TROPICAL MARINE ECOLOGY

AT

SOUTH WATER CAYE

INSTRUCTOR'S MANUAL

for

High School Teachers

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I. COURSE OBJECTIVES

Students taking this course will study the inter-relationships of marine organisms found on coral reefs and isles, sea grass meadows, and mangrove swamps. The course runs for 5 days at 5 hours of activities a day; and includes a series of short lectures, slide and video shows, and field and laboratory activities. Students will also take part in cooperative research projects.

The objectives of this course are as follows:

a. to promote a greater understanding and appreciation of one of the most biologically diverse ecosystems on earth – coral reefs;

b. to introduce students to the inter-relationships between marine organisms and their environment and the effect of each on the other;

c. to give students a working knowledge of laboratory and field techniques;

d. to provide students with hands-on experience of the biological processes that occur on coral reefs;

e. to encourage team-work and respect for group cohesiveness.

II. COURSE SYLLABUS & SCHEDULE

Day 1: **Arrival of Students**

Activity # 1: Orientation
Activity # 2: Check-out Snorkel
Activity #3: Ecological Concepts

Day 2: **Seagrass and Beach Ecology**

Activity #1: Seagrass Ecology Lecture
Activity #2: Life in the Grassbeds
Activity #3: Beachcombers Scavenger Hunt
Activity #4: Boat Trip to Whale Shoal Patch Reef
Activity #5: Sea of Belize Video Show

Day 3: **Coral Reef Ecology**

Activity #1: Coral Reef Ecology Lecture I
Activity #2: Students Research Projects
Activity #3: Coral Reef Ecology Lecture II
Activity #4: Student Presentations
Activity #5: Reef Creature Ecology Slide Show

Day 4: **Mangrove Ecology**

Activity #1: Mangrove Ecology Lecture
Activity #2: Boat Trip to Twin Cayes and Man-O-War Caye
Activity #3: Response of Jellyfish to Varying Water Conditions
Activity #4: Plankton Study
Activity #5: Night Snorkel(Optional)

Day 5: **Beach Plant Communities and Geology of Southwater Caye**

Activity #1: Guided Tour of Southwater Caye
Activity #2: Boat trip to White Reef – Barrier Reef
Activity #3: Benthic Sampling
Activity #4: Marine Conservation

Day 1: **Arrival of Students**

4:00pm Orientation
4:30pm Snorkel Practice off Sun-deck
5:30pm Dinner
6:30pm Introduction to some Ecological Concepts

Day 2: **Seagrass and Beach Ecology**

7:30am Breakfast
8:30am Seagrass Ecology Lecture
10:00am Life in the Grassbeds Snorkel Activity
12:00 Lunch
1:00pm Beachcombers Scavenger Hunt
2:00pm Boat Trip to Whale Shoal Patch Reef
4:30pm K_Vball Competition
5:30pm Dinner
6:30pm Sea of Belize Video Show

Day 3: **Coral Reef Ecology**

7:30am Breakfast
8:30am Coral Reef Ecology Lecture I
10:00am Student Research Projects
12:00 Lunch
1:00pm Coral Reef Ecology Lecture II
4:30pm K-Vball Competition
5:30pm Dinner
6:30pm Student Presentations
7:30pm Reef Creature Ecology Slide Show

Day 4: **Mangrove Ecology**

7:30am Breakfast
8:30am Mangrove Ecology Lecture
9:30am Boat trip to Twin Cayes and Man-O-War Caye
12:00 Lunch
1:00pm Cassiopea Lab – Response of Jellyfish to Varying Water Conditions
4:30pm K-Vball Competition
5:30pm Dinner
6:30pm Plankton Study
7:30pm Night Snorkel(Optional)

Day 5: **Beach Plant Communities and Geology of Southwater Caye**

7:30am Breakfast
8:30am Guided Tour of Southwater Caye
9:30am Boat Trip to White Reef – Barrier Reef
12:00 Lunch
1:00pm Water Analysis
4:30pm K-Vball Competition
5:30pm Dinner
6:30pm Marine Conservation

III. FIELD ACTIVITIES

BEACHCOMBER'S SCAVENGER HUNT

Objective: Students will become familiar with some common fauna and flora found washed up on the wrack Line. They will also learn about the ecological functions these organisms play in the food chain.

Background: A wrack line can be described as a detrital-based ecosystem created at the high tide line of beaches during tidal inundations. Each day, tonnes of marine plants and other coral reef organisms are carried towards shore by the incoming tide and left there as the tide recedes. Since these organisms require seawater, they soon die and within a few hours start to decompose forming tonnes of detritus (organically decaying material). As the tide continues to rise and fall, more plant and animal materials are brought to shore from the nearby coral reefs and the organically decaying materials are taken back to the coral reef environment.

