

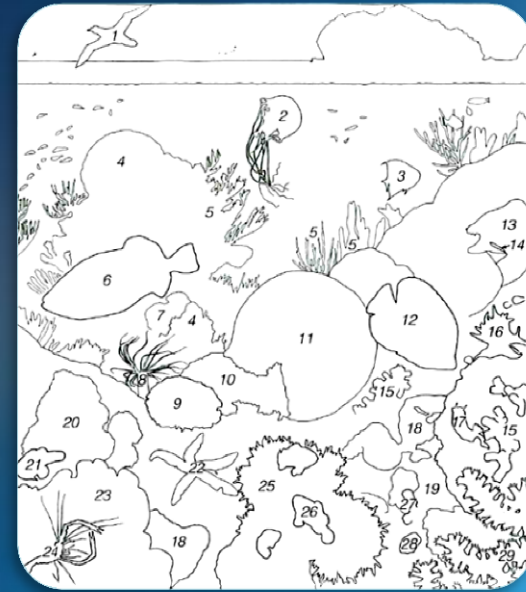
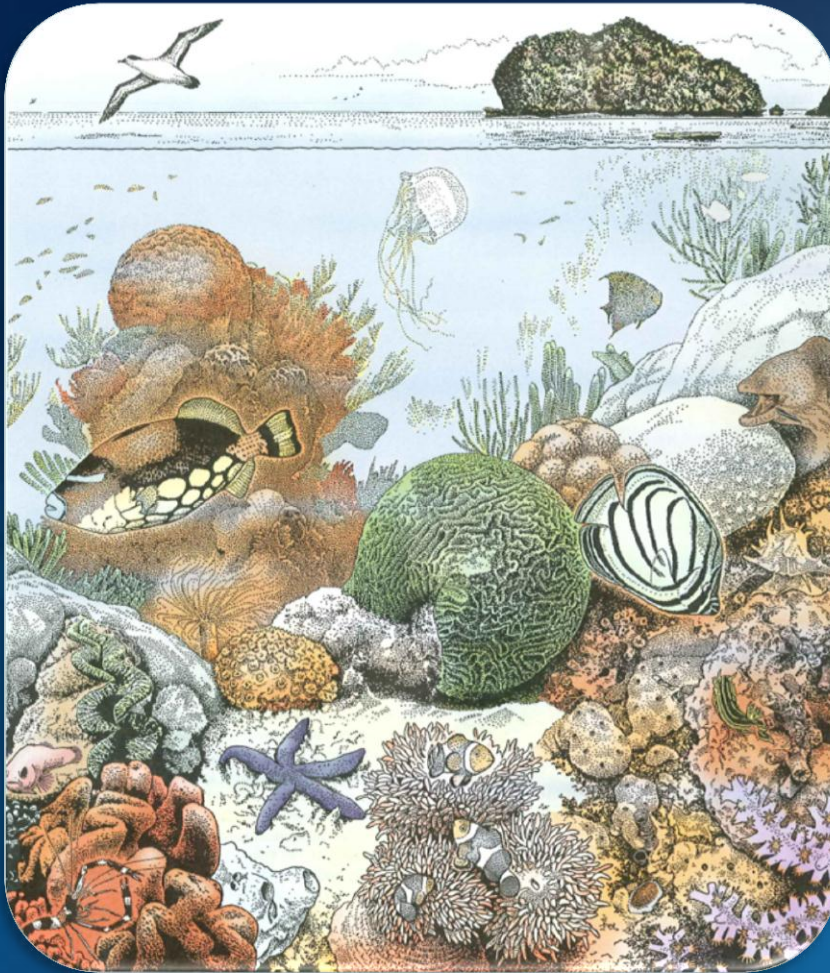
Coral Reef Ecology

Introduction to Oceanography
(OCS 1005-4)

October 27, 2009

Introduction to Coral Reefs

Coral Reef Ecosystems



Key for coral reef habitat

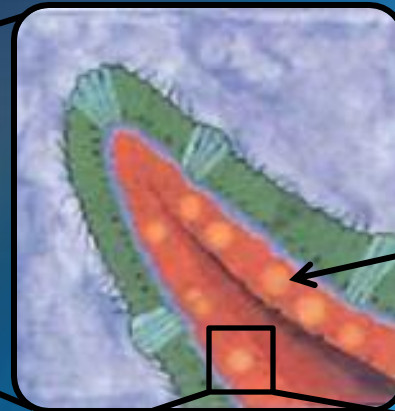
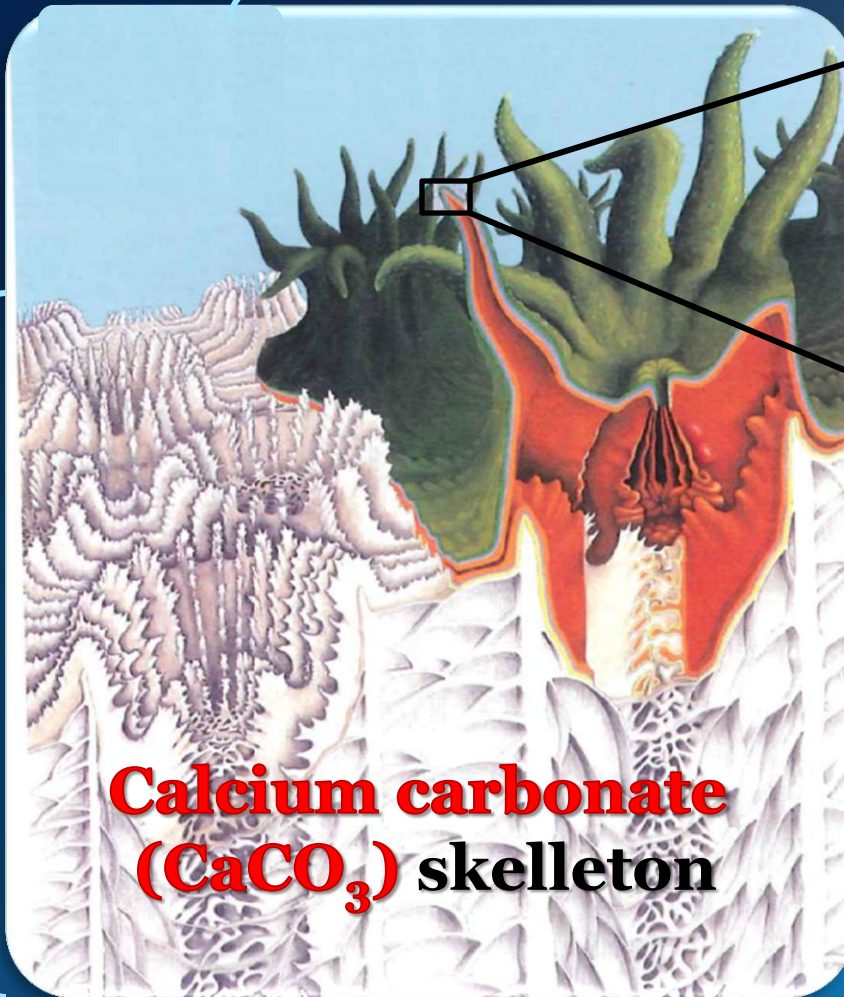
- | | |
|-----------------------------|------------------------------|
| 1 black-capped petrel | 16 muricid snail |
| 2 sea nettle | 17 nudibranch |
| 3 angelfish | 18 sponges |
| 4 lobed corals | 19 colonial tunicate |
| 5 sea whips and soft corals | 20 giant clam |
| 6 triggerfish | 21 purple pseudochromid fish |
| 7 sea fans | 22 cobalt sea star |
| 8 tube anemone | 23 soft corals |
| 9 orange stone coral | 24 barber pole shrimp |
| 10 bryozoans | 25 sea anemones |
| 11 brain coral | 26 clown fish |
| 12 butterfly fish | 27 worm tubes |
| 13 moray eel | 28 cowrie |
| 14 cleaner fish | 29 sea fan |
| 15 tube corals | |

(Garrison 2007; Fig. 16.2 (a-b); p. 460-461)

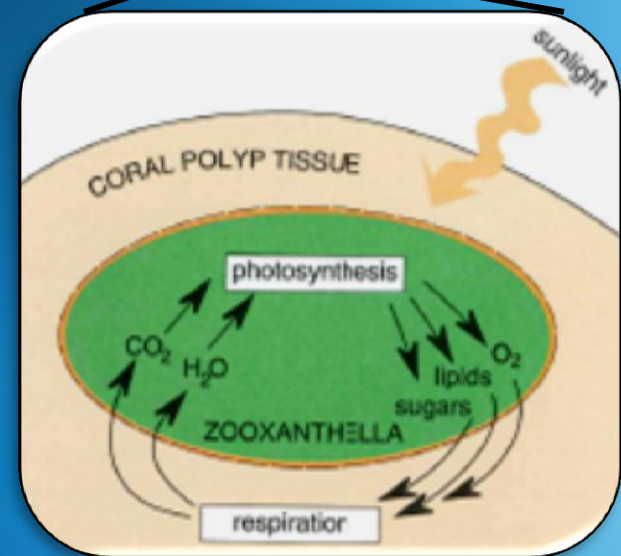
“Coral Reefs”

Biologic Context

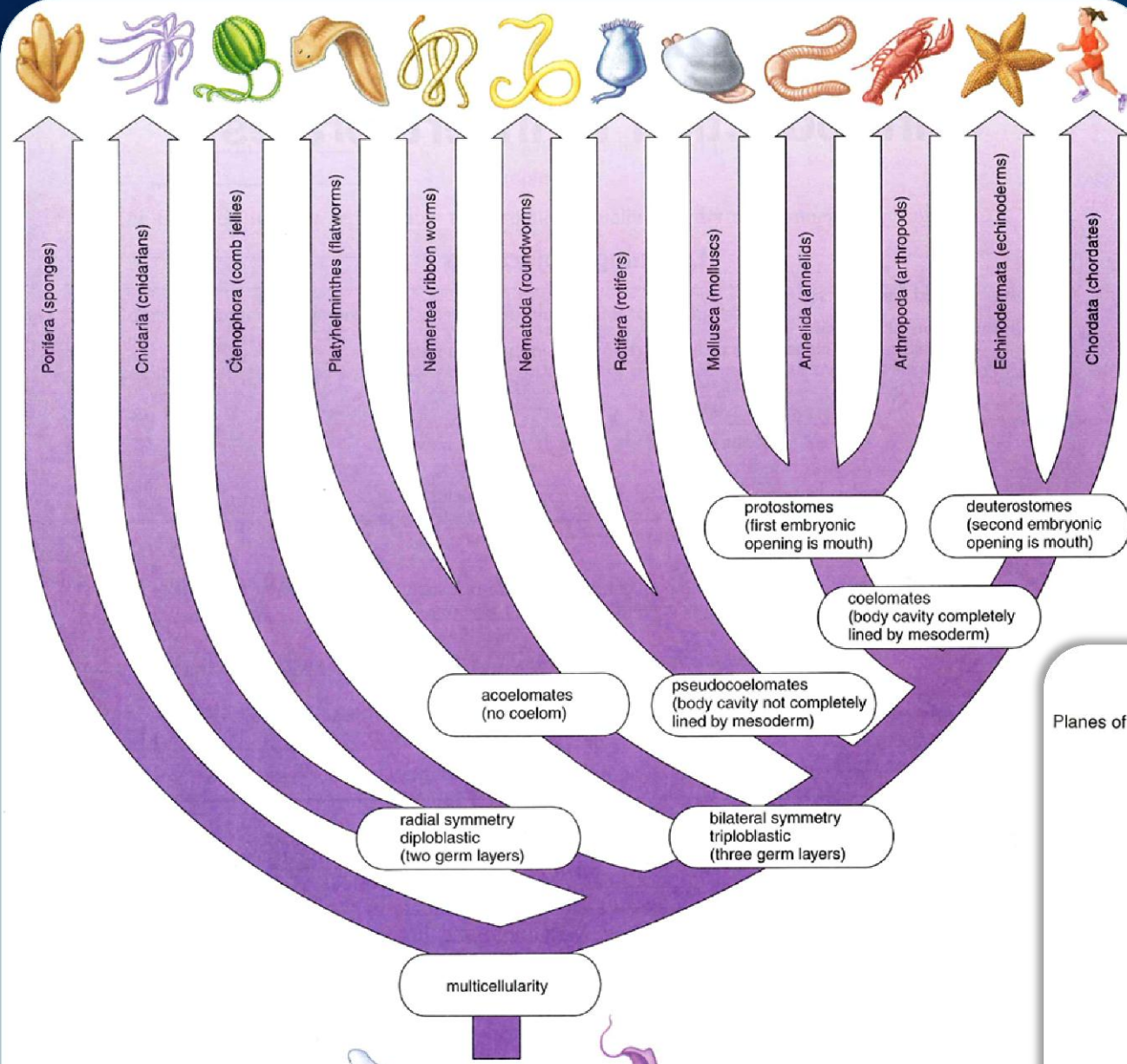
Geologic Context



Zooxanthellae
(algae)



