4

When did modern reef corals originate?

NMiTA *Neogene Marine Biota of Tropical America*

Lesson 4: Use NMITA to determine *when* modern reef corals originated.

This lesson is designed to help you learn how to use a biodiversity bioinformatics database known as NMITA to determine *when* modern reef corals from the Dominican Republic originated. Did all the living genera and species of corals appear recently, or many millions of years ago? Did the modern genera and species appear together or randomly through time? NMITA's data on fossil reef corals, combined with data from living reefs, can be used to answer these questions.

Lesson 4 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 when, in geological time, modern reef coral biodiversity originated in the Dominican Republic. You will collect data from 3 samples from each of the 5 time periods.

Key Terms:		**Key Concepts:**
Origination	*Holocene*	*Evolution*
Biodiversity	*Database*	*Extinction*
Coral reef	*Sedimentary rock*	*Speciation*
Geological time	*Pliocene*	*Sampling*
Miocene	*Pleistocene*	*Dating rock*

Directions:

1. Go to NMITA http://nmita.geology.uiowa.edu/

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**); and (d) **Rio Cana** (Middle Pliocene, Early Pliocene, and Late Miocene). Be sure that you can find all four localities on the map.
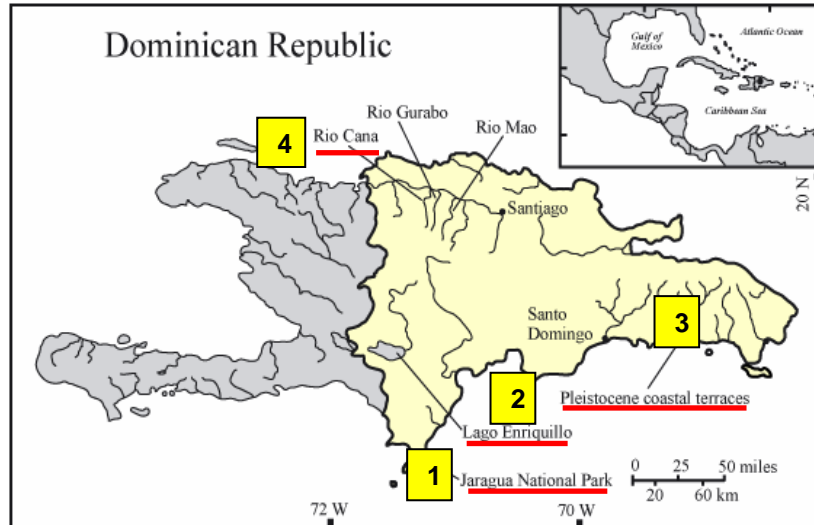
5. You will record data on these four regions on the **lesson 4** data worksheet.

6. Take out the data worksheet. You will notice that we are gathering data on the number of **modern** genera and species that have been found in samples from previous time periods (e.g., Holocene, Pleistocene, etc.). The **total** number of genera and species in each sample has already been tabulated on the data worksheet. You will be calculating the **percentage** of modern genera and species that have been found in each sample.

7. In order to gather data, you will need to find out if any of the modern genera or species are present in the fossil record. A list of all the modern genera and species is provided as an appendix to this lesson. You will need to use this list to complete the lesson.

8. Use NMITA to explore all the regions of the Dominican Republic that have samples of fossil corals (e.g., Lago Enriquillo, Pleistocene coastal terraces, and Rio Cana). Compare the genera and species that occur in these samples to the list of **modern** coral species.

9. Record the number of modern genera and species from each fossil sample on the data worksheet. Repeat step 8 until you have filled in all the boxes.

10. When you are finished, you should know the number of modern corals that occur in all the fossil samples. Calculate the **percentage** of modern corals in each sample by dividing the number of modern species by the total number of species and multiplying by 100: [(#Modern / Total #) x 100].

11. Plot the **percentage** results on the **Lesson 4 graph**.

How to gather data for lesson 4

1

Go to: http://nmita.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

Rio Cana

Cana Gorge
Locality AB03-3: Mao Formation, Middle Pliocene, ~3.6 - 3.8 Ma

Faunal List (reef corals only)

Caulastrea portoricensis [branching]
Diploria zambensis [massive/mound]
Favia maoadentrensis [mostly freeliving]
Montastraea-II canalis [massive/mound]
Montastraea-II cavernosa [massive/mound]
Placocyathus variabilis [freeliving]
Porites-I macdonaldi [plates]
Porites-I portoricensis [branching]
Porites-I waylandi [massive/mound]
Porites-II baracoaensis [branching]
Stephanocoenia duncani [massive/mound]
Stylophora granulata [branching]
Stylophora minor [branching]
Undaria agaricites [plates]

List of living coral species

6

Compare the list from your sample to the list of living coral species

Determine if any of the genera or species found in the sample **also** occur in the living fauna.

