Coral Morphometrics and the Missing Paleontologist

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Objectives

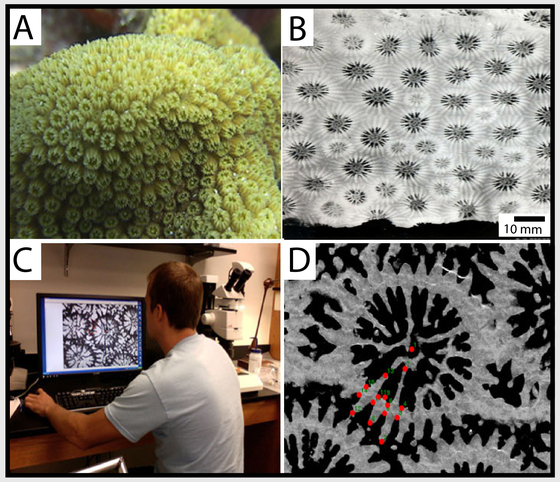
Paleontological Principles

* What is a species?
* How do paleontologists recognize species?
* Genetic vs. ecophenotypic morphologic variation
* What is a coral and what are the basic skeletal structures of a coral?

Student Skill Development

* Quantification of morphologic shape
  - landmark vs. traditional measurements
* Confidence organizing and manipulating paleontological datasets
* Analysis and interpretation of morphometric data
  - Analysis using PAleontological STatistics software (PAST)
* Write a scientific research report describing and interpreteing results from a complex dataset

Data Collection



As part of a cooperative effort, students plotted 15 landmarks on a total of 200 coral thin section photomicrographs from specimens of the coral genus *Montastraea*. Corals were sampled from the Miocene, Pliocene and Holocene. Thus with minimal effort, the students were able to generate a large dataset of morphologic data. **(A)** Living colony of *Montastraea faveolata* **(B)** Calical surface of aragonite skeleton showning ~45 coralites. **(C)** Student collecting morphologic data. **(D)** Image of corallite showing the 15 landmarks identified by students.

Write Up

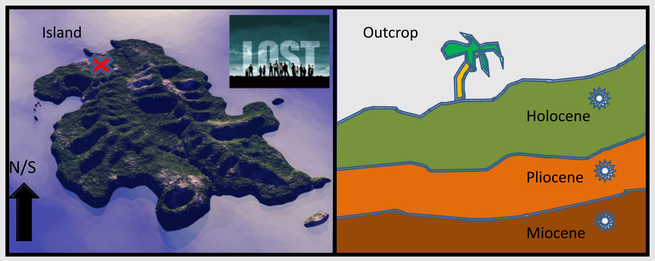
Students were asked to write their results in a scientific report including an abstract, introduction, methods, results and discussion.The following are a few of the questions the students were asked to address in their discussion.

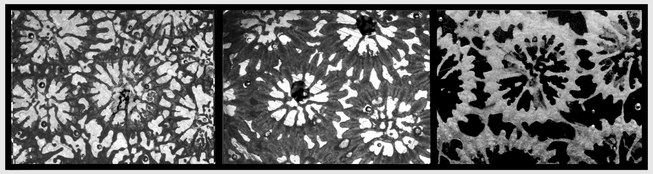
a) Are they the same species? If not how many species do you think there are?

b) Provide evidence that supports your answer above. Use your analyses to support your interpretation.

c) Provide some possible interpretations or hypotheses that could explain your results.

