2 Quantify coral reef biodiversity patterns using

NMITA Neogene Marine Biota of Tropical America

Lesson 2: Gather data to test hypotheses about biodiversity change through time

This lesson is designed to help you learn how to use a biodiversity bioinformatics database known as NMITA to test hypotheses about coral reef biodiversity change through time. Lesson 1 reviewed the overall structure and data contained in NMITA. Lesson 2 takes you on a virtual journey to the Dominican Republic, a country located on the island of Hispañola in the Caribbean Sea. On the island you will explore the marine fossil corals and coral reefs that occur in different sedimentary rock layers that were formed when parts of the island were under the Caribbean Sea. You will also explore the diversity of living coral reefs from the southwestern part of the country. You will collect coral reef biodiversity data from six different time periods in order to determine if coral reef biodiversity has increased, decreased, or stayed the same over the past 20 million years in the Dominican Republic. You will collect 3 samples from each of the 6 time periods. An additional lesson (Lesson 3) is provided that builds upon what you learn here. It explores *ecological* patterns of biodiversity change in the same coral reef samples that you study here.

Key Terms:

Hypothesis
Biodiversity
Coral reef
Species
Miocene
Holocene
Database
Sedimentary rock
Pliocene
Pleistocene

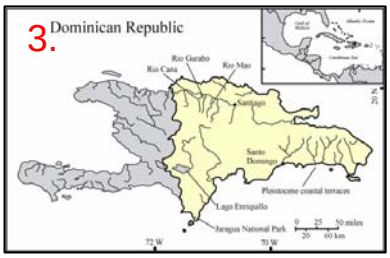
Key Concepts:

Evolution
Extinction
Speciation
Sampling
Dating rock

1.

2.

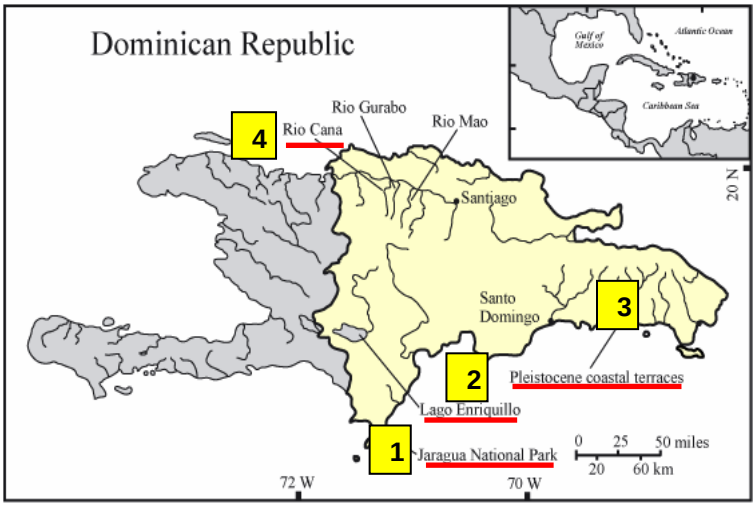
3.



Directions:

1. Go to NMITA http://porites.geology.uiowa.edu/index.htm
2. Click Maps & Faunal Lists
3. Click Dominican Republic

4. Note the map of the Dominican Republic. You will be collecting coral reef biodiversity data from **four** major regions: (a) **Jaragua National Park** (Recent); (b) **Lago Enriquillo** (Holocene); (c) Santo Domingo (**Pleistocene coastal terraces**); (d) **Rio Cana** (Middle Pliocene, Early Pliocene, and Late Miocene). Be sure that you can find all four localities on the map.



5. Take out the **lesson 2** data worksheets. You will notice that we are studying **3** samples from **each** time period (e.g., Holocene). Data for some samples are already filled in for you and the total number of species for that sample has been tabulated.