Bacteria and fungi are the first micro-organisms to start the decomposition process converting the plant and animal materials (cellulose and protein) into a more edible form (lignin and sugars). This is the start of an intricate food web whereby energy in the form of ditritus is passed from producers (plants) to consumers (herbivores and carnivores). In the wrack line itself, the detritus is immediately consumed by tiny crustaceans called Amphipods and Isopods or "beach flea". Small crabs that lives at the surf zone also consumes the detritus. They include the Ghost crab, Ocypode quadrata, the Fiddler crab, Uca spp., and the Spider crab, Libnia emarginata. These crustaceans in turn are consumed by marine birds such as herons, egrets, and turnstone. Any detritus that are not consumed at the wrack line are transported to the nearby grass beds and coral reef where other similar food chains are established.

The wrack line is made up of seagrass, macroalgae, bivalve and univalve shells, small pieces of corals, floating seeds, and a few manmade stuff. The most common seagrass are the turtle grass, *Thallasia testudinum* and the manatee grass, *Syringodium filiforme.* These two species are easy to tell apart; the turtle grass is flat and broad bladed, and the manatee grass is slender and cylindrical. A third species, the shoal grass is also occasionally found in the wrack line. Seagrass make up the largest biomass in the wrack line.

The macroalgae are more interesting because they come in all different variety and some even carry floatation devices. The greens most commonly seen are the Lettuce algae, Ulva lactuca, Chaeotomorpha linum, and the adorable mermaid's wine glass Acetabularia crenulata. The brown algae Sargassum spp.and Turbinaria turbinata has the highest biomass of all algae combined. Both these species carry air sacs or air bladders which they use for keeping afloat. The reds are more common and consists of the following species: Spyridia filanmentosa, Liagora spp., Wrightiella blodgettii, Acanthophora spicifera, Galaxaura oblongata, Amphiroa rigida, and Neogonolithium strictum. The red algae, Neogonolithium, is calcaerous and can easily be confused for a branching coral.

BEACHCOMBER'S SCAVENGER HUNT

Divide the class into small groups of 3 – 5. Each group will be responsible for choosing a team name and a team leader. The team leader is responsible for the identification of anything that's not clear to the group. A bit of book research should do the trick. Each team will then spend about 30 minutes scavenging for 20 items on the wrack line and rocky shore before returning back to the lab. The team leaders will then present the correct items to the Instructor who will also be keeping a score for each team. The team with the most points will receive a small treat.

1. **A feather**
2. **A shell that was attacked by an oyster drill**
3. **Driftwood**
4. **A molt**
5. **A bivalve shell**
6. **A univalve shell**
7. **Turtle grass**
8. **Manatee grass**
9. **A leaf**
10. **A volcanic rock**
11. **A green algae**
12. **A red Algae**
13. **A brown algae**
14. **Brain Coral**
15. **Star coral**
16. **Finger coral**
17. **Staghorn coral**
18. **A seed**
19. **Something manmade from the wrack line**
20. **A special treasure**

1. Describe a wrack line explaining how energy is passed from producers to consumers.

2. What is detritus and how is it produced?

3. How does a detrital food chain contribute to the general health of the reef?

4. If you were a hotelier, how would you manage your beach for guests and at the same time allowing the wrack line to perform its functions?

LIFE IN THE GRASSBEDS

Objective: Students will become familiar with a grass bed and the organisms that are associated with that community. Students will also collect a few grass blades for further observation under a microscope.

Background: Seagrass are true flowering plants (Angiosperm) that bear a vascular system and set seed. Seagrass grow in large dense beds spreading mainly by rhizomes (underground stem). They grow on a variety of loose substrates such as sand, mud, and broken shells and favors areas of calm clear water.

Turtle grass, Thallasia testudinum, is the most abundant marine grass and is probably the most ecologically important seagrass as well. Its broad blade leaves provides an excellent substrate for numerous sessile organisms to attach on. As a matter of fact over 135 species of algae are known to grow on turtle grass blade alone. Other organisms commonly found on turtle grass blades are: turtle grass anemone, Viatrix globulifera, feather tree hydroid, and the bicolor flatworm, Pseudoceros bicolor.

Manatee grass, Syringodium filiforme, is usually found interspersed among the turtle grass; however, these species can establish distinct zones of monospecific stands from the beach to the reef flat or lagoon. When this occur, the shoal grass and manatee grass are found close to shore and the turtle grass is found near to the reef environment. The two main environmental parameters influencing the distribution of these seagrasses are salinity and water temperature. Nearshore, the water temperature and salinity can fluctuate quite rapidly depending on the time of the day and the weather condition. For example, a thunder shower (which could last 30 – 50 minutes) can lower the salinity of the seawater immediately around the caye due to surface runoffs. There is also the possibility of freshwater seepage from the groundwater table into the nearby seawater. It therefore appears that the shoal grass and manatee grasses are more tolerant to a wider salinity and temperature range than turtle grass. It seems that turtle grass prefer a similar environment as corals. This is also why there is no hard coral growing right up to the beach.

