Studying the Climate of the Past – Planktic Foraminifera Bio-Provinces

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Introduction

Audience: This activity is designed as a tabling activity for reaching community members at a science-related event (e.g., museum, open house, or science fair). This activity may be adapted for high school students (Freshman/Sophomore) or middle school students in a science class or in a pre-college program.

Prerequisites: Audience members should have a general understanding of climate science and the relationship between ocean temperatures and the changing climate over long periods of time (thousands of years). Audience members should also have a basic concept of taxonomy.

Activity Purpose (framework adapted from the COMPASS Message Box)

Issue: The fossil shells of planktic foraminifera store information about the ancient ocean and climate.

The Problem: It is still a mystery why and how our climate has changed in the past.

Solutions: Sediment cores in the deep ocean record the history of Earth's climate; slices of time are stacked on top of one another like pages in a book. We recover fossil shells of planktic foraminifera in these sediments to read the writing on these pages.

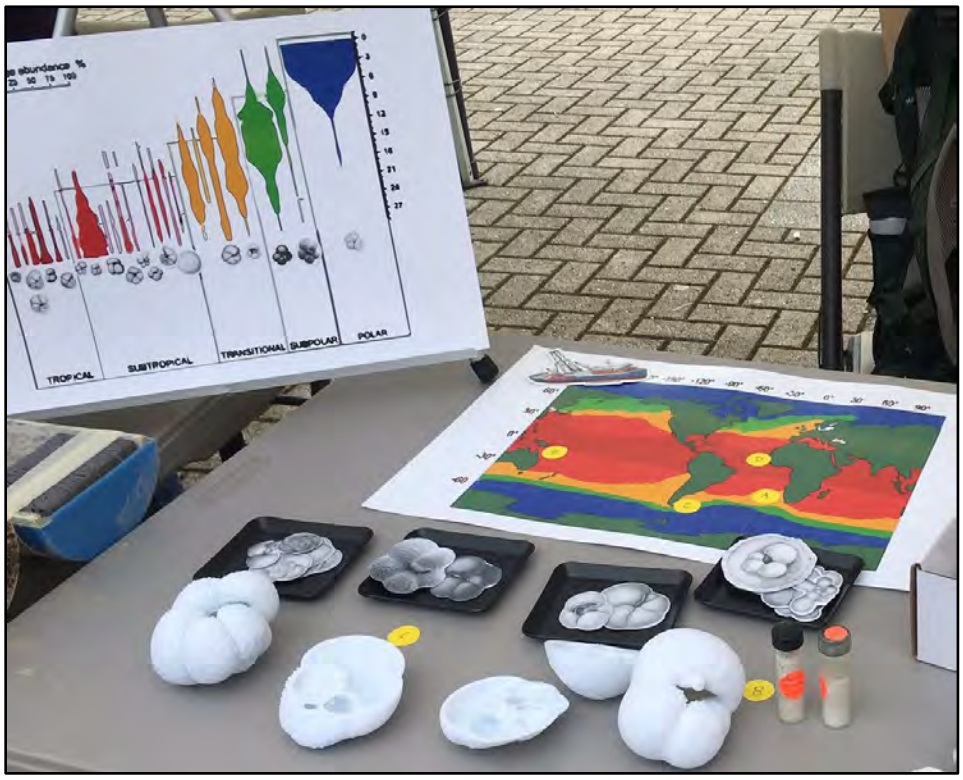
Benefits: Earth's climate has changed dramatically in the past. For example, during the last ice age, global temperatures dropped by 10°F. Information about the temperature of the past is stored inside the fossil shells of planktic foraminifera. There are about 50 species of planktic foraminifera still living today and where they live is primarily controlled by the temperature of the ocean: certain species only like warm temperatures and certain species only like colder temperatures. Each species has a uniquely shaped shell that is used to identify that species (taxonomy). Taking net samples all over the global oceans and identifying the species gives us a good idea of where these species live today. We pair the knowledge of where species live in the modern ocean with identified fossil species recovered from slices of time within a sediment core. This tells us how about temperature changes of the past, for example, colder-loving species from the last ice age living in regions that are far too warm for them today.

We study planktic foraminifera so we can unlock the mystery of how temperature changes occurred and make sense of the complex way the climate is changing now in a warming world.

So What: Not only are the shells of planktic foraminifera beautiful to look at (they have inspired so much art), but they provide us with the data that informs major global decisions. International conferences like the UN Climate Change Conferences (COP26 in 2021) use the record obtained from planktic foraminifera to tell us how much the climate has changed from long before humans were present to our world now dominated by human activity.