6. To finish this activity you will need to sum the total number of species for **18** data points.

7. In order to gather data, click on the name of each region (e.g., Jaragua National Park) and then click on the sample number or **locality listed on the data worksheets** (e.g., region Jaragua National Park locality "Cabo Falso.") **Detailed visual instructions are shown on the next page.**

8. Copy the list of species that occur at the locality to your worksheet.

9. Count the total number of species and write it at the bottom of the data cell.

10. Repeat step 9 until you have filled in all of the coral species that occur in all of the samples.

11. When you are finished, you should know the number of coral species that occur in 3 samples from 6 different time periods (Recent, Holocene, Pleistocene, Middle Pliocene, Early Pliocene, and Upper Miocene). You will therefore have 18 total data points.

12. Take out your **Lesson 2 analysis worksheet**. On this worksheet you will plot the data points on coral reef biodiversity in the Dominican Republic from the Miocene to today.

How to use NMITA to gather biodiversity data

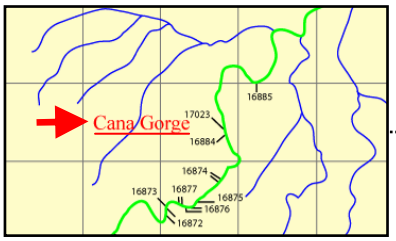
1

Go to: http://porites.geology.uiowa.edu
Click on: Maps & Faunal Lists
Click on: *Dominican Republic*
A map of the Dominican Republic will appear.

2

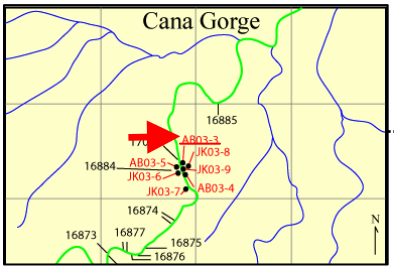
Note the rivers west of the city of Santiago. These rivers have exposed sedimentary rock rich in coral and mollusk fossils.
Click on the river *Rio Cana*

3



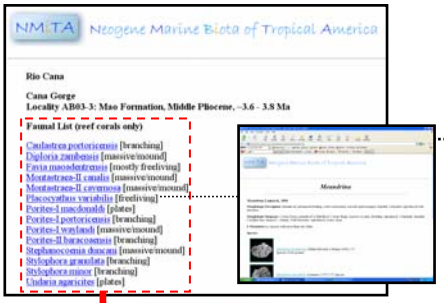
A detailed map of the Rio Cana will appear along with small tributaries.
Note the three main regions of the river.
Click on *Cana Gorge*.

4



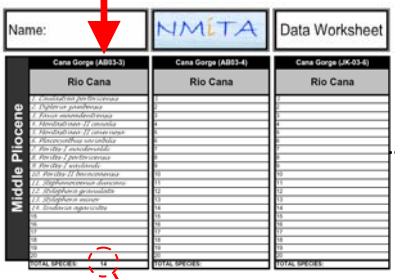
A detailed map of the Cana Gorge locality will appear along with sample localities. We will be studying three localities from Cana Gorge
Click on locality *AB03-3*

5



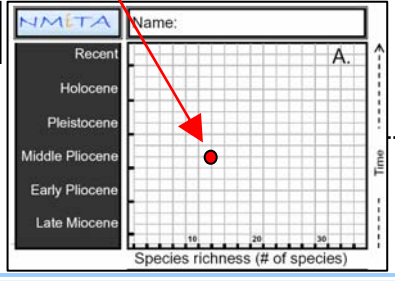
A data screen will appear with information on the sample and the coral reef species that occur in the sample. Next to each genus and species is the shape of the coral species. You may click on each species to learn more about it.

6



For one of the lessons you will be comparing the number of coral reef species through time.
Take out your Data Worksheet and transfer the data for Rio Cana sample "Cana Gorge AB03-3" to the worksheet.

7



Take out the Analysis Worksheet. You will plot the number of species that you found at Cana Gorge AB03-3 on the graph. You will repeat this process in order to determine how coral reef biodiversity has changed from the Late Miocene to Recent.