Record the number of genera or species from the sample that occur in the modern fauna in the data worksheet

Data interpretation

1. Describe how the percentages of modern reef coral <u>genera</u> change through geologic time.

2. Describe how the percentages of modern reef coral <u>species</u> change through geologic time.

3. Are the two patterns similar? Explain why or why not.

4. Which time period, or *epoch*, had the least modern species?

5. Which time period, or *epoch*, had the most modern species?

4. If you wanted to conduct further studies to better understand modern reef coral origination, which time period, or *epoch*, would you investigate? Explain why.

Discussion questions

1. Corals are marine animals. What environmental variables could have possibly influenced the patterns of coral extinction or origination that you documented?

2. Why is studying changes in biodiversity through geologic time important?

3. How could such data influence conservation efforts or environmental policies?

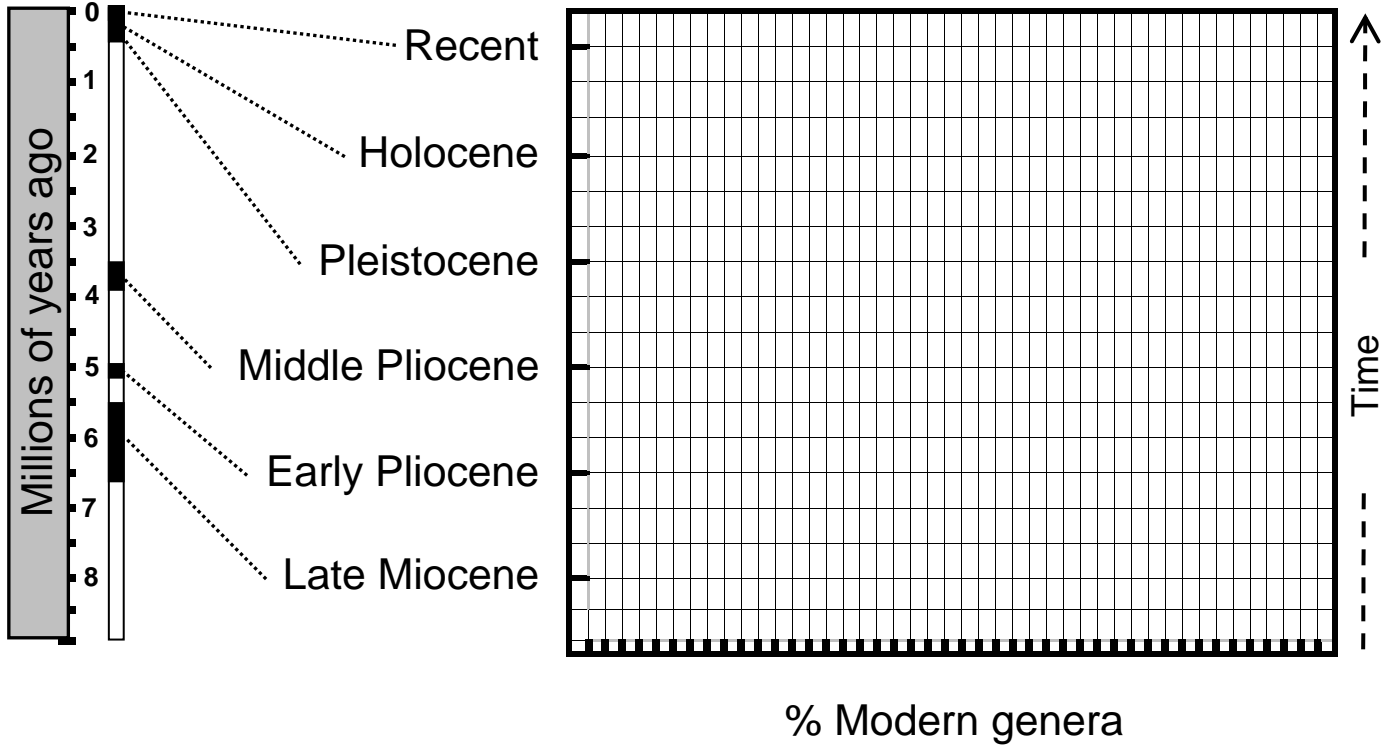NMITA   Neogene Marine Biota of Tropical America