Set-up

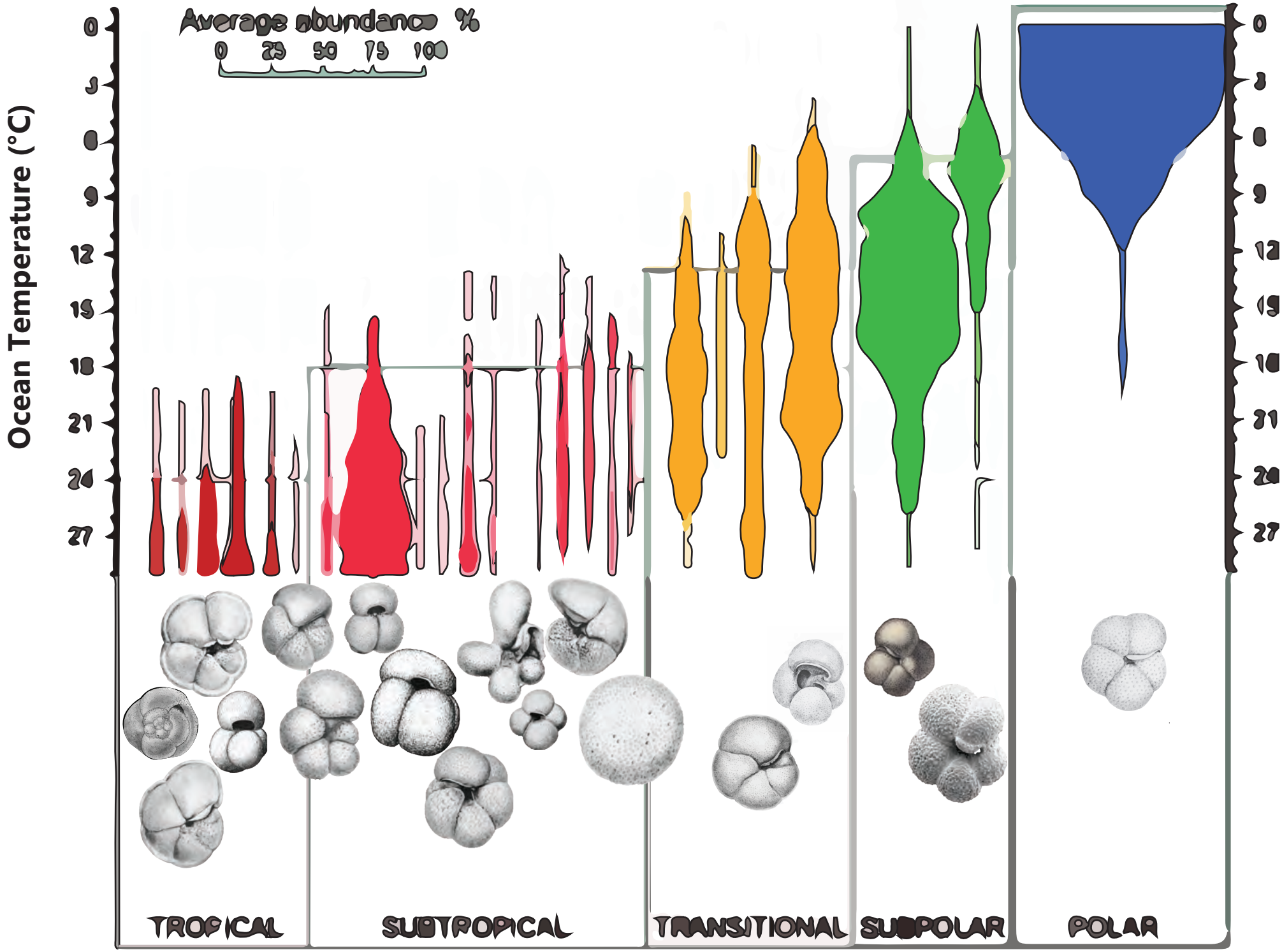
To present this activity as a tabling activity, print the files titled **Planktic Foraminifera Abundance Graph** and **Planktic Foraminifera Bioprovince Map** on poster-sized paper. Print and cut out the 5 **Bioprovince Cards**. Print and cut out each planktic foraminifera from the PDF file titled **Planktic Foraminifera Species**. This file contains the front and back views of 18 species and the paper can be folded in half or cut and taped so the front and back views face out (see **Set-Up Picture**). Categorize the species by their listed bioprovince.