Seagrass perform many important ecological functions. Here are some role seagrass play in maintaining a healthy environment. It supply nutrients to adjacent habitats (eg. coral reefs). It filters sediments from the water column thus allowing light to penetrate through. Feeding grounds for coral reef fishes. Aerate the water with a constant supply of O2 during photosynthesis.

LIFE IN THE GRASS BEDS

Divide the class into 3 groups. Each group will choose a team leader before going into the water. The team leader will be responsible for organizing the group and making sure that the data sheets are completed. Each team leader will be given a pre-designated study site. Read the questions before you snorkel in the grassbeds. Travel slowly and take care you don't stand up on the grasses.

1. **Are turtle grass and manatee grass evenly distributed? If not, what seems to characterize their respective locations?**

2. **In certain locations the grass looks like it has been "mowed". How can you account for this phenomenon?**

3. **What evidence in the water column can you find that shows that photosynthesis is taking place?**

4. Slowly swim through an open area of grass and then do the same at an interface (adjacent to the sandy bottom). What differences do you notice in the numbers, species and size of fishes found in these two areas? Are there also differences in the activity of the fishes?

5. What ecological purposes do the grass beds serve?

6. Collect several blades of turtle grass and examine its content under a microscope. Identify as much organisms that are attached to the grass blades.

LIFE IN THE MANGROVES

Objective: Students will be able to identify three species of mangroves. They will be able to define the term mangrove and list ecological and economical values of mangrove forests. They will be able to describe a detrital-based food chain.

Background: The term mangrove can refer to a species of tree or to a forest community. There are approximately 50 species of true mangroves worldwide and another 60 or so species of mangrove associates. They are generally found between 25 degrees north and 25 degrees south of the equator. They are not necessarily phylogenically related. Mangroves are defined as: 1. A halophyte (salt tolerant), 2. They tend to grow in loose soil and display some root modifications capabilities, 3. They depend on tidal flux to disperse propagules, and lastly, 4. They display some degree of viviparity.

The red mangrove, Rhizophora mangle, tends to dominate overwashed islands, fringe forest, riverine forest and dwarf forest. The black mangrove, Avicennia germinans, dominates the basin forests. The white mangrove, Laguncularia racemosa, is found mixed with other mangroves and usually inhabits the high back berms. The buttonwood, Conocarpus erectus, is not a true mangrove but is found in the mangrove community.

Mangroves perform many important ecological functions and are of economic value to humans as well. Here are some values to mangroves: prevents erosion; protect islands and coastlines from the destructive energies of storms and hurricanes; supply nutrients to support adjacent ecosystems (eg. Seagrass and coral reefs), filter stormwater runoffs; nursery for coral reef fishes; nectar source for bees / $3 million per year.

LIFE IN THE MANGROVES

You will be walking through a mangrove forest carefully recording what you observe. You will also be snorkelling in a mangrove channel making observations as well.

1. Differentiate between the three species of mangroves and draw their identifying characteristics.

2. List four characteristics that identify the term "mangroves".

3. Name at least six reasons why mangroves are considered valuable.

4. **Look at the ground around the red mangroves. Is there a great amount of leaf accumulation? Why?**

5. **What benefit is it to the red mangroves to have so many supporting roots?**

6. **Mangroves drop their leaves continuously. Is this a benefit to the tree? Explain how this represents another detrital food chain.**

7. **After snorkelling in the mangroves, list the organisms found on the prop roots. Differentiate between those found above the tide line and those found below the tide line.**

WATER ANALYSIS

Objective: Students will learn and perform the proper procedure for 5 water quality tests. They will understand the importance of water quality monitoring. Students will run tests for: Salinity, Dissolved Oxygen, pH, Phosphate, Nitrate using a HACH Kit.

Background: In marine biology, there are water quality tests that need to be made to determine productivity of reefs. The tests you do in this lab are the same ones that help researchers determine the stability of the marine environment.

WATER ANALYSIS

Divide the class into 3 groups. Each group will choose a team leader before going into the water. The team leader will be responsible for organizing the group and making sure that the data sheets are completed. Each team will be given a pre-designated study site where tests for salinity, dissolved oxygen, pH, phosphate, and nitrate will be done. Inside each test kit are a set of instructions. Follow these instructions step by step. After each test, asked each student to write their results on the data sheet along with any conclusions.

WATER QUALITY DATA SHEET

Parameter	**Sandy Bottom**	**Seagrass Bed**	**Coral Reef**	**Comments**
Salinity				
PH (Alkalinity)				
Temperature				
DO				
Phosphate				
Nitrate				

1. **Did the salinity and temperature differ as the habitat changes? If so, why?**

2. **Did the dissolved oxygen remain the same for all three sites? If no, what can you say about the productivity of the three sites?**

3. What causes changes in DO level?

4. Is the pH acidic or basic? Why?

5. Where and how do the above nutrients originate? Explain the importance of these two nutrients in maintaining a stable marine environment.