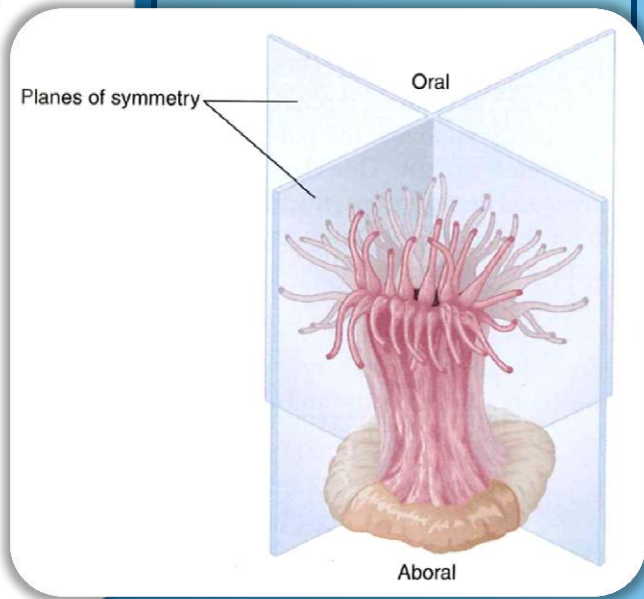
(Adapted from: Murphy 2002, Fig. 2, p. 46; & Sumich & Morrissey 2004; Fig. 9.6; p.258)



Basic Coral Biology

Kingdom Animalia

- Phylum Cnidaria



(Mader 2001; Fig. 21.1; p. 260)

Biological Context of Reefs

Cnidarian Life Cycles

Life Cycle is 1 to 2 Phases

- Many only have 1 phase (Polyp or Medusa)
- When both are present...
 - Phase 1= Polyp (asexual phase)
 - Phase 2= Medusa (sexual phase)

Class Anthozoa:

- Sea Anemones: solitary polyps
- Corals: colonial polyps (usually)

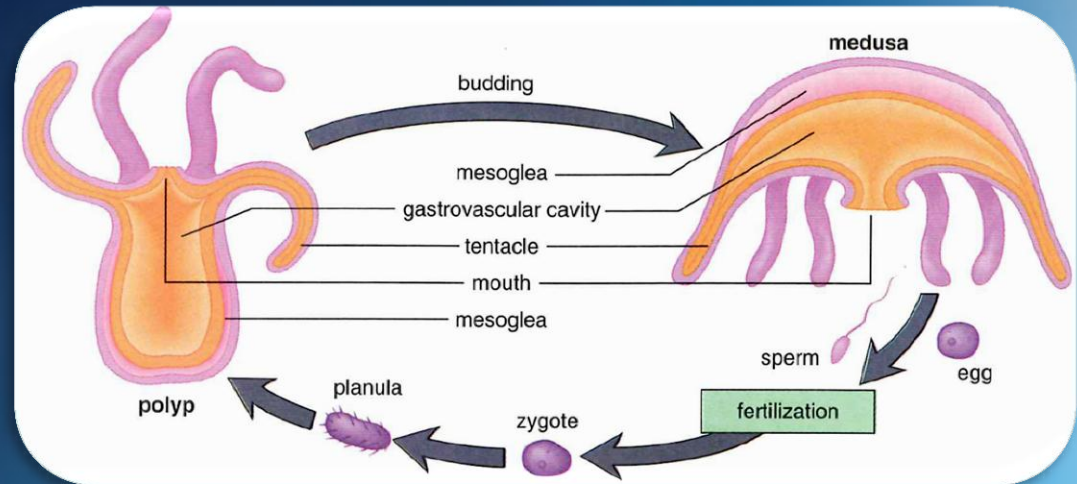
Class Hydrozoa:

- Jellyfish with colonial polyps & free-swimming medusae phases
- ex. *Obelia* & Portuguese man-of-war

Class Scyphozoa:

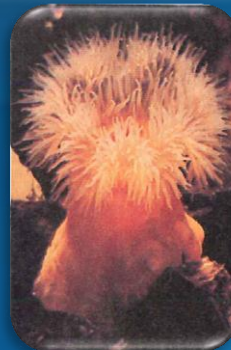
- True Jellyfish: small polyp (phase 1) & large, pronounced medusa (phase 2)

(Mader 2001; Fig. 21.4; p. 266)



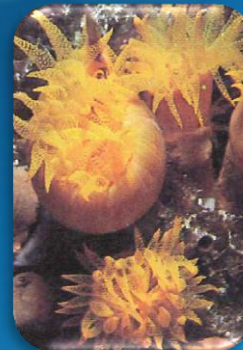
Anthozoa

Sea Anemones



solitary polyp

Corals



colonial polyps (usually)

Hydrozoa

Jellyfish



colonial polyps with free-swimming medusa phases

Scyphozoa

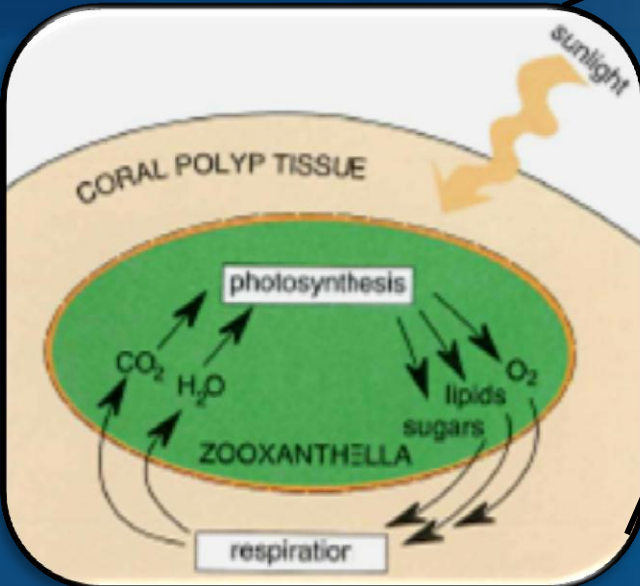
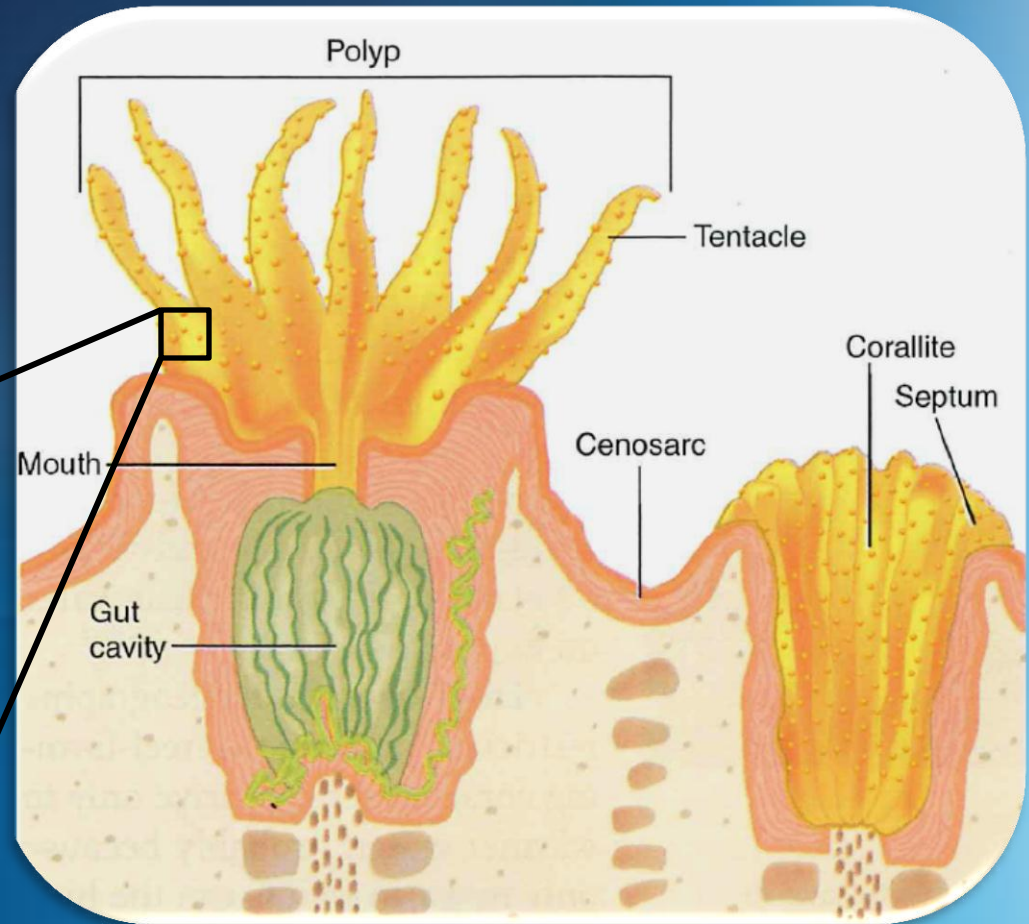
True Jellyfish