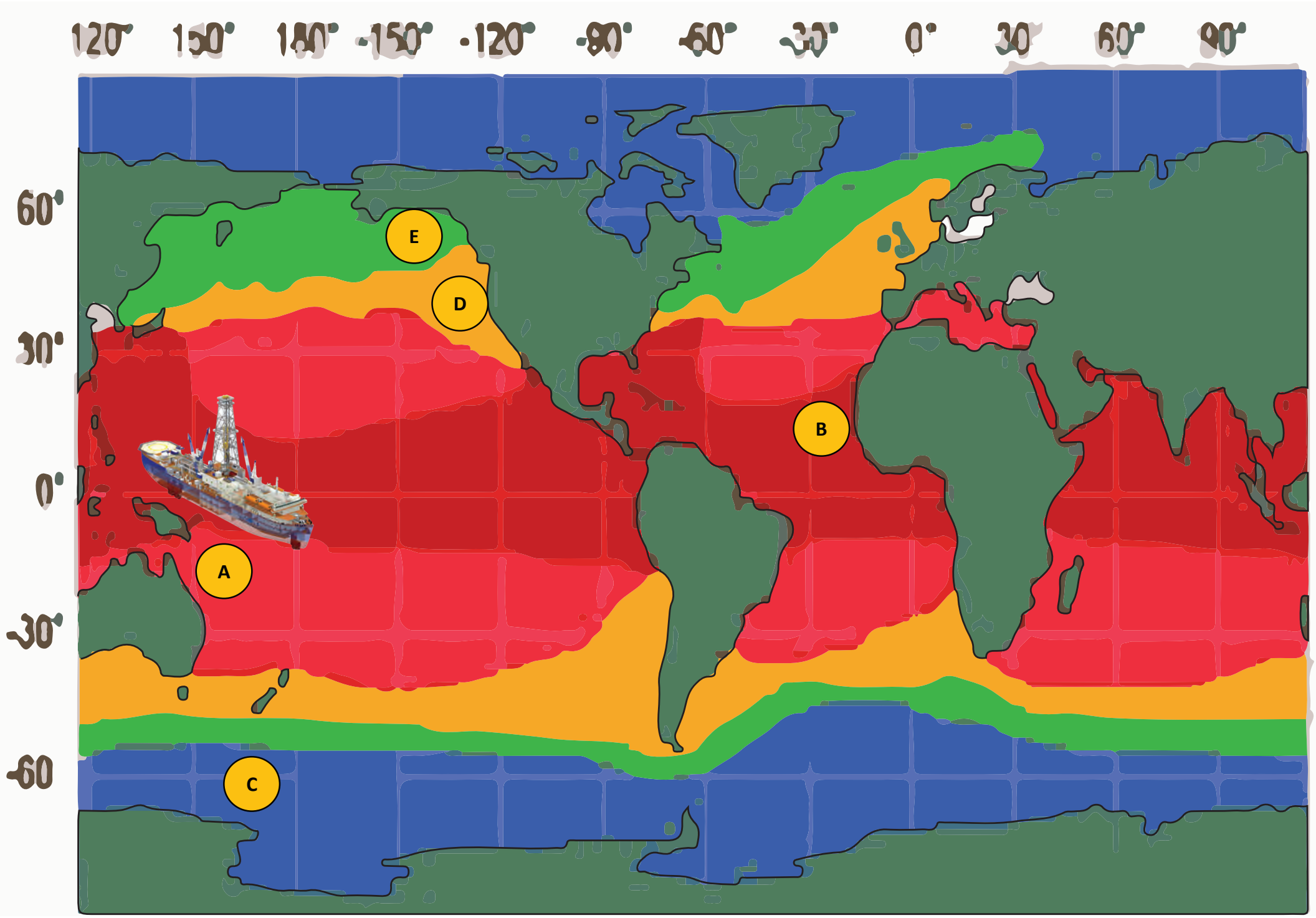


Example activity set-up

Activity

- You have been given sediment samples from the International Ocean Drilling Program Research Vessel the R/V Joides Resolution. This 470-foot-long research vessel travels around the world with an international crew of scientists and drills into the ocean floor to recover sediment cores. Sediment cores were obtained from 5 locations around the globe and the following species of planktic foraminifera were found at each of these locations.
- Look closely at the planktic foraminifera cut-outs and think about how they are different based on their shell shapes. Are some small, elongated, round, coiled, have more chambers, have different surface textures?
- Look at the **Planktic Foraminifera Abundance Graph** and observe how the planktic foraminifera species are categorized by where they live in Tropical, Subtropical, Transitional, Subpolar, and Polar waters. *Advanced: What does the range of temperatures mean? What does the average abundance % mean?
- There has been a mix-up at the core repository! The labels have fallen off the sediment samples and the scientists do not know where in the world the sediment samples were collected from. Look at the 5 locations A, B, C, D, and E drilled by the R/V Joides Resolution from each of the bioprovinces on the **Planktic Foraminifera Bio-Province Map**. Use the categories from the **Planktic Foraminifera Abundance Graph** to identify which location on the map your sample of planktic foraminifera came from.
- *Advanced: The Oregon Coast is in a region of Transitional waters. If we drilled the Oregon Coast sediments and found Subpolar species here in a time interval of the past, what might that say about that past time-interval? What age might that time-interval be? How might you use other data to verify that your hypothesis was correct?


