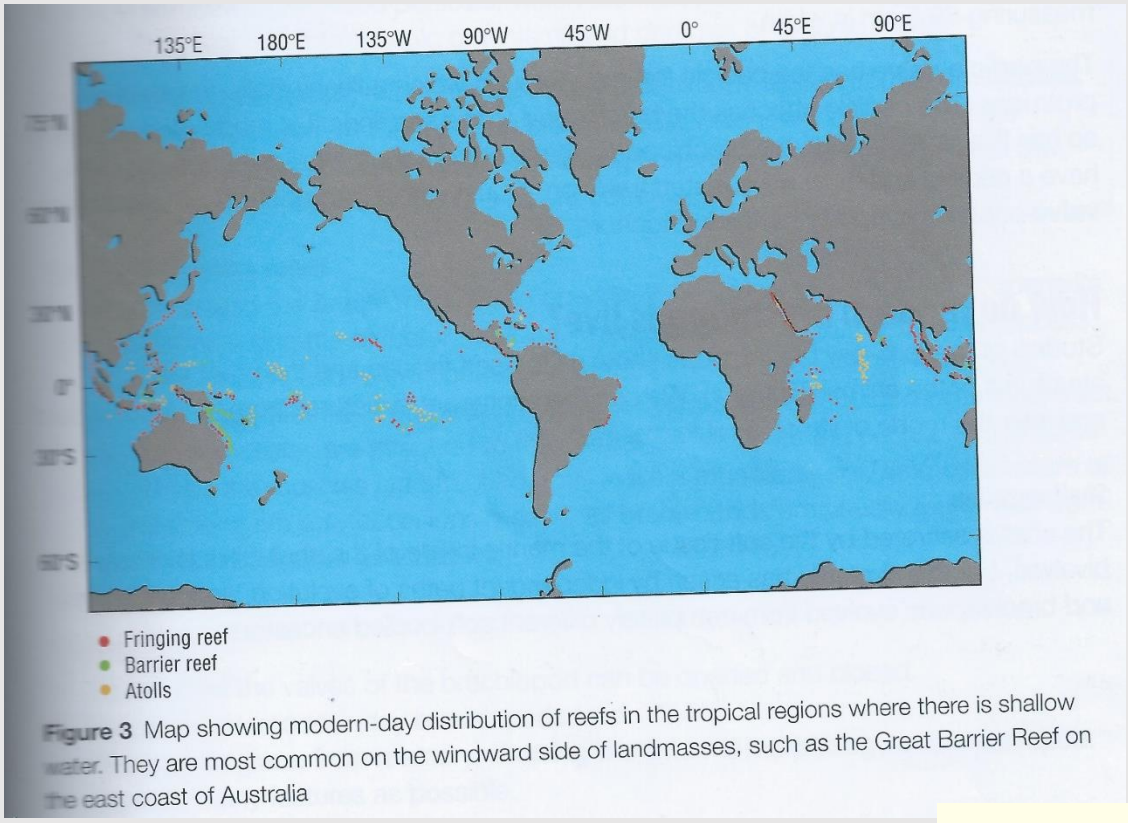


Figure 3 Map showing modern-day distribution of reefs in the tropical regions where there is shallow water. They are most common on the windward side of landmasses, such as the Great Barrier Reef on the east coast of Australia

Since corals have a log lifespan they can record the incremental changes within their skeletons. A rugose corallite which is wide suggests a time when the polyp thrived but when the corallite narrows it suggests a time where the polyp was under stress so lost body mass, contracting towards the centre of its calice and only adding skeletal material to this central portion.

It is not known if rugose and tabulate corals had zooxanthellae and so it is harder to judge the paleoenvironment. Modern corals only survive within 30^0 of the equator where there are clear, shallow, warm waters.

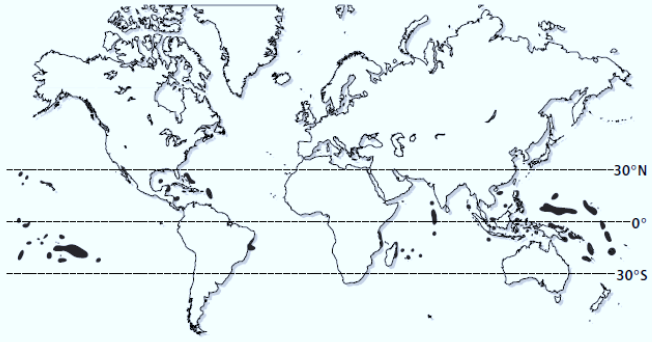


Fig. 4.9 Map of the modern world showing the current distribution of coral reefs within 30° of the equator. Note the abundance of open ocean sites that are areas of low nutrient availability.

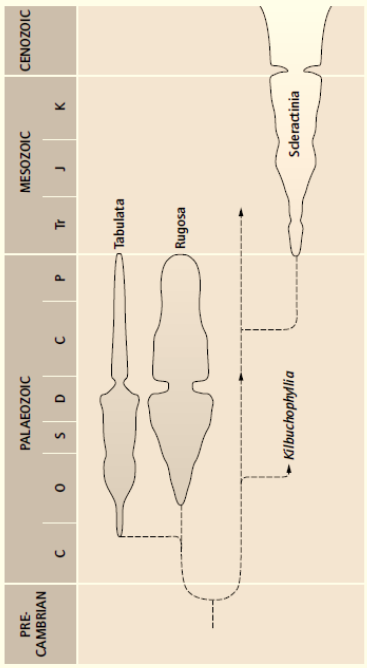


Fig. 4.2 The ranges and possible evolutionary relationships of the major groups of corals. Skeletons evolved separately several times within the group, and each coral order has a soft-bodied ancestor.