small polyp with large, pronounced medusa phases

Biological Context of Reefs

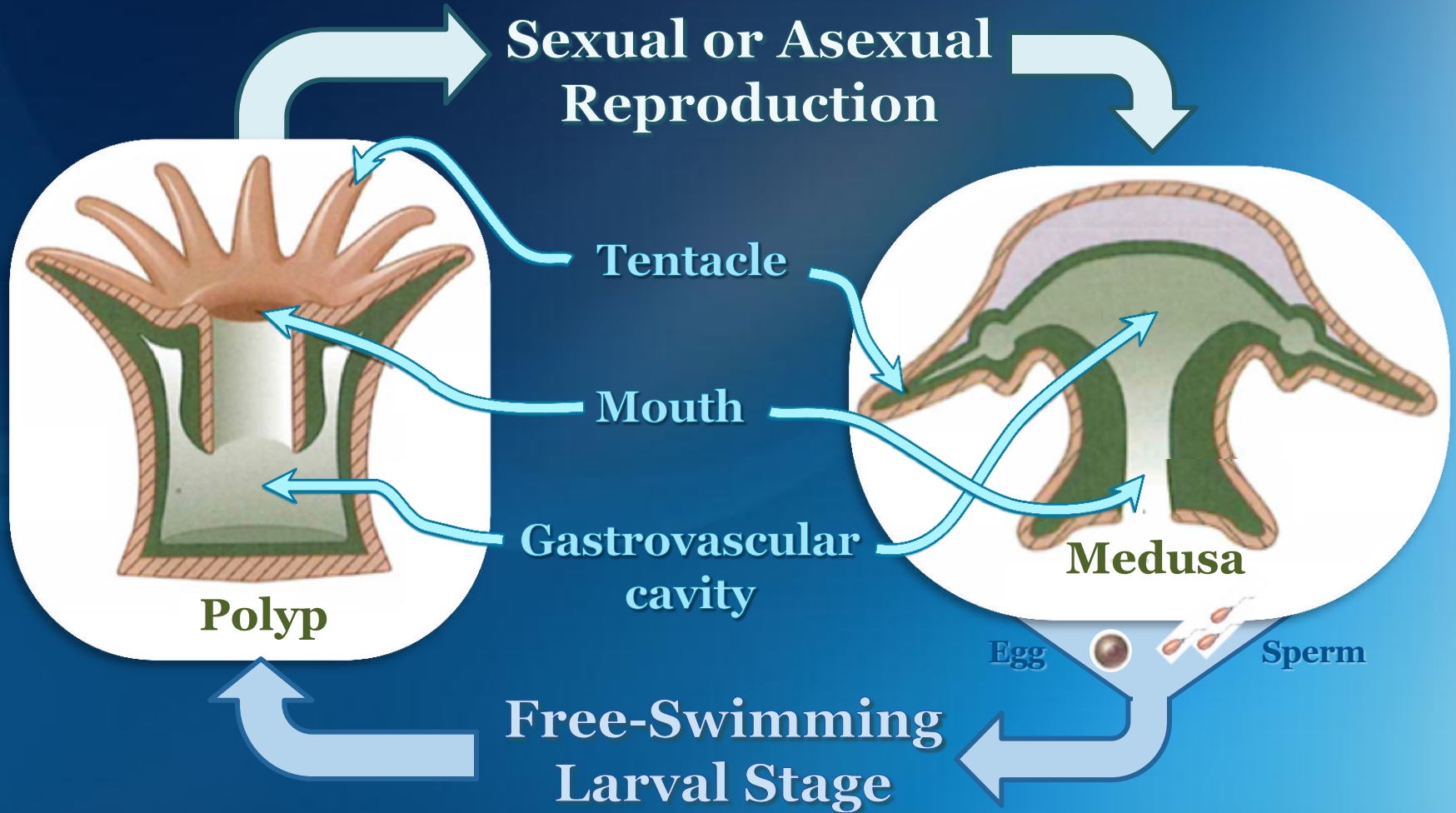
Basic Coral Biology



(Sumich & Morrissey 2004; Top Left: Fig. 5.12, p.136; Right: Fig. 9.2, p. 255)

Biological Context of Reefs

The Biology, Reproduction, & overall Life Cycle of Corals

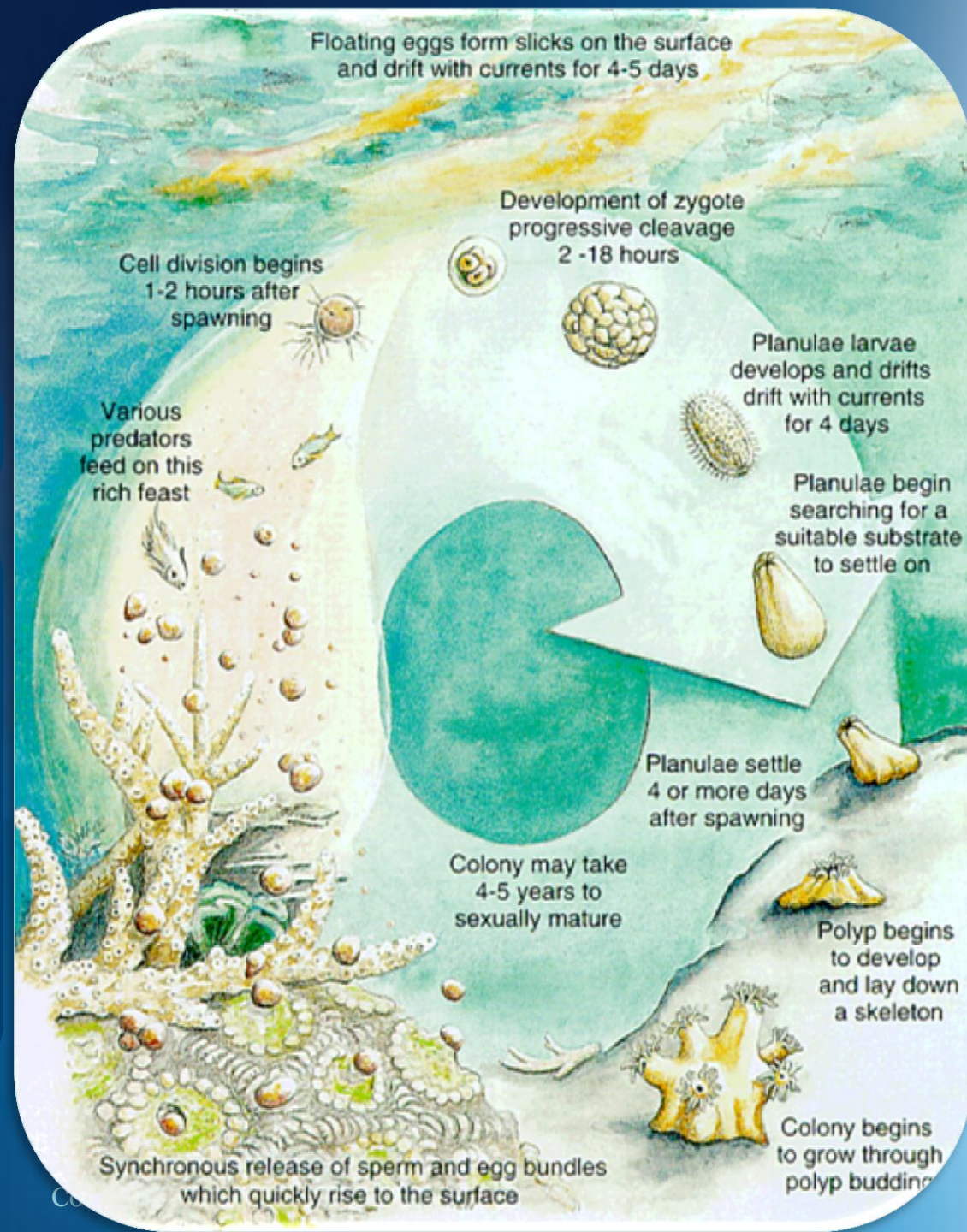


(Adapted from: Sumich & Morrissey 2004; Fig. 5.10; p. 134)

Biological Context of Reefs

Coral Growth & Reproduction

- This figure depicts Coral Reproduction by a **Broadcast** Spawner
- Corals need a hard substrate to attach to
- Grow in direction of current/wave action

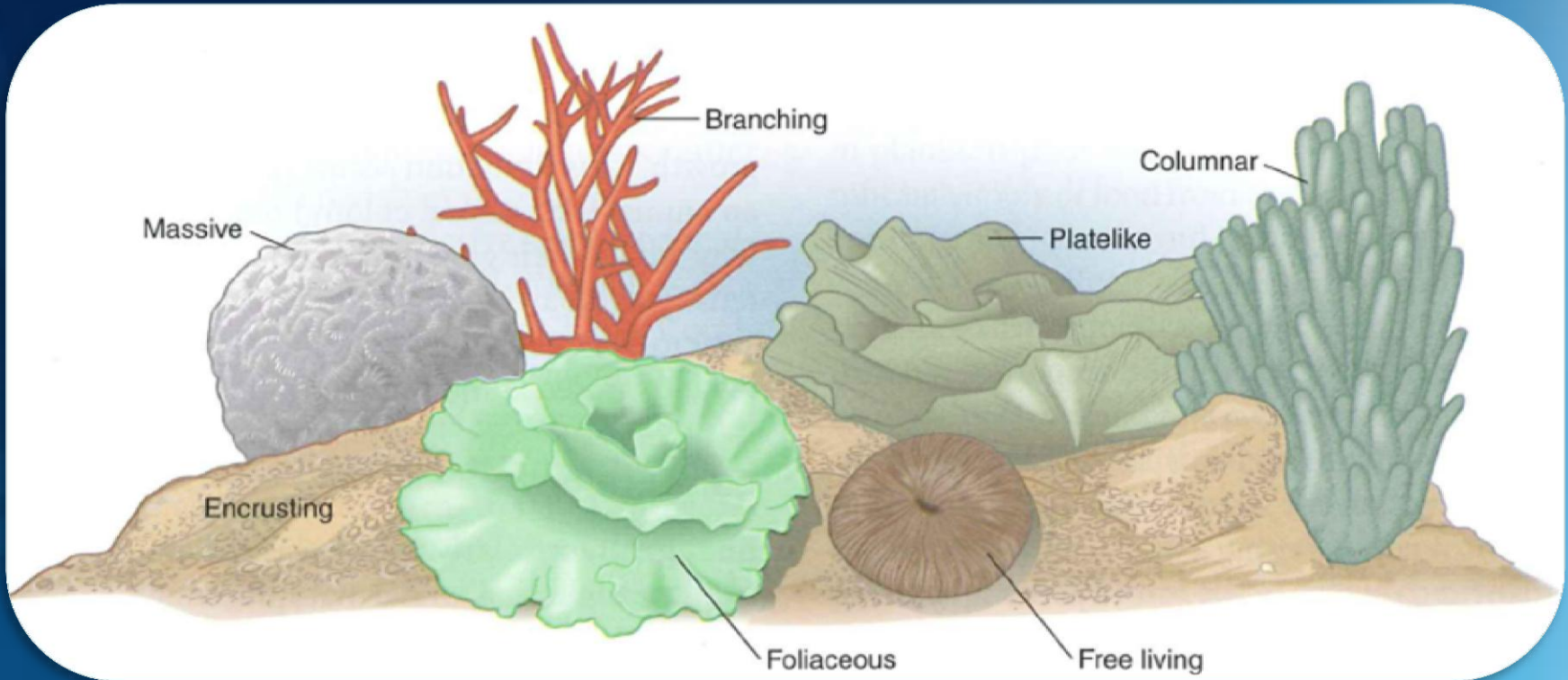


(<http://www.aims.gov.au/pages/reflib/bigbank/pages/bb-09e.html>)

Jennifer Lentz

Biological Context of Reefs

Coral Morphologies

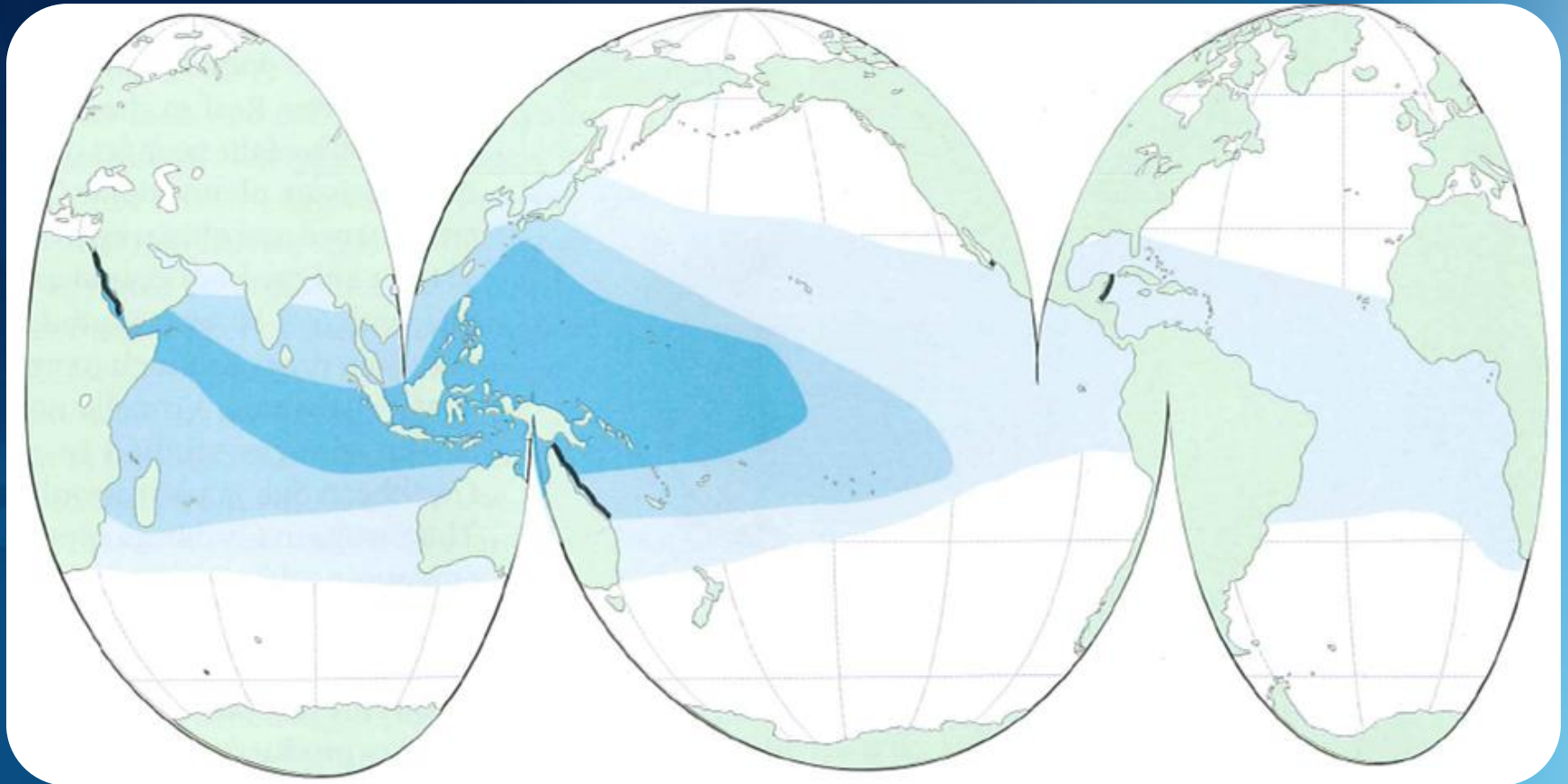


- Massive
- Branching
- Free-living
- Columnar
- Encrusting
- Foliaceous
- Platelike