IV. LABORATORY ACTIVITIES

PLANKTON STUDY

Objective: Students will be able to recognize and identify several types of zooplankton and phytoplankton. They will also be expected to distinguish between holoplankton and meroplankton.

Materials: plankton sample, microscopes, slides and cover slips, plankton key, eye dropper.

Background: Plankton is defined as any free floating organisms unable to swim against the currents. They are usually found in the upper 200 meters of the water column. The term plankton means wanderer or drifter in Greek. Plankton rely on currents for their means of locomotion and can range in size from microns to the large ocean sun fish at 10 meters. Plankton is a vital part of the food chain in both fresh and marine waters. Plankton is able to stay in the upper regions of the photic zone by using special adaptations such as: spines which increase surface area; and secreting oil on their body surfaces to increase buoyancy and retain a high surface to volume ratio. Phytoplankton is the world's number one source of oxygen and they produce about 90% of all photosynthetic processes that take place on earth. Because of the above facts, one can see how important phytoplankton is as the base for marine life.

The next level up from the phytoplankton are the zooplankton. These animals eat the phytoplankton and serve as a stable food source for the larger marine organisms. Zooplankton can be classified into two types of organisms. Meroplankton, which are organisms that spend only part of their life time as plankton and holoplankton which are organisms that spend their entire lives as plankton.

PLANKTON STUDY

Five students will be asked to collect plankton for the class. For this particular lab, plankton will only be collected at night. To collect plankton, a plankton net will be towed behind a boat for about 5 minutes, at one foot below the water's surface. Cap vial and return to lab. Using an eyedropper, take a sample of palnkton from the vial and view the plankton under the microscope. Begin with low power and observe the organisms. With a video flex, attach the microscope to the television and adjust the focus to display the organisms on the screen. Record your observations.

PLANKTON DATA SHEET

Name	Phylum	Phyto or Zoo	Structural Adaptations	Mero or Halo

1. Draw two organisms that you recorded and include any structural adaptations that you can identify.

2. Were there any recognizable difference in the numbers of phytoplankton and zooplankton? If so, Why?

3. How does the food chain in the ocean compare to that of a sea grass or mangrove community? How do they differ?

4. Explain how does plankton contribute to the general health of the coral reef environment.

RESPONSE OF JELLYFISH TO VARYING WATER CONDITIONS

Objective: Students will demonstrate understanding of how an estuarine organism will respond to varying water (salinity and temperature) conditions.

Materials: jellyfish, thermometer, plastic jars, graduated cylinder, ice, burner (stove), small net.

Background: The up-side down jellyfish, Cassiopea frondosa, is a member of the phylum Cnidaria. The characteristics of this phylum include radial symmetry, a simple internal cavity and nematocysts (stinging cells). It is an unusual jellyfish in that it has 8 oral arms and is able to release its nematocysts even though they are not powerful enough to penetrate callous skin such as hands. However, non-callous skin (neck, face) can be sensitive to the sting.

The relationship between the Cassiopea and the one celled algae, zooxanthellae, is an excellent example of symbiosis (any relatively long-term relationship characterized by interdependence between two species.) It is a mutualistic relationship where both organisms benefit. The zooxanthellae live in the tissues of the oral arms. Along with exchanging oxygen, waste product removal, and food, the jellyfish modifies its behavior by lying "upside down" at the bottom to permit the algae to photosynthesize.

Because of the zooxanthellae, the Cassiopea is able to live in stressful environments. The salinity of shallow semi-enclosed areas changes rapidly in response to rain and freshwater run-offs. During the hot/dry part of the year, the water may become hypersaline due to evaporation. The jellyfish responds by either increasing or decreasing its pulse rate.

RESPONSE OF JELLYFISH TO VARYING WATER CONDITIONS

Observe Cassiopea in a small, shallow container half-filled with sea water. Record the temperature. Count the number of times the Cassiopea pulses within a one minute time period. It is important that you stress the organism as little as possible. Slowly pour in 100ml of warmed (37 degrees C) salt water. Wait two minutes. Record the temperature of the water. Count the number of pulses per minute. Place the container on a block of ice. Wait for three minutes. Record the temperature of the water. Record the pulse rate. Students might want to count the pulse rate for each set of experiments at least twice and then find the average.

JELLYFISH TEMPERATURE DATA SHEET

Prepare another container that is 75% sea water. Normal sea water has an average salinity of 35 ppt. 75% sea water is 27 ppt. Place the jellyfish in the 75% sea water solution. Allow it to adjust for two minutes, then record the pulse rate per minute. Repeat with 50 % sea water, which is 17 ppt and a 10% se water which has a salinity of 35 ppt. Record the pulse rate per minute. Again students might want to count the pulse rate for each set of experiments at least twice and then find the average.