Name:

Lesson 2
Data Worksheet

Living today

	Los Carraplanes (2)	Cabo Falso (5)	Bahia Honda en Cabo Rojo (8)
	Jaragua National Park	**Jaragua National Park**	**Jaragua National Park**
1		*Acropora palmata*	*Acropora cervicornis*
2		*Acropora cervicornis*	*Undaria agaricites*
3		*Undaria agaricites*	*Undaria pusilla*
4		*Undaria pusilla*	*Agaricia lamarcki*
5		*Helioseris cucullata*	*Agaricia grahamae*
6		*Agaricia lamarcki*	*Agaricia fragilis*
7		*Agaricia grahamae*	*Helioseris cucullata*
8		*Agaricia fragilis*	*Porites porites*
9		*Helioseris cucullata*	*Porites astreoides*
10		*Porites porites*	*Madracis decactis*
11		*Porites astreoides*	*Madracis mirabilis*
12		*Madracis decactis*	*Madracis pharensis*
13		*Madracis pharensis*	*Diploria strigosa*
14		*Madracis formosa*	*Diplora labyrinthyformis*
15		*Diploria strigosa*	*Colpophyllia natans*
16		*Diploria clivosa*	*Colpophyllia breviserialis*
17		*Diplora labyrinthyformis*	*Colpophyllia amaranthus*
18		*Colpophyllia natans*	*Meandrina meandrites*
19		*Colpophyllia breviserialis*	*Montastraea "annularis"*
20		*Colpophyllia amaranthus*	*Montastraea faveolata*
21		*Meandrina meandrites*	*Montastraea franksi*
22		*Montastraea "annularis"*	*Montastraea cavernosa*
23		*Montastraea faveolata*	*Solenastrea bournoni*
24		*Montastraea franksi*	*Siderastrea siderea*
25		*Montastraea cavernosa*	*Dichocoenia stokesi*
26		*Siderastrea siderea*	*Dichocoenia stellaris*
27		*Siderastrea radians*	*Eusmilia fastigiata*
28		*Dichocoenia stokesi*	*Manicina aerolata*
29		*Dichocoenia stellaris*	*Manicina mayori*
30		*Eusmilia fastigiata*	*Mycetophyllia aliciae*
31		*Mycetophyllia aliciae*	*Mycetophyllia lamarckiana*
32		*Mycetophyllia lamarckiana*	*Mycetophyllia danaana*
33		*Mycetophyllia danaana*	*Mycetophyllia ferox*
34		*Mycetophyllia ferox*	*Mycetophyllia reesi*
35		*Scolymia cubensis*	*Scolymia cubensis*
36		*Scolymia lacera*	*Scolymia lacera*
37		*Scolymia wellsi*	*Scolymia wellsi*
38		*Isophyllastrea rigida*	*Isophyllastrea rigida*
39		*Mussa angulosa*	*Isophyllia sinuosa*
40		*Stephanocoenia intersepta*	*Mussa angulosa*
41			*Stephanocoenia intersepta*
	TOTAL SPECIES:	**TOTAL SPECIES: 40**	**TOTAL SPECIES: 41**

Name:

Holocene

Sample 1	Sample 3	Sample 4
Lago Enriquillo	**Lago Enriquillo**	**Lago Enriquillo**
1. Acropora cervicornis	1	1
2. Undaria agaricites	2	2
3. Colpophyllia natans	3	3
4. Eusmilia fastigata	4	4
5. Favia fragum	5	5
6. Helioseris cucullata	6	6
7. Manicina areolata	7	7
8. Oculina diffusa	8	8
9. Porites astreoides	9	9
10. Porites divaricata	10	10
11. Porites furcata	11	11
12. Porites porites	12	12
13. Scolymia lacera	13	13
14. Siderastrea siderea	14	14
15. Stephancoenia intersepta	15	15
16	16	16
17	17	17
18	18	18
19	19	19
20	20	20
TOTAL SPECIES: 15	**TOTAL SPECIES:**	**TOTAL SPECIES:**