(Sumich & Morrissey 2004; Fig. 9.3; p. 255)

Biological Context of Reefs

Geographic Distribution & Diversity of Corals



> 40 Genera

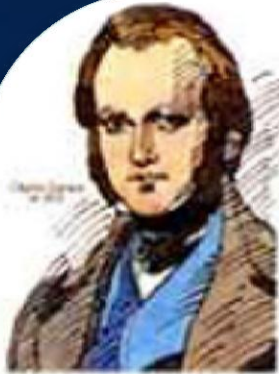
20 – 40 Genera

< 20 Genera

(Sumich & Morrissey 2004; Fig. 9.5; p. 257)

Geological Context of Reefs

Charles Darwin & Coral Reefs



Theory of Subsidence of Atolls and Coral Reefs

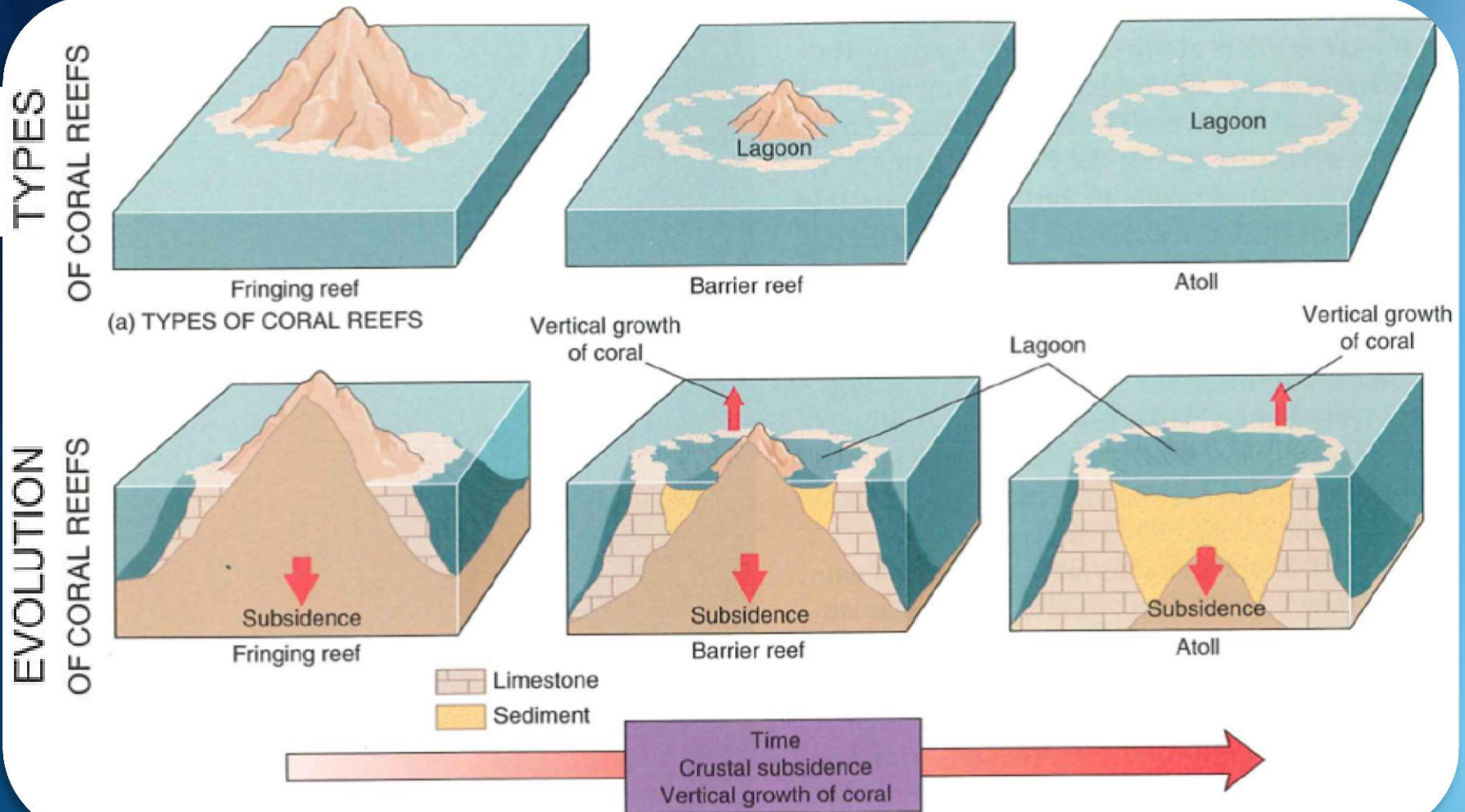
On leaving the Cocos Islands on the 12th April 1836, Charles Darwin wrote, "I am glad we had visited these islands, such formations surely rank amongst the wonderful objects of this world. We feel surprise when travellers tell us of the vast dimensions of the Pyramids and other ruins, but how utterly insignificant are the greatest of these when compared to these mountains of stone accumulated by the agency of various minute and tender animals! This is a wonder which does not at first strike the eye of the body, but after reflection, the eye of reason."



<http://earthguide.ucsd.edu/team/yasuda/oceanography/tectonics/atolldarwin.jpg>

Geological Context of Reefs

Types & Evolution of Coral Reefs

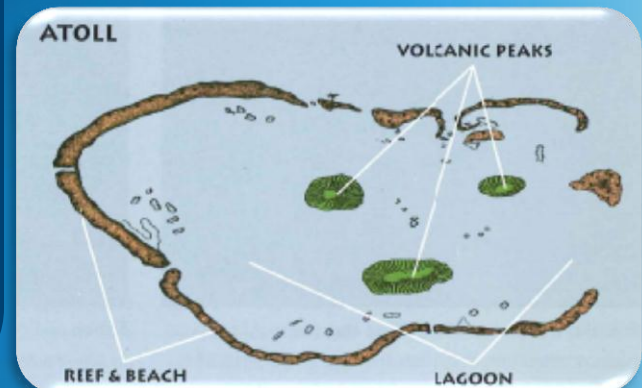
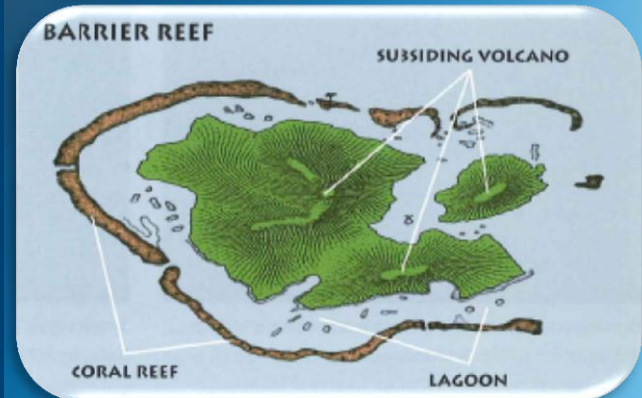
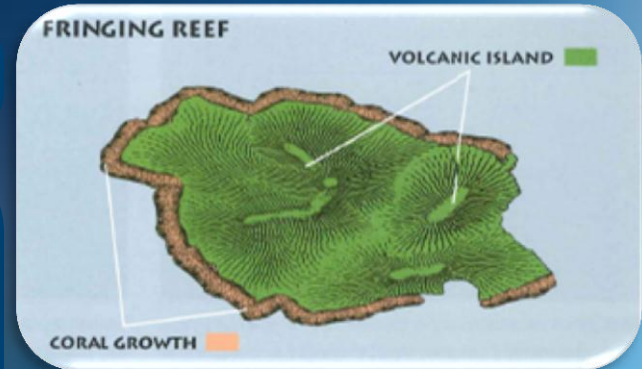


(Sumich & Morrissey 2004; Fig. 9.8; p. 260)

Geological Context of Reefs

Types & Evolution of Coral Reefs

- **Fringing Reefs**
 - Cling to land
 - Areas with low rainfall & clear water
- **Barrier Reef**
 - Separated from land by a **lagoon**
 - Great Barrier Reef is the largest structure made by living organism (135,000 mi²)
- **Atolls**
 - Ring-shaped island of coral reefs surrounding a lagoon
 - **Formation:** Volcano → Fringing reef → Barrier reef → Atoll
 - > 1000 feet of coral fragments beneath present reefs

