

Evidence of Ice-Free Seas

Preview

Paleontologists have some ingenious ways of finding out what the climate was like long ago. For instance, they've developed a way to learn how much sea ice was present in the past, simply by counting different forms of a certain kind of fossil diatom.

In this activity, you'll make a model core using two types of buttons to represent fossil diatoms. By comparing numbers of the two forms, you'll figure out whether the seas were free of ice while the diatoms were alive.



A living *Eucampia* chain of two individual diatoms. (Courtesy of the Japan National Institute of Polar Research)

Eucampia antarctica

Eucampia antarctica (yoo-kamp-ee-a ant-ark-tik-a) is the name for a kind of diatom that grows in a chain—a group of individual diatoms connected together in a line. Microbiologists who study living diatoms have observed how *Eucampia* diatoms live today: the chains can survive under sea ice, but they need sunlight in order to grow new cells that make the chain longer.



Here's how a *Eucampia* cell looks after it first develops as a result of sexual reproduction. The individual diatom is made of two similar halves.

When sea ice is thin or the ocean is ice-free, diatoms receive sunlight, and new cells grow in the center of the chain, making the chain longer. The opposite case is important too: when sea ice is thick, diatoms below it don't get much light, and they stay short because they don't add new cells.

Here's how two different chains might look at the end of a growing season.



Eucampia from a time when climate was cold and sea ice was relatively thick.



Eucampia from a warmer time, when sea ice was thin or absent

Time

⌚ 30 minutes

Tools & Materials

- 📖 *Eucampia* Index chart (Pages 165-168)
- 3-inch-diameter corrugated plastic drain pipe (30 inches long, split in half lengthwise)
- Duct tape
- Polished aquarium gravel (2 cups)
- Shank buttons (86)
- Flat buttons (50)
- Assorted plastic beads (½ cup)
- Pebbles (15-20 pieces)
- Sturdy paper plates (6)
- Toothpicks (60)
- Blank mailing labels (60)
- Needle & thread
- Scissors
- Measuring cups
- Colored markers
- + Large sheet of construction paper or poster board

📖 Items found in this book

- Items included in the Flexhibit Kit, available from <http://www.andrill.org/flexhibit>.
- + Additional items



Look at the tips of the two diatom halves. The one with the sharp points is an end form. The one with flattened extensions is a middle form. (Photo by Diane Winter)

Eucampia chains grow in a unique way: they only add new cells in the middle of the chain, in between the two end cells. Look carefully at the diagrams—the diatoms at the ends of the chains are visibly different from those in the middle.

After a chain of *Eucampia* dies, it breaks apart and the diatom halves settle to the ocean floor. The ends and middles can still be recognized and counted. Knowing that every chain has only two ends, counting the number of pointed end forms versus flat middle forms gives information about how long the chains were.

See for Yourself

Look at these examples. They show sets of *Eucampia* diatoms from different depths in a rock core. Which set represents a time with longer chains?



Working with a partner, discuss and describe how you can figure out which sample was deposited at a time when there was less sea ice.

Here's another example: A micropaleontologist takes a sample from a rock core and finds 8 end forms and 20 middle forms of *Eucampia* diatoms. Does this represent a time with *more* sea ice or with *less* sea ice than the samples pictured above?

Statistically speaking

It's unlikely that a single sample from a rock core would contain all the diatoms from a single *Eucampia* chain. The numbers of ends and middles for a whole population of *Eucampia* chains still show, on the average, how short or long the chains were.

Dividing by zero (no middle forms)

If there are no middle forms in a sample, you would need to divide by zero. Mathematically, dividing by zero is "undefined" - in other words, you can't do it. In this investigation, if there are no middle forms, you will record the sample's *Eucampia* Index as "≥1.0," which suggests a very cold climate.

On the other hand, if there are no end forms in your sample, suggesting a warm climate, the *Eucampia* Index is zero (0), because dividing zero by any number gives zero.

The *Eucampia* Index

You can probably tell that the example described above is from a period with less ice: it has a larger number of middle forms compared to the number of end forms than the samples pictured above have. For any sample, dividing the number of end forms by the number of middle forms results in a number called the *Eucampia* Index. Two ways to show this calculation are:

$$\frac{\text{Number of End Forms}}{\text{Number of Middle Forms}} = \text{Eucampia Index}$$

$$\text{Number of Middle Forms} \overline{) \text{Eucampia Index}} \text{Number of End Forms}$$

The smaller the value of the *Eucampia* Index, the more ice-free the ocean was when they grew.

Prepare

Make a core holder

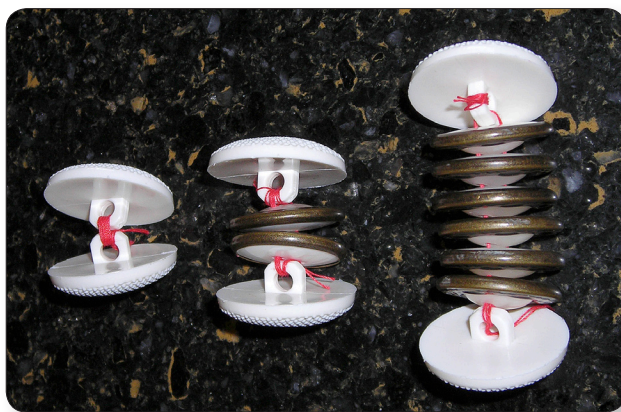
Add duct tape to the ends of a 30-inch length of 3-inch-diameter drain pipe that has been cut in half lengthwise. You'll fill the trough with model sediments and a variety of "microfossils."