JELLYFISH SALINITY DATA SHEET

Parameter	Pulse Rate 1	Pulse 2	Average
100% Sea water			
75% Sea water			
50% Sea water			
10% Sea water			

1. **In which sea water did the Cassiopia pulse the fastest? The slowest? Why do you think this is so?**

2. **Why does the jellyfish react to heated water?**

3. **What combination of salinity and temperature do you think would result in the highest pulse rate?**

4. **Based on your data, what habitats would be Cassiopia be best suited for?**

5. **Graph your results of the Cassiopia experiment. Place the number of pulses per minute on the vertical axis, and the various water conditions on the horizontal axis.**

COMMENSALISM IN THE RINGED AND GIANT ANEMONE

Objective: Students will demonstrate understanding of the intricate relationship that exists between two dissimilar organisms and the degree of dependence of one on the other.

Materials: Alpheus and Bartholomea anemones with shrimp, aquarium, thread

Background: Over the course of evolution, many marine organisms have improved their chances of survival by developing a close association with some other organisms. Most marine organisms spend at least part, if not all, of their lives living on or with another organism. These types of relationships are called symbiotic. Symbiosis can then be defined as two dissimilar organsisms living in close association, regardless of the harm or benefit to either.

In some symbiotic relationships, the two organisms are physiologically dependent on one another (eg. coral and zooxanthellae). In others, the organisms could just as easily live apart. Although it is difficult to categorize symbiotic associations, three general types are recognized:

1. **Mutualism:** both organisms benefit from the association
2. **Commensalism:** one organism benefits, the other is unaffected
3. **Parasitism:** one organism benefits, the other is harmed

The reasons for symbiosis are also hard to pinpoint. An association may involve one or more of these elements:

1. **protection**
2. **food**
3. **cleaning**
4. **transportation**

COMMENSALISM IN THE RINGED AND GIANT ANEMONE

Place the ringed anemone, Bartholomea annulata, in an aquarium filled with sea water. Using a piece of thread, tag two of the shrimps and place in the aquarium. Observe if the shrimp will take up residence. Remove the shrimps. Place a second ringed anemone in the aquarium and tagged two more shrimps. Use a different color thread for the second pair of shrimps. Place all four shrimps in the aquarium. Observe if the shrimps will take up residence together or maintained their original pair-bonds.

Place two Condylactis anemones and one Bartholomea in an aquarium. Add a pair of shrimp. Observe if the shrimp will select the Bartholomea.

1. **Did the shrimp take up residence together?**

2. **Have the original pair-bonds been maintained?**

3. **Have the pairs chosen their original anemones?**

4. **Which organism do you think is benefiting from this relationship? Explain what bebefits the orgainsm is receiving.**

V. STUDENT PROJECTS

STUDENT PROJECTS

Objective: Students will become familiar with some of the ecological processes and inter-relationships of various coral reefs organisms. Students will choose a research project before going into the water to collect observational data. Students will also be asked to present their results to the rest of the class.

Background: Since each project pertains to a specific ecological process or interrelationship, it is rather more beneficial for both teachers and students to research these topics in books. Below is a list of references.

1. Coral Reefs by Eugene Kaplan. Parrotfishes, pgs. 206 – 247. Territoriality in Damselfish, pgs. 211 – 215. Cleaning Symbiosis, pgs. 246 –250.
2. Marine Biology by Herbert Webber/Harold Thurman. Schooling of Fishes, pgs. 138 – 141.
3. Marine Life by Sumich. Color in Fishes, pgs.
4. Reef Fish by Paul Humann.
5. Reef Creature by Paul Humann.

COLOR PATTERNS IN REEF FISHES

Review the section on Color in the Coral Reef book before conducting your fieldwork. Draw six fish outlines on an underwater slate and then snorkel out to a safe area on the reef. Remaining in one position over a clump or patch of reef, randomly select one fish concentrating on color and pattern. Don't try to identify the fish. On your slate, record the patterns and note the colors. Try to document at least six fish. After completing your fieldwork, prepare a 10 minute presentations based on the questions provided and the data collected.

1. What sort of pattern was the most common? Explain how these patterns help in the survival of the fish.

2. What colors were the most common? Explain how these colors help in the survival of the fish.

SCHOOLING OF FISHES

Review the section on Schooling of Fish in the Marine Biology book before conducting your fieldwork. Take a walk on the dock or swim over a grassbed area to locate a school of fish. In this case you may want to choose a school of sardines for your study. Make general observations on size, species, numbers, movement, spacing, and feeding behaviour.