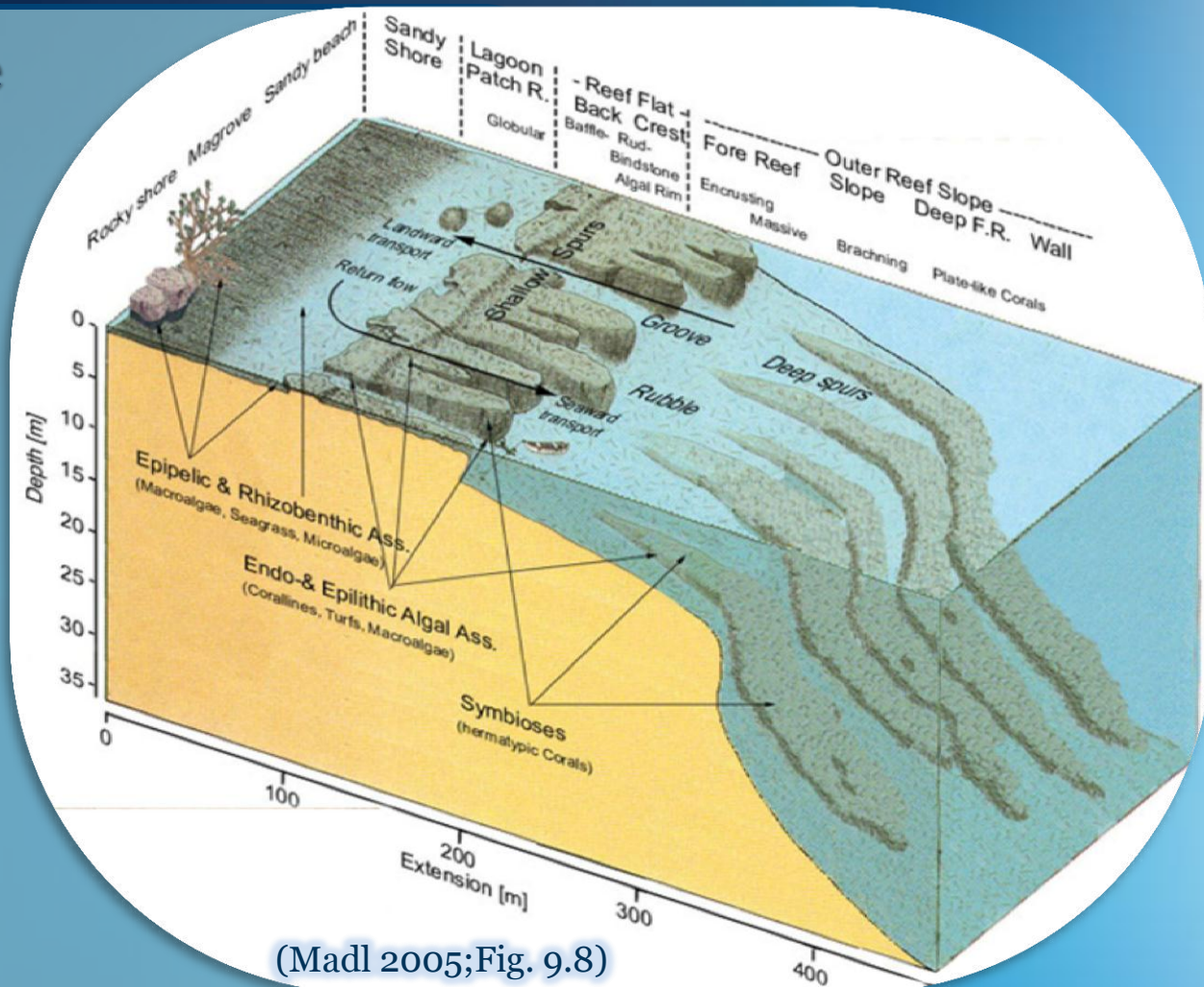


Geological Context of Reefs

Types & Evolution of Coral Reefs

○ Spur & Groove Formations

- Adaptation to Wave Energy & Currents
- Mechanism for Sediment Removal during storms



(Madl 2005; Fig. 9.8)

Importance of Coral Reefs

- Protection from Wave Erosion
- Mitigate Hurricane Damage
- Base of the food chain, providing habitat & protection
- Economic reasons – Food/Tourism
- Enhances Quantity & Quality of Life
- Beauty

Current Status of Corals

Past

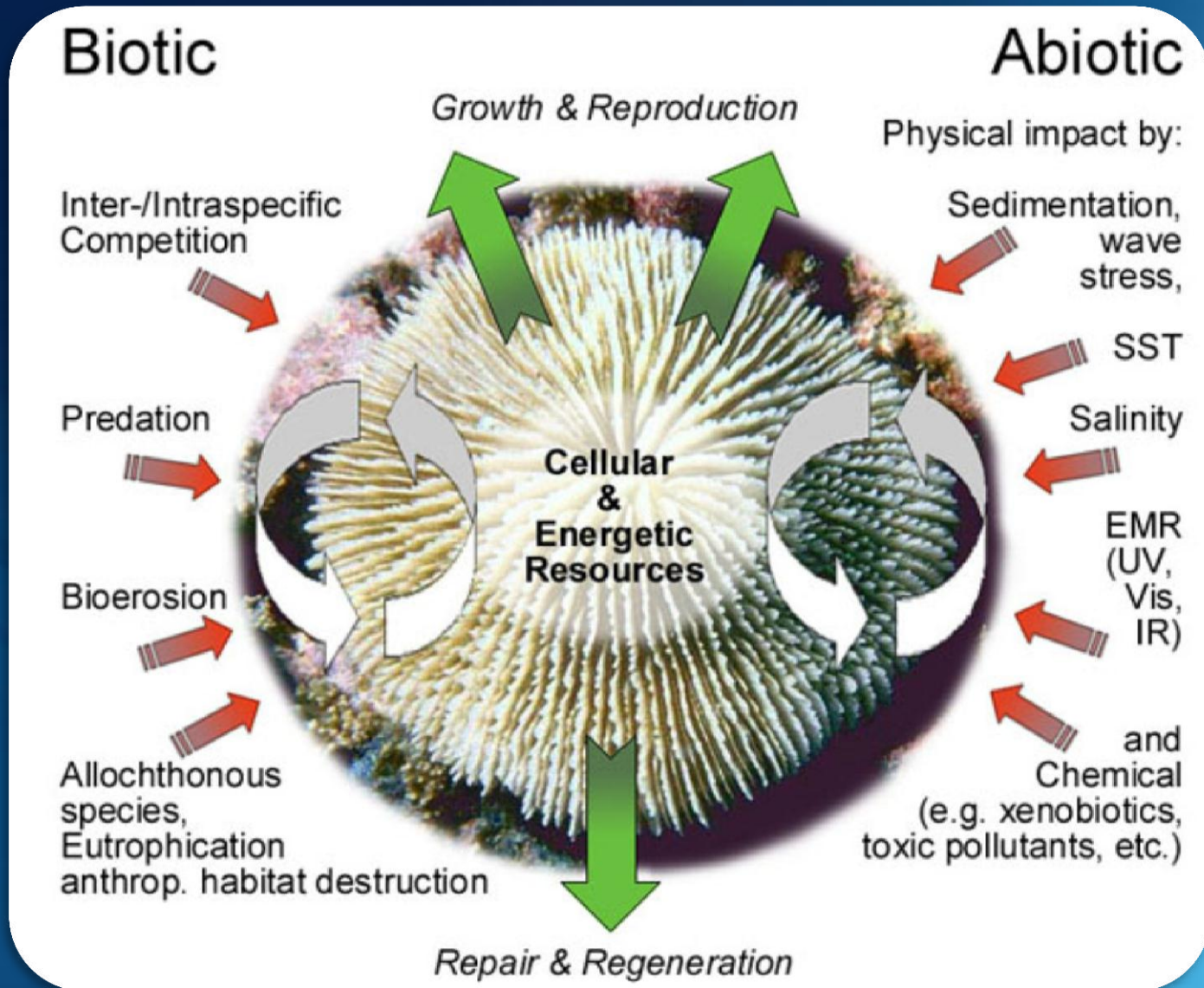


Present



Fig.3.15a: Images from a Caribbean coral reef. Major storm events change a reef from a more or less intact community to one dominated by dead coral, algae and bioeroders.

Coral Stressors



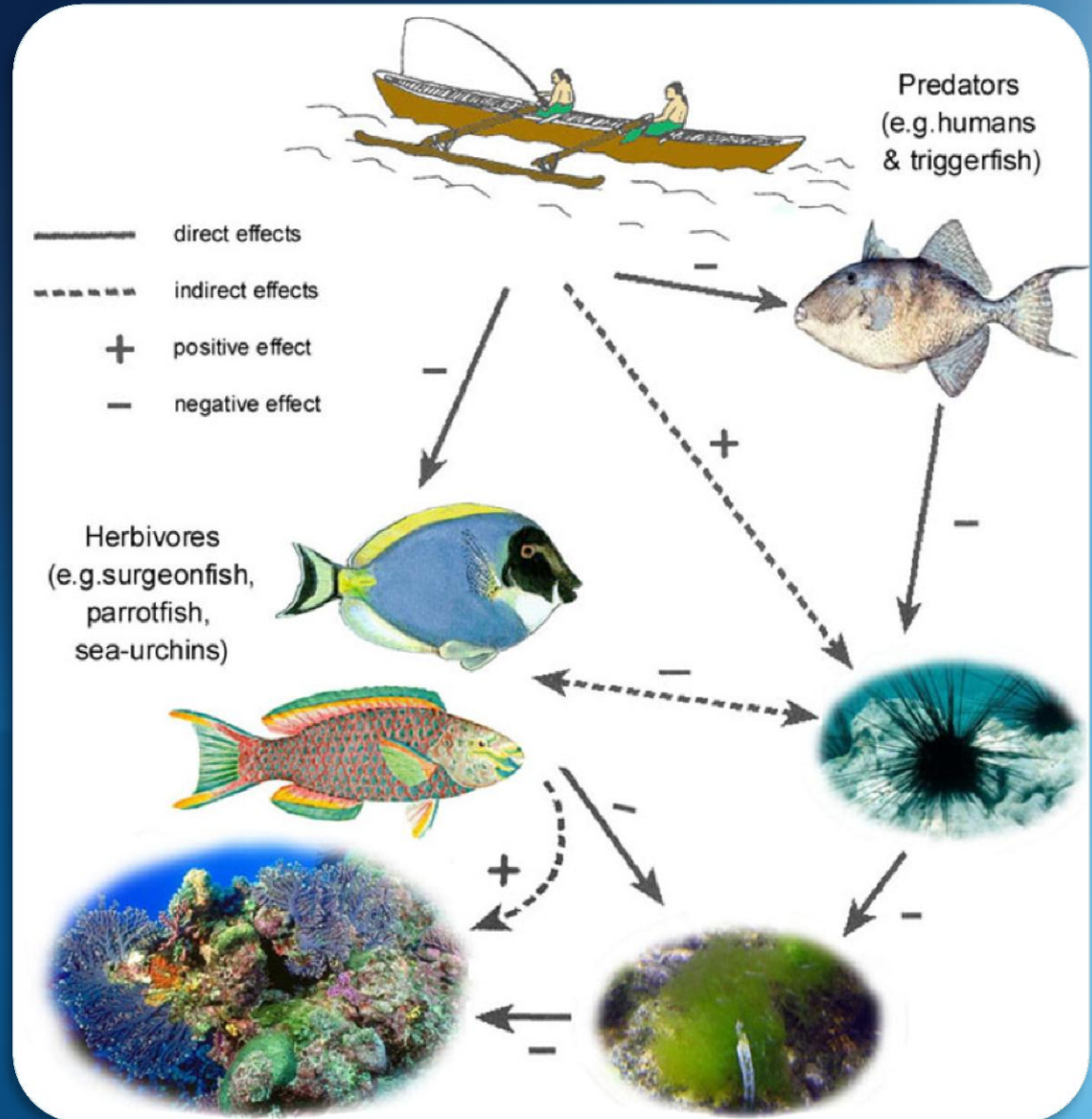
(Madl 2005; Fig. 4.1)

Coral Stressors

Over-fishing

“Herbivorous feeding pressure: Since herbivorous fish and sea urchins consume algae any fishing pressure exerted on these species by humans does interfere with the sensitive balance of feeding pressure and algal blooms”

(Madl 2005; Fig. 3.7)