Get out your button box!

You'll use buttons to represent the two forms of *Eucampia* diatoms.

- **Shank buttons** have loops or tabs on the back with holes for the thread. These will represent the end forms of *Eucampia* diatoms.
- **Flat buttons** have two or more holes through them. They will represent the middle forms of *Eucampia* diatoms.



If buttons were to form chains like *Eucampia* does, they might look something like this. The shank buttons represent the end forms because new buttons can only be added to the chain on one side of them. Flat buttons represent the middle forms because they can be added to the middle of the chain.

Environmental conditions and *Eucampia* chain length

The average lengths of *Eucampia* chains provide evidence of the local climate:

- Shorter chains = fewer middle forms = colder climate = more sea ice.
- Longer chains = more middle forms = warmer climate = less sea ice

Recipe for a button core

1. Spread 1 cup of polished aquarium gravel along the length of the core holder.
2. Add about 80 shank buttons, spreading them fairly equally along the length of the core.
3. Sprinkle about 20 of the flat buttons along the entire length of the core, then drop groups of several flat buttons at 3 or 4 different levels in the core.
4. Sprinkle the beads and other plastic doodads along the length of the core. These will represent diatoms of other species besides *Eucampia*.
5. Add 1 more cup of aquarium gravel along the core.
6. Prepare your *Eucampia* Index chart and place it next to the core.



Sample the buttons and calculate the *Eucampia* Index

1. Scoop a sample of the core onto a paper plate. Sort and count the shank and flat buttons to come up with a ratio. You can ignore everything that is not a shank or flat button.
2. Prepare a small flag by sticking a label to itself around a toothpick. Put your initials on the flag and record the number of shank (end) and flat (middle) buttons on it. Stick your flag in the edge of the drain pipe at the location where you took your sample. Be careful to return your entire sample to the same location where you took it from along the core.



3. Divide the number of shank buttons in your sample by the number of flat buttons. This value is the *Eucampia* Index. Mark the value by putting an X in the appropriate column on the chart next to your flag.
4. Take samples from several locations along the core. For each sample, count the buttons, post the data flags, and mark the *Eucampia* Index on the chart.
5. Once the chart has several data points, interpret it to tell how climate changed over the time represented by the core.

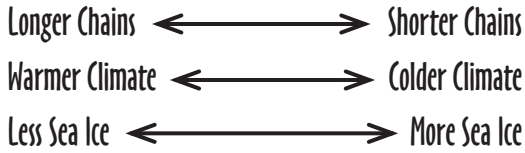


Unit 4 - Tiny Clues to Antarctica's Past

Activity 4B - Evidence of Ice-Free Seas

Eucampia Index Chart

Put an "X" in the column that shows the *Eucampia* Index for sample locations along the core.
If there are no middle forms (flat buttons) in your sample, put an "X" in the ≥ 1.0 box.



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Distance from bottom of core (cm)

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Ponder. . .

Draw several frames of a cartoon or storyboard. Show some *Eucampia* chains growing in different climate conditions, the diatoms dying and breaking apart, and a paleontologist finding and counting the middle and end forms to understand what the environment was like when the diatoms grew.

Practice

Got the Big Idea?

Eucampia diatoms record climate conditions by growing longer chains during warm periods when the sea is ice-free and shorter chains during cold periods when sea ice is present. The numbers of end and middle forms of these diatoms reveal the lengths of the chains and the relative amounts of sea ice that were present when they lived.

Get ready to present

Come up with an introductory comment or a question to invite people to interact with you and the button core. Take a look at the banner for this unit, and consider which pictures or text might help you explain your topic.

For demonstrations, you may want to make and display some sample chains of *Eucampia* models from shank and flat buttons, similar to those in the photographs for this activity. You can point to the short and long chains and explain how length indicates how much sea ice was present when they grew.

You might also draw some diagrams of *Eucampia* cells on a poster board, or keep the pages of the activity available to show diagrams and photographs to visitors.

Present

Set up the core, paper plates, sampling spoon, and flags. Place a copy of the *Eucampia* Index chart next to the core. Encourage visitors to scoop a sample of the core and count the shank and flat buttons. Post a flag with their data along the core and mark their *Eucampia* Index on the chart. Tell them how their sample compares to others from the core—did their sample indicate a time of relative warmth or cold?

Try to return the samples to the same location in the core that they came from, or the data may change through the event. Knowing the locations of the concentrations of flat buttons can help you keep them in that general spot.

Safety Note: Watch that young children don't walk off with your buttons. Toddlers may find them very attractive, yet they represent a choking hazard.