Pleistocene

Santo Domingo (JK 5)	Santo Domingo (JK 6)	Santo Domingo (JK 8)
Pleistocene Coastal Terraces	**Pleistocene Coastal Terraces**	**Pleistocene Coastal Terraces**
1. Acropora cervicornis	1	*Acropora cervicornis*
2. Acropora palmata	2	*Acropora palmata*
3. Colpophyllia natans	3	*Colpophyllia natans*
4. Dendrogyra cylindricus	4	*Diploria labrynthiformis*
5. Diploria labrynthiformis	5	*Diploria strigosa*
6. Diploria strigosa	6	*Isophyllia sinuosa*
7. Montastraea "annularis"	7	*Montastraea "annularis"*
8. Montastraea faveolata	8	*Montastraea faveolata*
9. Montastraea franksi	9	*Montastraea "organ pipe"*
10. Montastraea "organ pipe"	10	*Montastraea cavernosa*
11. Montastraea cavernosa	11	*Siderastrea siderea*
12. Siderastrea siderea	12	*Stephanocoenia intersepta*
13. Stephanocoenia intersepta	13	*Undaria agaricites*
14	14	
15	15	
16	16	
17	17	
18	18	
19	19	
20	20	
TOTAL SPECIES: 13	**TOTAL SPECIES:**	**TOTAL SPECIES: 13**

Name:

Middle Pliocene

Cana Gorge (AB03-3)	Cana Gorge (AB03-4)	Cana Gorge (JK-03-6)
Rio Cana	**Rio Cana**	**Rio Cana**
1. Caulastrea portoricensis	*1*	*1*
2. Diploria zambensis	2	2
3. Favia maoadentrensis	3	3
4. Montastraea-II canalis	4	4
5. Montastraea-II cavernosa	5	5
6. Placocyathus variabilis	6	6
7. Porites-I macdonaldi	7	7
8. Porites-I portoricensis	8	8
9. Porites-I waylandi	9	9
10. Porites-II baracoaensis	10	10
11. Stephanocoenia duncani	11	11
12. Stylophora granulata	12	12
13. Stylophora minor	13	13
14. Undaria agaricites	14	14
15	15	15
16	16	16
17	17	17
18	18	18
19	19	19
20	20	20
TOTAL SPECIES: 14	**TOTAL SPECIES:**	**TOTAL SPECIES:**

Early Pliocene

Canada de Zamba (AB03-2)	Canada de Zamba (JK03-10)	Canada de Zamba (JK03-5)
Rio Cana	**Rio Cana**	**Rio Cana**
1. Agaricia lamarcki	*Caulastrea portoricensis*	*1*
2. Favia dominicensis	*Favia maoadentrensis*	2
3. Goniopora hilli	*Leptoseris gardineri*	3
4. Isophyllia sp.A	*Montastraea-I limbata*	4
5. Madracis cf.herricki	*Porites-I macdonaldi*	5
6. Madracis decactis	*Porites-I portoricensis*	6
7. Madracis decaseptata	*Porites-I waylandi*	7
8. Madracis mirabilis	*Porites-II baracoaensis*	8
9. Madracis sp.A	*Siderastrea siderea*	9
10. Manicina grandis	*Stephanocoenia duncani*	10
11. Montastraea-I limbata	*Stylophora affinis*	11
12. Montastraea-II cavernosa	*Stylophora granulata*	12
13. Placocyathus variabilis	*Stylophora minor*	13
14. Porites-I macdonaldi	*Undaria agaricites*	14
15. Porites-I waylandi		15
16. Porites-I baracoaensis		16
17. Stylophora granulata		17
18. Stylophora minor		18
19		19
20		20
TOTAL SPECIES: 18	**TOTAL SPECIES: 14**	**TOTAL SPECIES:**

Name:

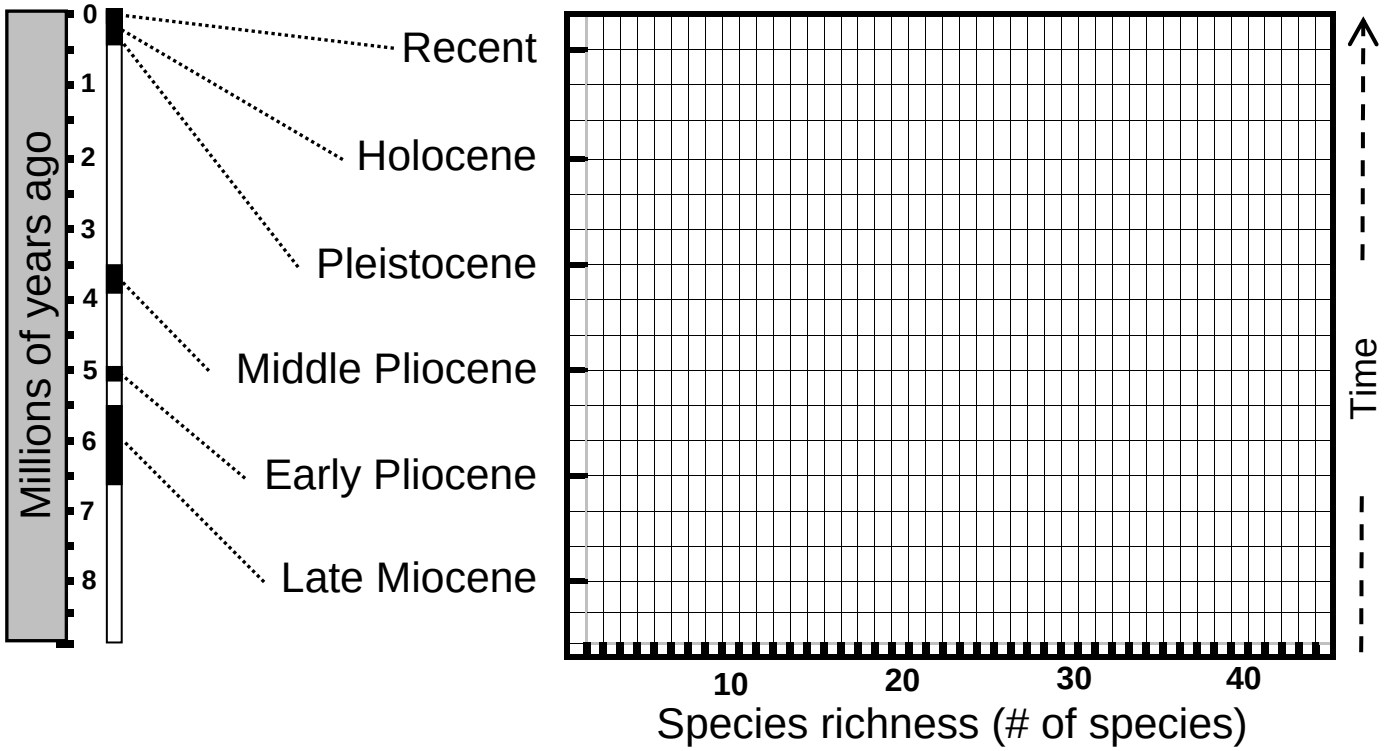
Late Miocene

Arroyo Bellaco (BEL-1)	Arroyo Bellaco (BEL-3)	Arroyo Bellaco (BEL-6)
Rio Cana	**Rio Cana**	**Rio Cana**
1. Agaricia lamarcki	*1*	*Favia dominicensis*
2. Dichocoenia sp.A	2	*Goniopora imperatoris*
3. Gardinerseris planulata	3	*Madracis mirabilis*
4. Goniopora hilli	4	*Montastraea-I limbata*
5. Goniopora imperatoris	5	*Montastraea-II endothecata*
6. Montastraea-I limbata	6	*Pocillopora crassoramosa*
7. Pocillopora crassoramosa	7	*Porites-I portoricensis*
8. Porites-I waylandi	8	*Stylophora affinis*
9. Siderastrea siderea	9	*Undaria agaricites*
10. Solenastrea bournoni	10	
11. Stephanocoenia duncani	11	
12. Stephanocoenia spongiformis	12	
13. Stylophora affinis	13	
14	14	
15	15	
16	16	
17	17	
18	18	
19	19	
20	20	
TOTAL SPECIES: 13	**TOTAL SPECIES:**	**TOTAL SPECIES: 9**

Name:

NMITA

A.