Average abundance %
0 25 50 75 100
Ocean Temperature (°C)
0
3
6
9
12
15
18
21
24
27
TROPICAL
SUBTROPICAL
TRANSITIONAL
SUBPOLAR
POLAR


120°
150°
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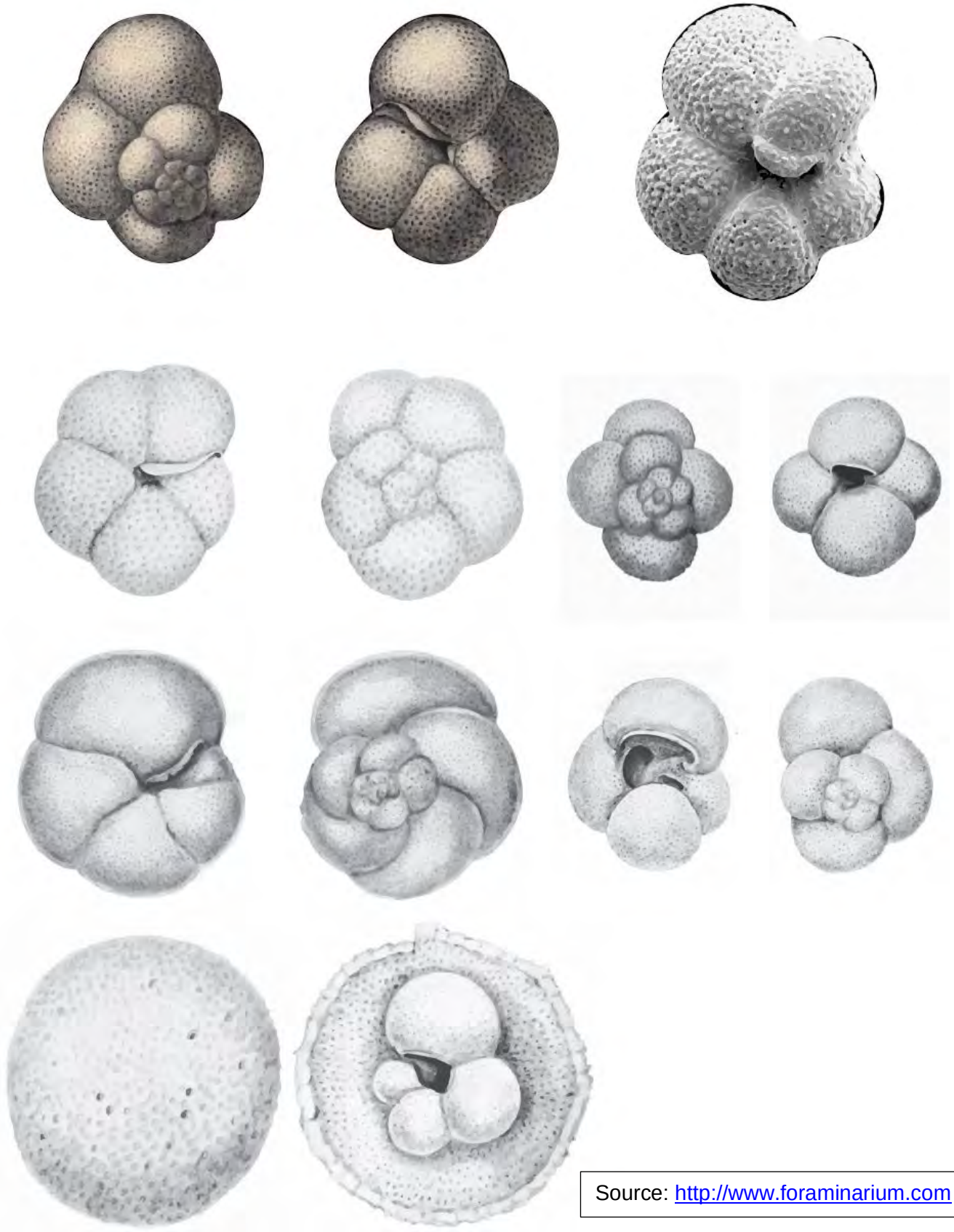
A
B
C
D
E

Planktic Foraminifera Species - To Print



Source: http://www.foraminarium.com

Planktic Foraminifera Species - To Print