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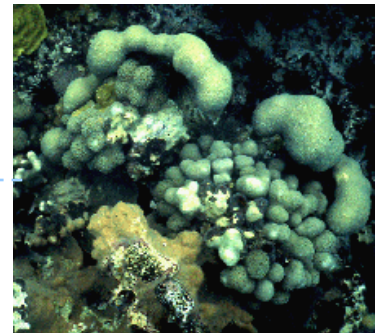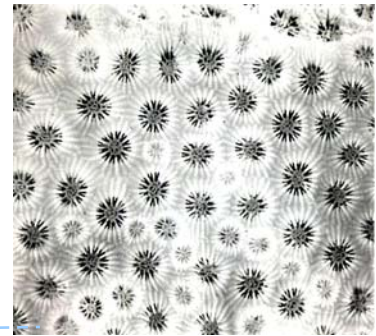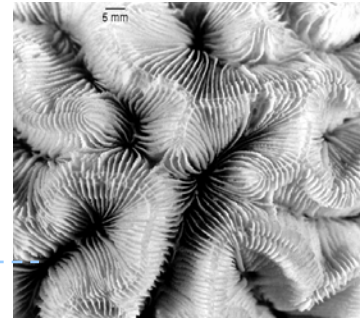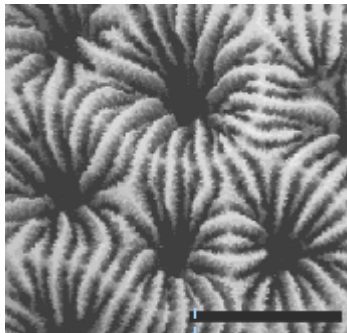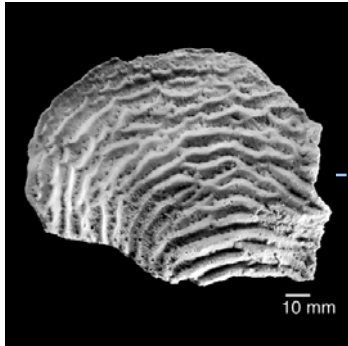
1 *Acropora palmata*
2 *Acropora cervicornis*
3 *Acropora palmata*
4 *Agaricia fragilis*
5 *Agaricia grahamae*
6 *Agaricia lamarcki*
7 *Colpophyllia amaranthus*
8 *Colpophyllia breviserialis*
9 *Colpophyllia natans*
10 *Dichocoenia stellaris*
11 *Dichocoenia stokesi*
12 *Diplora labyrinthyformis*
13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

Age of sample	Region	Locality	Modern species in sample		Total genera and species in sample		%	
			# living genera in this sample	# living species in this sample	total genera in this sample	total species in this sample	% living genera in this sample	% living species in this sample
Holocene	Lago Enriquillo	Sample 1			12	15		
		Sample 3			15	17		
		Sample 4			16	19		
Pleistocene	Pleistocene coral terraces	Santo Domingo (JK 5)			7	13		
		Santo Domingo (JK 6)			9	13		
		Santo Domingo (JK 8)			8	13		
Middle Pliocene	Rio Cana	Cana Gorge (AB03-3)			9	14		
		Cana Gorge (AB03-4)			6	9		
		Cana Gorge (JK-03-6)			7	11		
Early Pliocene	Rio Cana	Canada de Zamba (AB03-2)			10	18		
		Canada de Zamba (JK03-10)			9	14		
		Canada de Zamba (JK03-5)			12	14		
Late Miocene	Rio Cana	Arroyo Bellaco (BEL-1)			11	13		
		Arroyo Bellaco (BEL-3)			7	11		
		Arroyo Bellaco (BEL-6)			8	9		

NMiTA

A.

Millions of years ago

0
1
2
3
4
5
6
7
8

Recent
Holocene
Pleistocene
Middle Pliocene
Early Pliocene
Late Miocene

Time

% Modern genera

B.

Millions of years ago

0
1
2
3
4
5
6
7
8

Recent
Holocene
Pleistocene
Middle Pliocene
Early Pliocene
Late Miocene

Time

% Modern species