Coral Stressors

Dynamite or Blast fishing

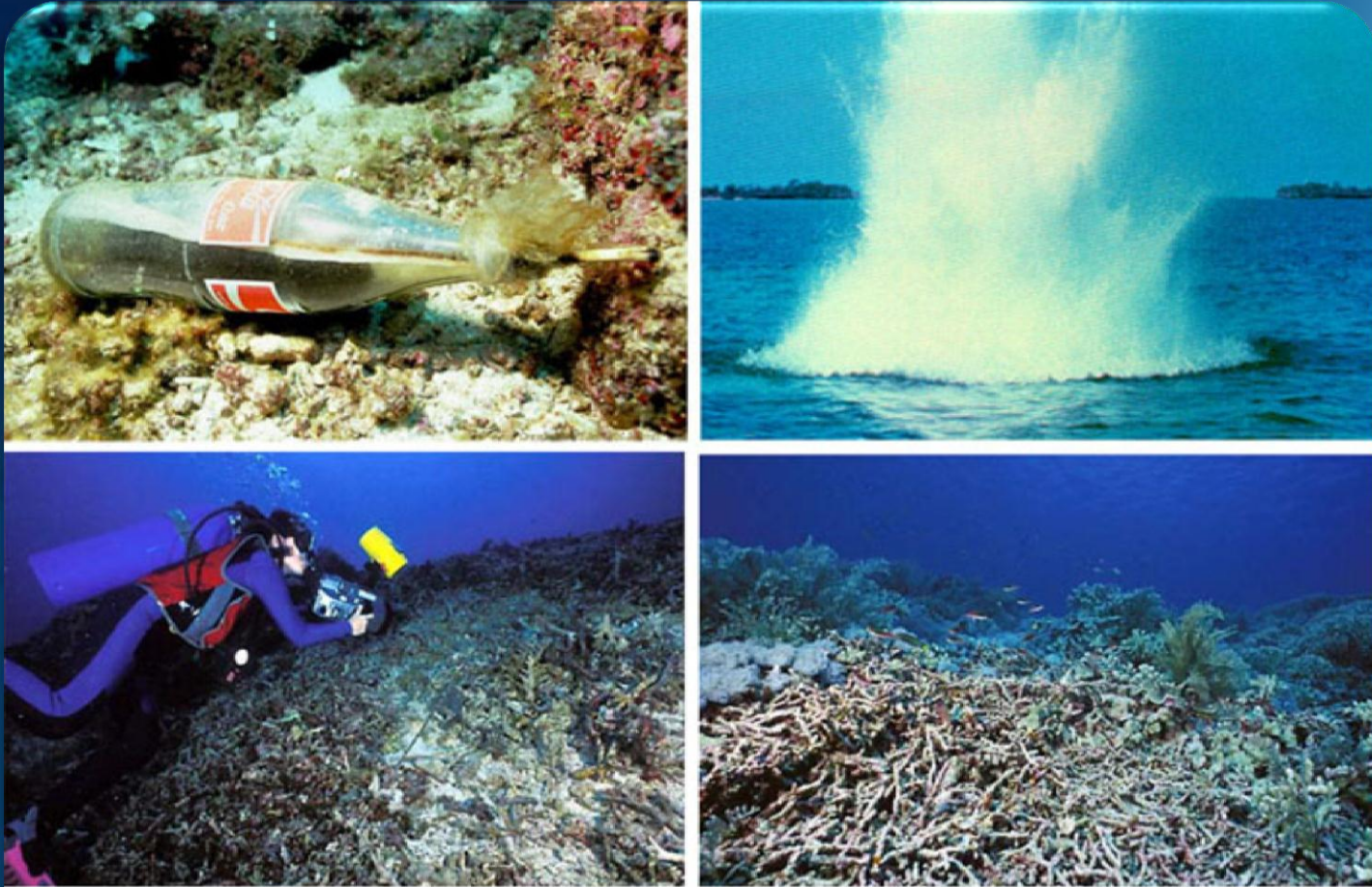


Fig.3.8a: Dynamite or blast fishing is a practice in which fishermen use explosives to kill and harvest fish. Although it is illegal, it is practiced in forty countries worldwide and is a major threat to coral reefs. The explosion, which indiscriminately kills all fish within the blast radius also destroys living coral. An explosive the size of a coke bottle will shatter to pieces all stony corals within a three meter radius. Repetitive blasting in an area reduces coral to rubble, which cannot support marine life.

(Madl 2005;
Fig. 3.8a)

Coral Stressors

Cyanide-fishing



Fig 3.8b: Although the practice has been outlawed in most countries, and despite many importers of reef fish refuse to accept cyanide-tainted fish, widespread use of cyanide continues to devastate huge areas.

(Madl 2005;
Fig. 3.8b)

Coral Stressors

Hydrocarbon Pollution from Oil Spills



Fig.3.10a: Crude oil polluting reefs in the Caribbean (left), oil washing on the coast of the northern Gulf of Aqaba / Eilat following an oil spill (right).

Coral Stressors

Sedimentation

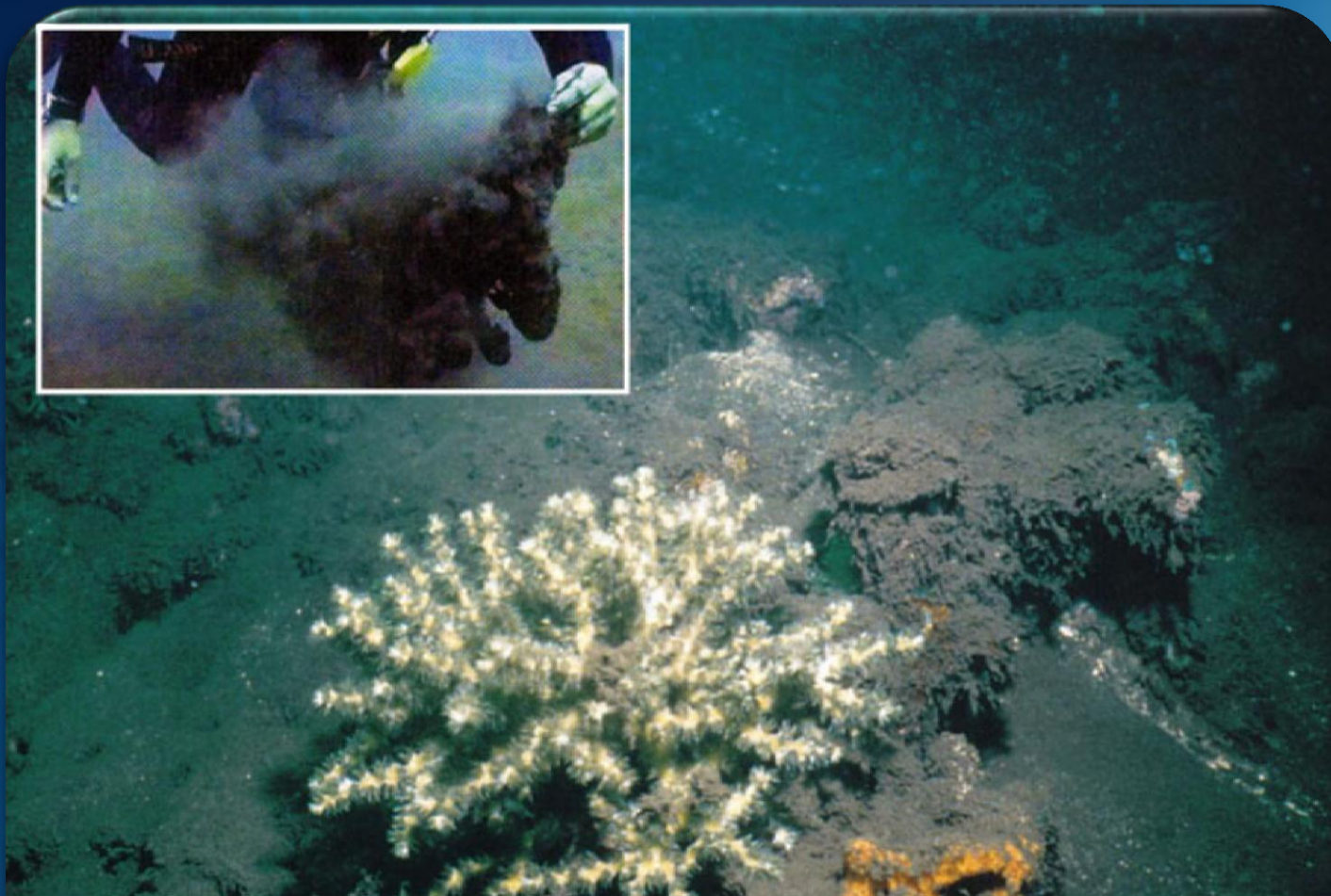


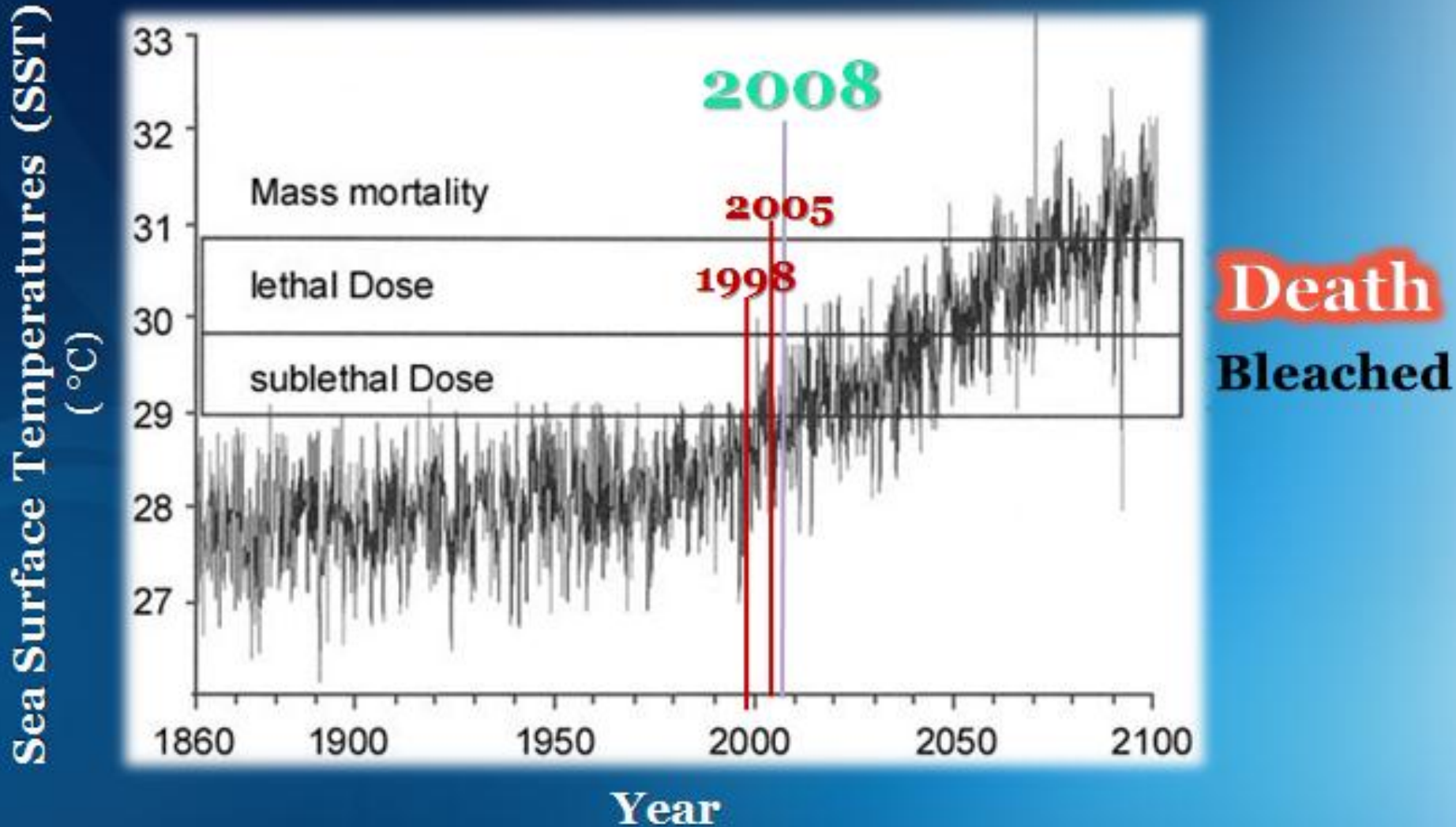
Fig.3.4b: Nutrient pollution and sedimentation from coastal development blocks sunlight, thereby reducing the coral's viability.