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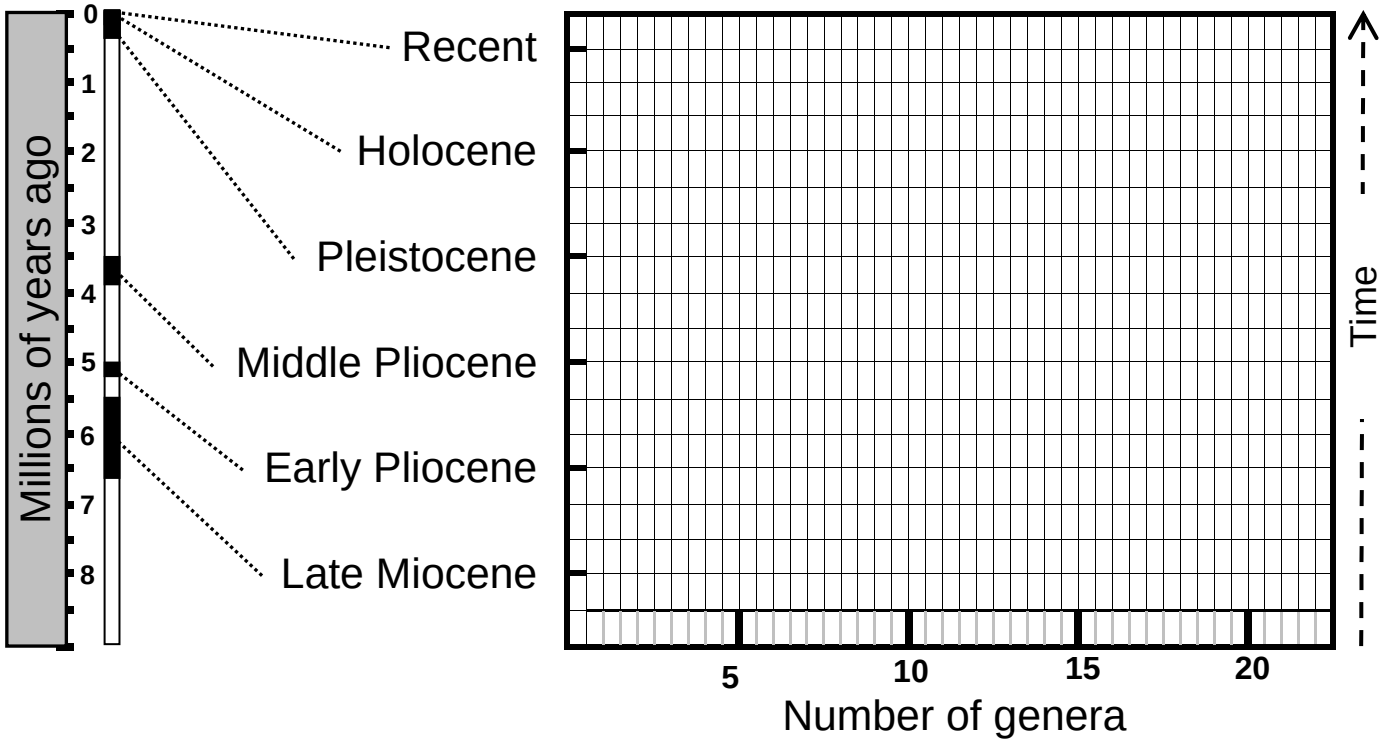

Discussion questions

1. How many samples do we need to take in order to obtain an accurate estimate of coral reef biodiversity in one time period (e.g., Late Miocene)? How do we know if three samples are sufficient?
2. Is it important to know if all species of corals have been collected, named and accurately identified from the Dominican Republic? Could this influence our results?
3. Is it possible to determine the impact of human activity on Caribbean coral reef biodiversity without using the fossil record? Explain.
4. Which of the following scenarios would be more accurate for estimating coral reef biodiversity: (a) Take three samples from the same place within each time period; or (b) take three samples from different places within each time period. Defend your choice.
5. Would it be better to estimate biodiversity using species or genera? Does it make a difference? Explain.