Place a decoy in the shape of a predatory fish (eg. barracuda) at the end of a rod. Swim slowly towards the school with the rod. Position the decoy along the periphery of the school. Then place the decoy at the middle of the school. Record your observations. After completing your fieldwork, prepare a 10 minute presentation based on the questions provided and the data collected.

1. **Are all the fish of the same species? Are all the fish of the same size? If so, why might this be?**

2. **Approximately what shape is the school? (spherical, cylindrical, sheetlike, etc.)**

3. **Make an estimate on the number of fish in the school.**

4. **Describe the swimming pattern of the fish within the school. Are the fish swimming parallel to each other? Is the spacing between the fish nearly uniform most of the time?**

5. **Explain what happens to the spacing and speed if the fish are startled by the decoy. How can you account for this uniform and well orchestrated movement ?**

6. **List at least four reasons why fish form schools.**

TERRITORIALITY IN DAMSELFISH

Review the section on Territoriality in Reef Fishes in the Coral Reef book by Kaplan. Swim out to a safe area on the reef and locate a damselfish. Slowly approach the fish and observe its behavior for several minutes. Then wait until another fish approach the damselfish territory. Record your observations. After completing your fieldwork, prepare a 10 minute presentation based on the questions and the data collected.

1. What's the approximate size (eg. in radius) of the damselfish territory?

3. Is the damelfish grazing or brooding its eggs? If so what evidence do you have of this?

3. How does the damselfish react if it is approached by other fishes? What evidence do you have of its territoriality?

4. Is there signs of aggression only with other herbivores? Or are all would be predators ward off as well? Explain.

CLEANING SYMBIOSIS

Review the section on Cleaning Symbiosis in the Marine Biology book by Webber/Thurnman. Snorkel out to a patch reef and locate a cleaning station. You may need to spend a while (about _ hour) before any "customer" shows up. Record any cleaning behavior on your slate. After completing your fieldwork, prepare a 10 minute presentation based on the questions provided and the data collected.

1. Describe what happens when a "customer" first approached the cleaning station.

2. How do the "cleaners" react when a customer approaches?

2. Are there evidence of communications through color changes, dances, etc.? Explain.

3. Describe the method the cleaner fish use to clean their customers.

4. How long is the average cleaning job?

VI. CLASSROOM LECTURE NOTES

SEAGRASS ECOLOGY

Definition:

Seagrass are true vascular plants that flower and set seeds and are among the very few true plants that are totally adapted to the marine environment. It grows in areas where there is protection from wind-driven currents and wave activity.

Geographic Distribution:

There are over 50 species of seagrass that can be found in both temperate and tropical regions of the world. In temperate regions such as, the eelgrass or Zostera can be found …………… In tropical regions such as Belize, the dominant seagrass is the turtle grass or Thallasia …………….

Ecological Adaptations:

The leaves have no stomata; instead, CO_2 is absorbed across the leaf surface (epidermis).

Pollen is dispersed by water & fertilization is by a chance encounter of the pollen grain with a flower.

The vascular system (transport of fluid) is poorly developed, so nutrients in the form of NO_4 and PO_4 are absorbed directly from the seawater across the leaf surface.

Ecological Functions:

Considered one of the richest biological communities, producing a high rate of plant material. For example, ………… However, few animals eat seagrass directly. Examples are the West Indian manatee, Trichechus manatus, the Green turtle, Caretta caretta, the parrotfish or Scaridae family, Surgeon fish, family Acanthuridae, and sea urchins. Might want ot mention halo. Less than 5% of the plant material produced by this community iseaten by herbivores. The remainder breaks down and enter the detrital food chain.

The blades of seagrass also provides an excellent substrate for organism to grow on. For example, about 103 spcecies of micro and macro algae have been found on Thallasia blades. Several species of snails, polychaete worms, and isopods also inhabit the grass blades.

It provides a refuge where animals can hide against predators.

It also stabilizes the sediment.

It act as a biological filter trapping sediments from the seawater as the blades reduces or baffles the velocity of the oncoming current.

CORAL REEF ECOLOGY I

Definition:

Corals are tiny animals that generally group together by the thousands, forming colonies that attach to hard surfaces of the seafloor. By drawing calcium carbonate from seawater they build skeletal structures in an infinite variety of shapes and sizes. Those species, known as reef building corals, produce massive skeletons that collectively form the limestone framework of tropical reefs (Humann, 1994.). Corals together with the vast array of animals and plants collectively make the coral reef.

Types of Coral Reefs:

Coral reefs are generally defined by their overall structure and the geological conditions under which they evolved. There are four basic types of coral reefs.

Fringing Reef grows out from shore and lacks a lagoon. It is characterized by a variety of coral types, often with no species dominating or forming zones. It is an area where rocks have provided a suitable foundation for the planula larva to settle and grow. Fringing Reefs are common in the Caribbean and Bahamian islands, and rare to absent along the Florida coast. They are geologically the youngest type of reef.