Bryant et al. 1998, Loya 2004

(Madl 2005;
Fig. 3.4b)

Coral Stressors: Temperature

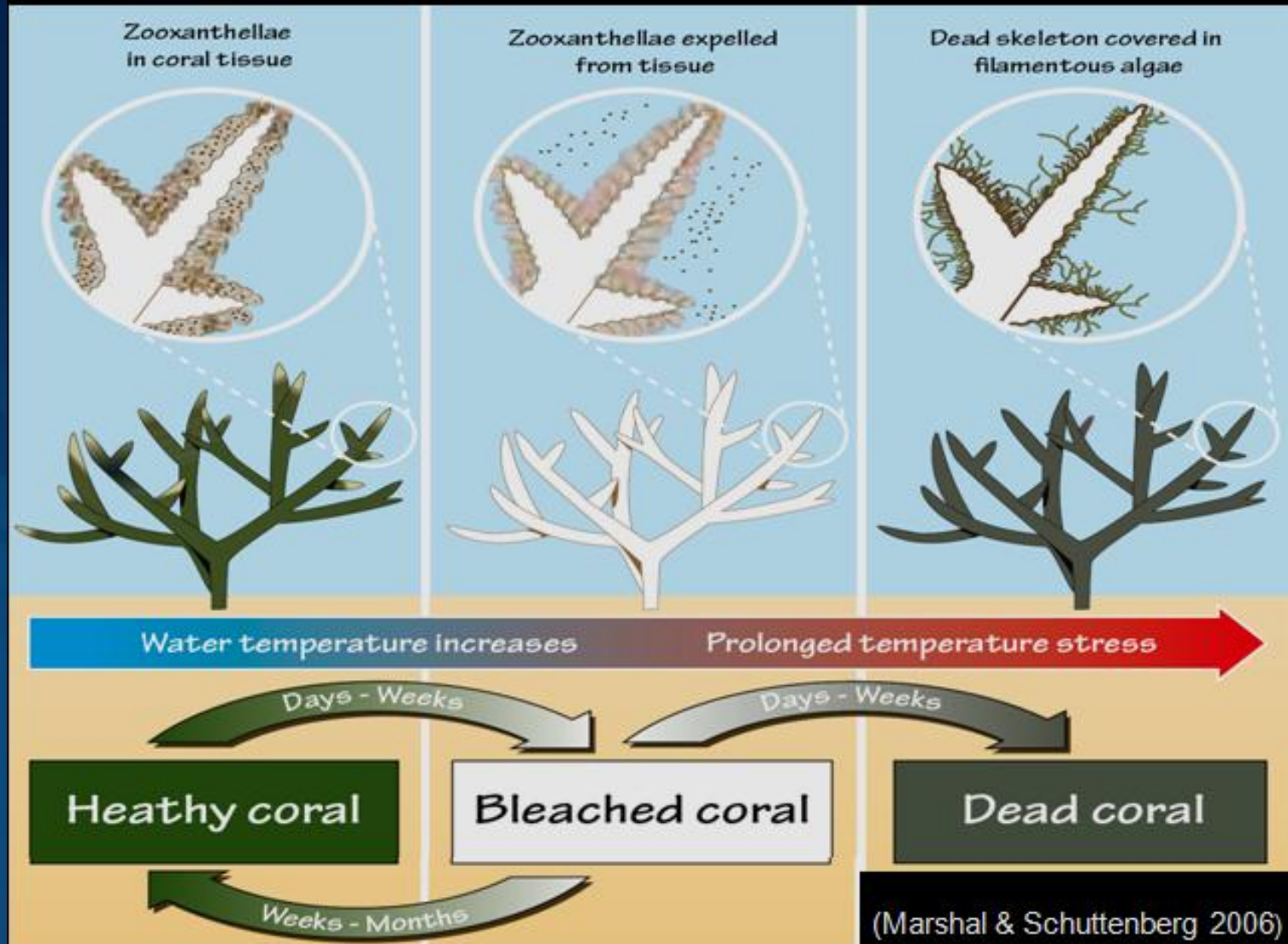
Coral Bleaching



(Hoegh-Guldberg 2004; Fig. 2; p. 14)

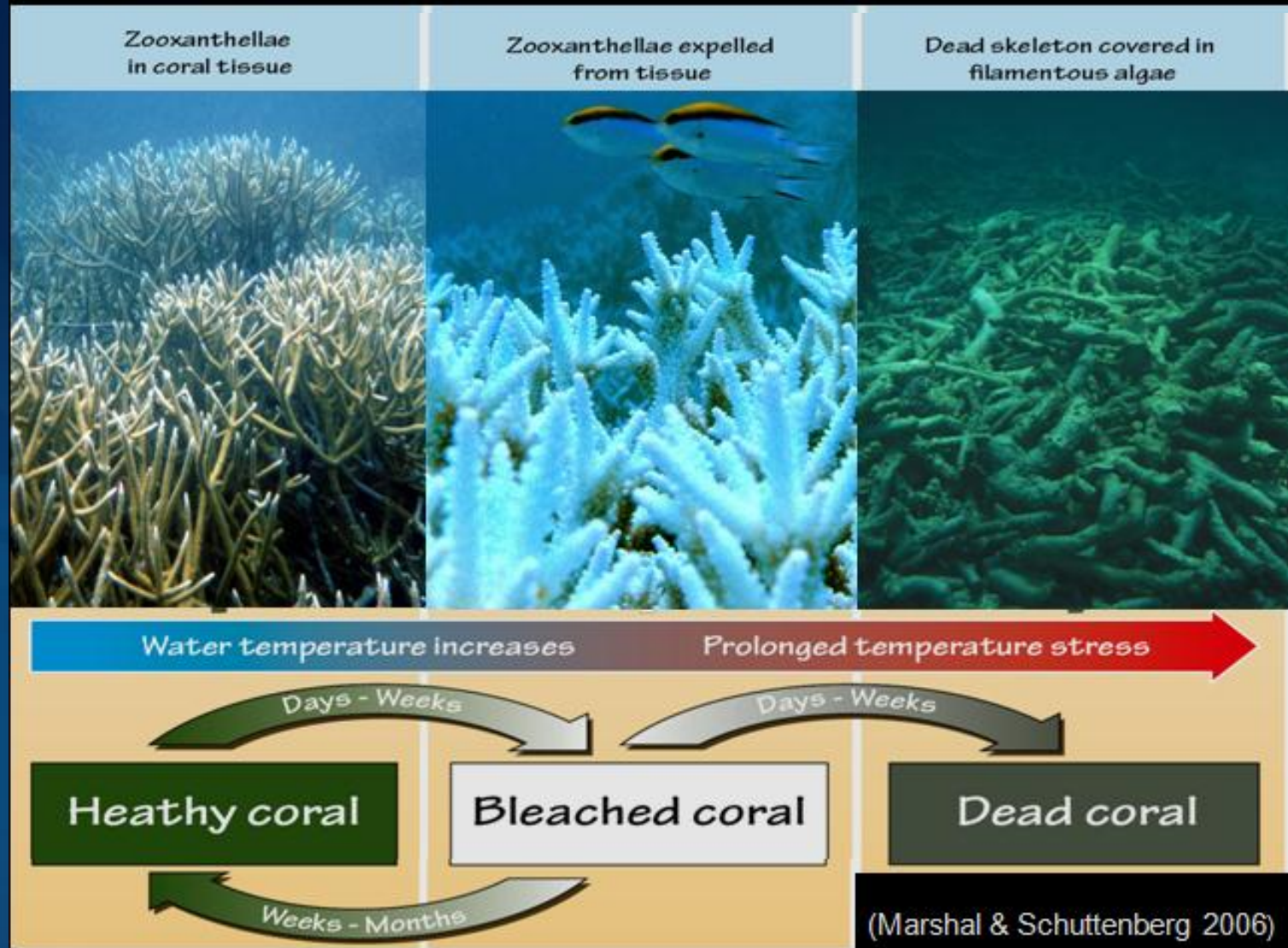
Coral Stressors: Temperature

Coral Bleaching



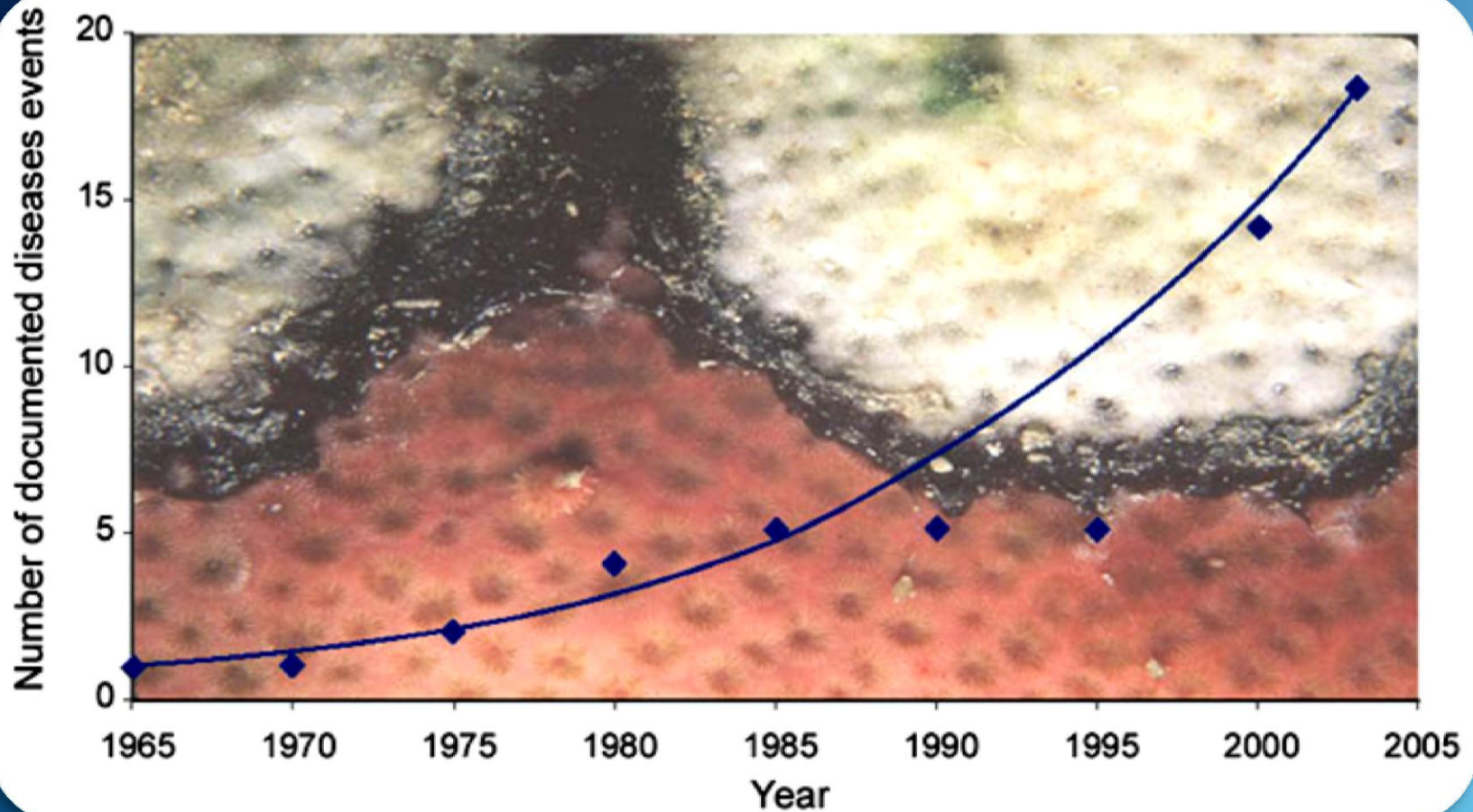
Coral Stressors: Temperature

Coral Bleaching



Coral Diseases

Coral Diseases

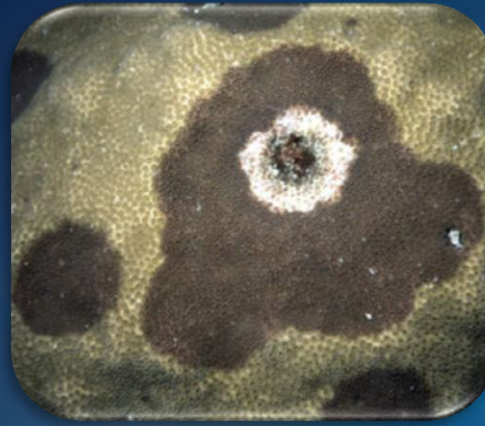


Exponential increase in the number of described coral diseases since the first since the first report of disease in 1965.