Background

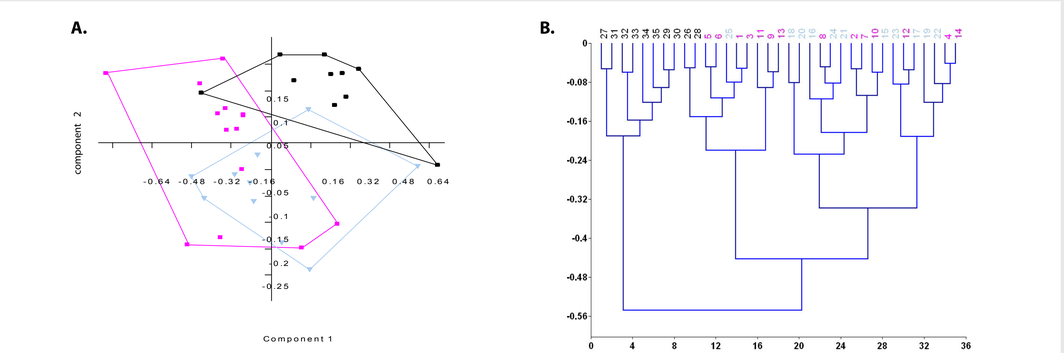




Modern Pliocene Miocene

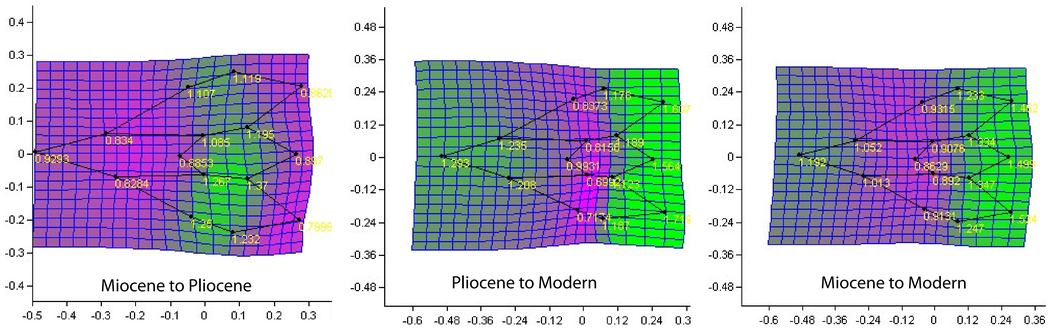
* The goal of the lesson was to present a geological field experience in a classroom setting. Provide students a feeling of ownership in a research project.
* This was completed by presenting the students with an outcrop on a ficticious island. They were given field notes from a paleontologist who mysteriously went missing on the outcrop.
* The challenge to the students was to analyze fossil corals of the genus *Montastraea* from the dated sections in the outcrop (Miocene, Pliocene and Holocene) to answer the missing paleontologist's question....."Are these the same species?"
* Students collected data from photomicrographs of corals from each time period to determine how unique they are from each other.

Data Analysis



A.) Principal Component Analysis accounting for the variance in the distances between the landmarks from the Modern (pink), Pliocene (grey) and the Miocene (black).

B.) Cluster Diagram showing the similarity between the samples used to measure the landmark distances from each group.



Thin-plate spines showing the where the morphologic variation of the landmarks occurs between each time period when plotted against each other. The comparisons are made as the coral would have changed through time from the Miocene to the Pliocene and to the modern.

Conclusions

* Students completed their final reports and gave short presentations to the class discussing their interpretations.

* Interpretations describing the possible reasons for the divergence within the Montastraea samples found along the outcrop were varied. It was generally agreed upon that the Miocene *Montastraea* had a unique morphology which may support it being a different species from the others. However, interpreting the Pliocene and Modern samples proved more difficult.

* Physical and biological factors (temperature, wave action, symbiosis and competition with other organisms) were discussed by the students in their efforts to determine links between morphology and funtion in the marine envrionment.

References

Klaus, J.S., and Budd, A.F. 2003, Comparison of Caribbean coral reef communities before and after Plio-Pleistocene faunal turnover: analyses of two Dominican Republic reef sequences: Palaios, v. 18, p. 3-21.

Klaus, J.S., Budd, A.F., and Fouke, B.W. 2007, Environmental controls on corallite morphology in the reef coral Montastraea annularis: Bulletin of Marine Science. v. 80, p. 233-260