Barrier Reef grows parallel to the coastline and are separated from the coastline by a lagoon. It is characterized by a number of more or less clearly defined coral zones that extends seawards. The outer edge of the coral zone or fore reef drops from the island platform or continental shelf into deep water. The leeward side of the barrier reef is characterized by a shallow lagoon. The floor of the lagoon is composed of coral sand and rubble with vast areas of vegetation. It ranges in width from less than 150 meters to 50 kilometers. The depth of the lagoon ranges from less than 1 meter to more than 20 meters. The best example in the Western Hemisphere is the Belize Barrier Reef located off the Central American coast of Belize.

Atolls are open sea reefs that form rings, ovals or horseshoe-shapes around a shallow lagoon. It is characterized by a number of more or less clearly defined zones. The seaward margin of the coral zone drops vertically into deep water forming “walls” along the fore reef zone. The floor of the lagoon is composed of coral sand and rubble with areas of vegetation. Atolls are commonly found in the Pacific Ocean. The best examples in the Western Atlantic are Lighthouse, Glovers and Turneffe off Belize, Chinchorro off Yucatan, and Hogsty in the Bahamas.

Patch Reefs are small, isolated reef areas unattached to any major reef structure. They grow from the open bottom between fringing and barrier reefs. It can vary in size from several square meters to several square kilometers.

Origin of Coral Reefs:

The first attempt to explain the formation of coral reefs was made in 1842 by Charles Darwin. In his book on the Structure and Distribution of Coral Reefs, Darwin offered the **Subsidence of Land Hypothesis** to help explain how coral reefs are formed. He suggested that barrier reefs began as fringing reefs along the shores of volcanic islands. Over million of years the land subsided, sinking lower and lower into the sea. Coral grows best within the zone of light penetration (ie. within 50 meters of the surface). As the land subsided, the coral growth kept up with the apparent rise of the sea level, allowing the reef to remain only a few meters below the surface. The outermost portion of the reef, with best access to the plankton being carried landward by ocean currents, grew faster because it had more food available. The result was a wall of coral that grew higher and higher. It was increasingly separated from its island by the conical nature of the volcano which becomes narrower towards its peak. The barrier reef, then, originated as a fringing reef along shore; as the island receded beneath the sea, the reef became more and more distant from shore. The landward portion of the reef, unable to keep up because of a lack of food, died, hence the formation of the lagoon between land and reef. As the island continues to subside and disappears beneath the sea, the coral reef continues to grow upward forming a ring of reef around the cone of the volcano. The result is an atoll, a ring of coral reefs, the descendants of the barrier reef.

In 1919, Reginald Daly proposed an alternate hypothesis called the **Glacial Control Theory**. According to Daly, during glacial periods in the earth's history, much of the water budget of the earth was tied up in the huge ice caps covering parts of North America, Europe and other continents. The generally cold climate retarded evaporation and rain was sparse. The sea level fell at least 60 meters below what it is present. The coral was killed by the cold water, and the land masses were left unprotected. The ocean surf, during thousands of years of glacial dominance, beat away at the shores, cutting platforms in the rock. When the glaciers receded and the climate warmed, the coral began to flourish, finding the wave-cut platforms suitable substrates. AS the sea level rose from the melt-water of the glaciers, the seaward edge of the platform supported the most rapid coral growth. Only the coral on the outer edge of the platform could keep up with the rising water. This produced the barrier reefs and their accompanying lagoons. Atolls formed on the platforms surrounding drowned islands.

According to researchers, some reefs have evolved according to the method described by Darwin, and some have formed on wave-cut shelves, as Daly suggested. In the Pacific Ocean where the majority of the islands are volcanic in origin, Darwin's Hypothesis holds true. In the Caribbean and tropical Atlantic waters, the evolution of coral reefs was interrupted by recent glaciation some 20,000 years ago. Coral reefs found in this region are much younger than in the Pacific (80,000 – 100,000 years old).

Structure and Zonation of the Belize Barrier Reef

A barrier reef is composed of several more or less clearly defined zones each with its own set of feature and group of organisms. The main reef system can first be divided into two major areas: the **reef crest** and the **fore reef**, each comprising a number of zones. The general geomorphology and zonation vary from reef to reef, so below is a generalized profile or cross section of the Belize Barrier Reef.

Reef Crest:

Reef Flat – Also called the **Rubble Zone** or **Zoanthus Zone**, this area is where the floor of the sea flattens out before it reaches the breaker zone. It ranges in width from 50 meters to over 400 meters on some old Pacific reefs. The depth only reaches 20 inches.

Palmata Zone – Also known as the breaker zone, this area is where the waves crashes with full force on the reef. It extends from the surface to a depth of about 5 meters.