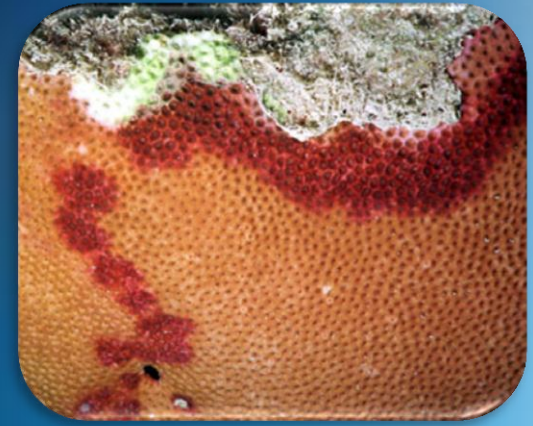
Coral Diseases



Coralline Lethal Disease (CLD)



Dark Spots Disease/Syndrome (DSD/S)



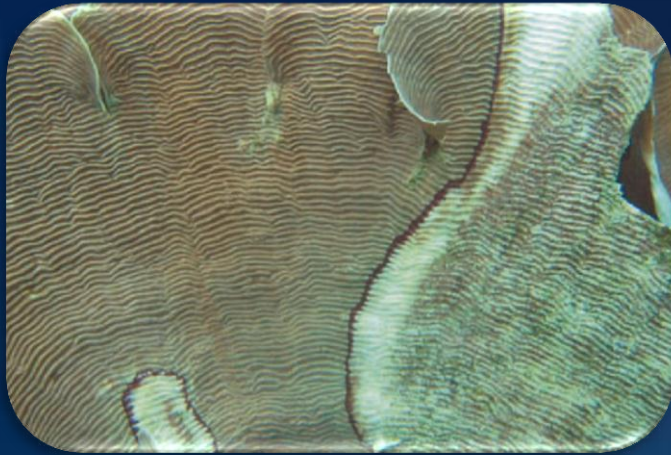
Coralline Lethal Orange Disease (CLOD)



Pink Line Disease/Syndrome (PLD/S)

(Madl 2005; CLD: Fig. 4.7; CLOD Fig. 5.8; DSD/S: Fig. 4.9; PLD/S: Fig. 4.10)

Coral Diseases



Red Band Syndrome (RBS)



White Plague Disease (WPL)



Yellow Blotch Disease (YBL)



Rapid Wasting Disease (RWD)

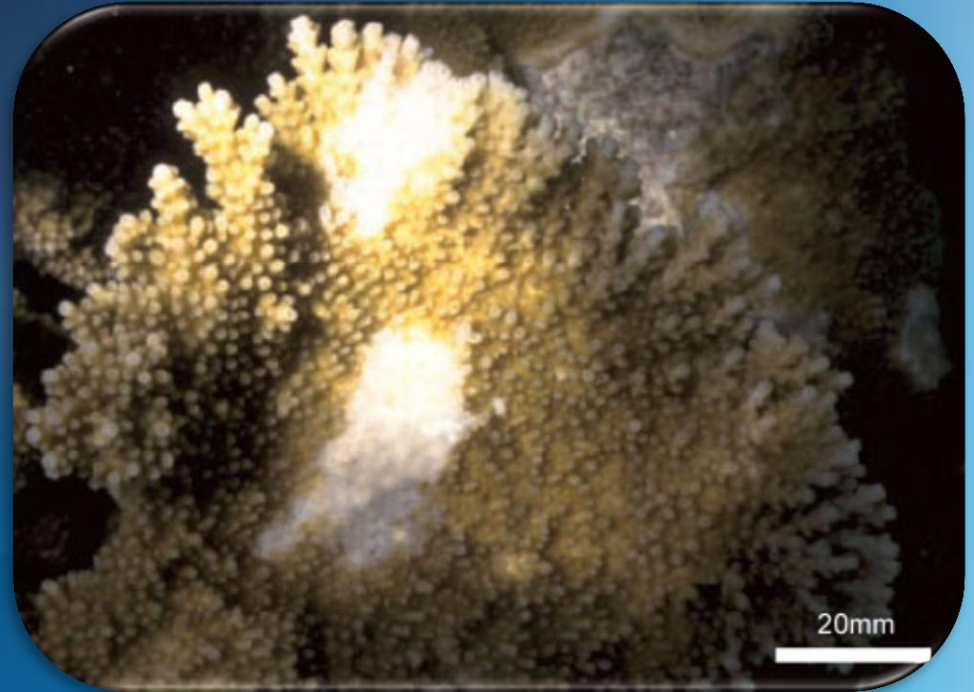
(Madl 2005; RBS: Fig. 4.11; WPL: Fig. 4.20-4.21; YBD: Fig. 4.23)

Coral Diseases

White Band Disease (WBD)



White Pox Disease (WPX)



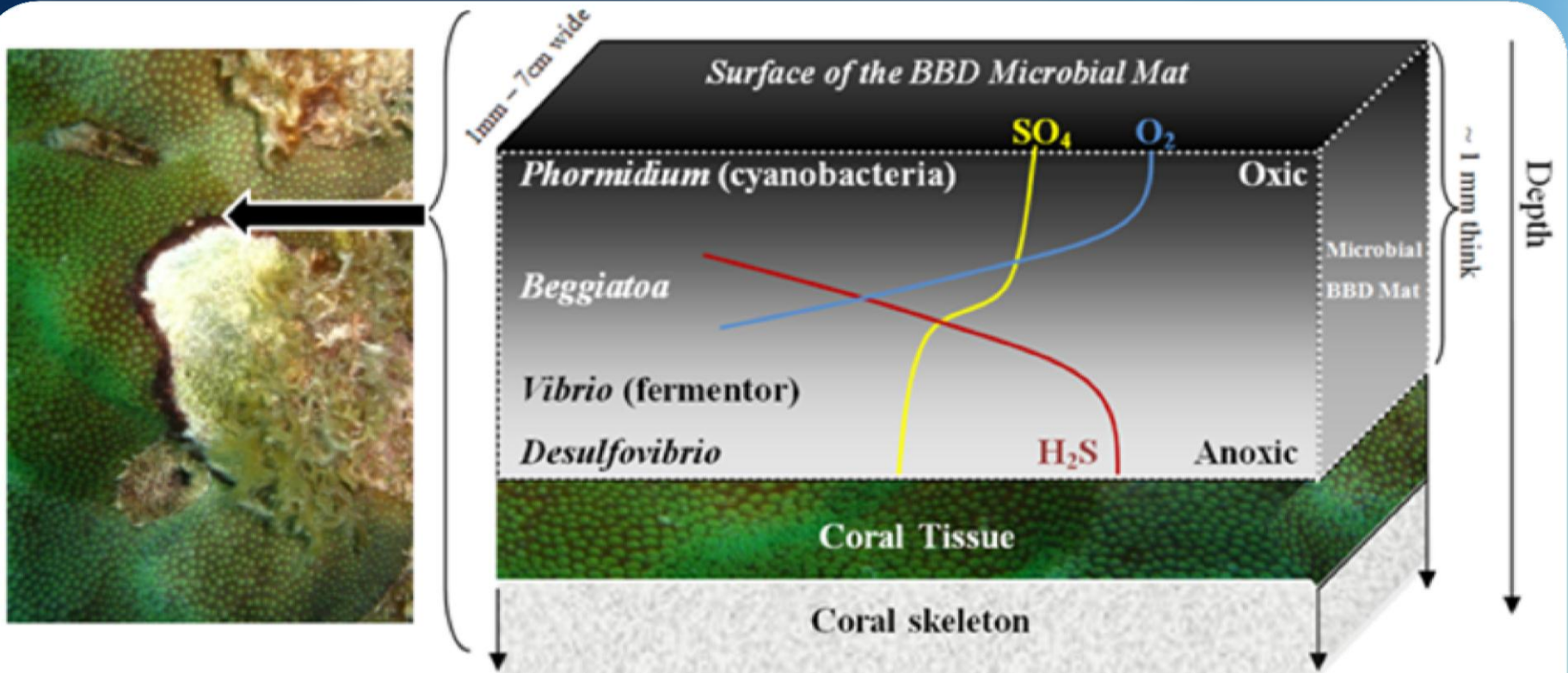
in the Caribbean WBD & WPD only affect
the coral genus *Acropora*

(Madl 2005; WBD: Fig. 4.19; WPX: Fig. 4.22)
Coral Reef Ecology

Coral Diseases



Black Band Disease (BBD)



Stylistic cross-section of the dominant microbes of the microbial consortium making up the BBD mat. *Note: this diagram is not done to scale.*

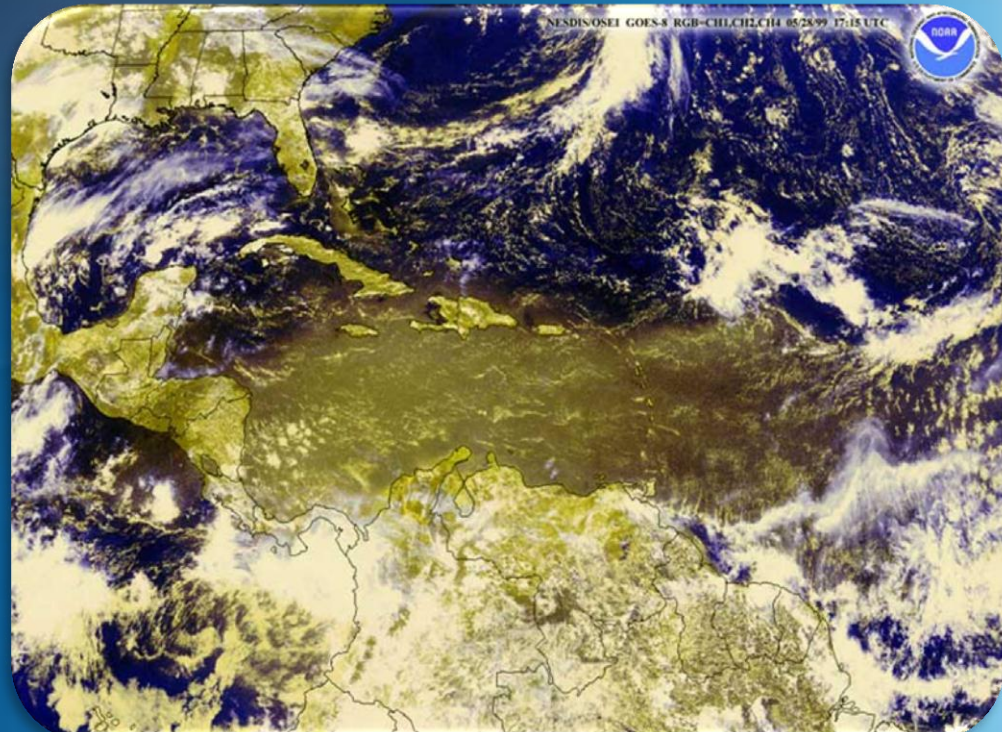
Coral Diseases

Aspergillosis (ASP)

- Caused by the terrestrial **fungus**, *Aspergillus sydowii*
- Causes irregularly shaped white crumbly patches on *Gorgonian* sea fans
- Visually identified by the **purple** line inbetween the diseased & healthy coral
- The fungus is carried from Africa to the Caribbean by the trade winds



(Madl 2005; Fig. 5.7a)



(http://coastal.er.usgs.gov/african_dust/index.html)

What can be done?

- Marine Reserves- preserve breeding stocks!
- No Anchoring
- Reduce stressors – pollution, sediment, cruise ships!
- Ban humans after bleaching events
- Seed reefs with fast growing *Acropora* spp.
- Re-introduce *Diadema* urchins
- Clean algae off dead corals to increase
- Create Artificial hard substrate for coral recruitment

Positive Note

Flower Garden Banks National Marine Sanctuary

- 110 miles from coast
- 66 ft-150 ft deep
- No anchoring
- No discharges
- Fishing by hook/line
- No take zone

- Reefs Healthy and provide breeding stock for Caribbean reefs
- Bathed in Loop Current
- Warm Eddy water



<http://www.csmonitor.com/2007/0314/csmimg/p13b.gif>

Window in the Waves: The Flower Garden Banks

10 minute Documentary Video

Quiz # 14

➤ Question:

What is the **name of the chemical compound** that corals secrete to form their “skelletion,” making up the geologic framework or structure of reefs?

➤ Answer: **Calcium Carbonate (CaCO₃)**

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