Fore Reef:

Inner Fore Reef – Beyond the palmata zone, the reef continues to slope downward to a depth of 10 meters. This zone is known for its spur and groove formations which are long ridges of corals separated by valleys of sand that generally run toward the direction of the prevailing wave.

Outer Fore Reef – Within this zone, the spur and groove formations continues to grow downward to a depth of 12 meters before it drops almost vertically to a depth of 20 meters. At the bottom of this vertical wall is a sand trough. Next to the sand trough is a coral ridge that grows upwards to within 12 meters of the surface before it slopes back downwards to several hundred meters.

Conditions Necessary for Coral Growth:

For coral reefs to develop and flourish, certain environmental parameters has to be present. These conditions include water temperature, movement, salinity, clarity, and a firm foundation for attachment. **Water Temperature** must be between 70 and 85 degrees Fahrenheit for the reef building corals to grow. Some individual species, however, can survive below or above these points but do not grow at a rate sufficient to construct reefs.
Water Movement provide a constant re-supply of fresh planktonic food and oxygen to the millions of hungry mouths on the reef.
Water Clarity play a very important role by allowing light to reach the zooxanthellae laden coral tissues. Like temperature, the **Salinity** of the water must be between 32 and 35 parts per thousand. Some species of hard and soft coral can survive in waters that are occasionally flooded with freshwater run-offs.

Like a building that needs a **Foundation** for it to stand, corals require a firm clean substrate or foundation to support its calcium carbonate weight. In the Pacific region, it is the volcanoes that support the weight of the coral reefs. In the Caribbean and Atlantic region, it can be either the wave-cut platform along coastlines or fault blocks beneath the sea.

Ecological Functions Of Coral Reefs:

Coral reefs play many important role in keeping the marine environment clean and healthy. Here are some important ecological functions of coral reefs.

CORAL REEF ECOLOGY II

Phylum: Cnidarians

Characteristic of the Phylum:

Cnidarians have a simple anatomy consisting of a **cup-shaped body**, with a large body cavity or **gastrovascular cavity**. At the oral end is a single central opening or **mouth** encircled by **tentacles**.

The gastrovascular cavity is used primarily for the digestion and distribution of food. Since all Cnidarians have no anus, waste product is removed by diffusion across the tissues or by excreting it through the mouth.

A unique characteristic of this Phylum is the presence of numerous stinging capsules, called **nematocysts**. These nettlelike stinging darts, located primarily on the tentacles, are used for defense and capturing of prey. They also contain a circlet of tentacles around the mouth for capturing prey and directing food to the mouth.

Life Cycle:

A unique characteristic of this Phylum is the ability of some species to reproduce both asexually and sexually. This elaborate life cycle is referred to as **Metagenesis or Alternation of Generation**. In one phase, the organism is sessile (eg. coral) growing asexually by budding off new polyps to form a colony, and in another, the organism can produce (through budding) a free-swimming medusa (eg. jellyfish) whose only function is to carry the gametes (eggs and or sperm) and ensure that fertilization takes place.

Following fertilization, the free-swimming medusa metamorphoses into a **planula** larva. The planula larva floats in the plankton for several days before it metamorphose into a young polyp completing its sexual phase. The young polyp then starts to once again reproduce asexually forming a colony of polyps. The colonial hydroid, Lytocarpus spp. is a good example.

Anatomy of a Polyp and Medusa:

Taxonomy:

Cnidarians are classified based on the extent to which 1 of the 2 phases of the life cycle is reduced.

1. Class: Hydrozoa

In this class the polyp phase is dominant and the medusoid stage is often reduced or absent. If the medusa is present, it is often short-lived. Species within this class generally form colonies of polyps on rocks and seagrass blades. Examples are fire corals, hydroids, and siphonophores.

2. Class: Scyphozoa

In this class the medusoid phase is dominant and the polypoid stage is reduced or absent. Most species within this class have a floating gel of mesoglea within their tissues to keep them afloat. Example is the jellyfish.

3. Class: Anthozoa

In this class, the mudusoid stage is absent. The polyps often form elaborate colonies. Examples are the sea anemones, soft corals, and hard corals. Anthozoans can further be divided into hard and soft corals depending on the type of skeleton they secrete.

The polyps of hard corals deposit around themselves a solid skeleton of calcium carbonate. Each individual polyp is housed within a cup or **corallite** into which it withdraws in the daytime. Inside each corallite are thin partitions or **septa** of calcium carbonate used by the polyp for added support. When the polyp dies, it leaves behind a distinctive pattern of radiating walls inside the cup. At the center of the radiating partitions is a central supporting rod called the **columella**. This structure provides support to the mouth and gastrovascular cavity of the polyp. In some species of hard corals (eg. brain coral), the polyps share a common wall of fused corallites. The result is a coral colony or **corallum** of sinuous valleys and ridges.