oceanexplorer.noaa.gov

2005 Hidden Ocean Expedition

Jelly Critters

Focus
Gelatinous zooplankton in the Canada Basin

Grade Level
5-6 (Life Science)

Focus Question
What groups of animals make up the gelatinous zooplankton of the Arctic Ocean, and how significant are these animals in the Arctic Ocean ecosystem?

Learning Objectives
Students will be able to compare and contrast at least three different groups of organisms that are included in "gelatinous zooplankton".

Students will be able to describe how gelatinous zooplankton fit into marine food webs.

Students will be able to explain how inadequate information about an organism may lead to that organism being perceived as insignificant.

Materials
❒ None

Audio/Visual Materials
❒ None

Teaching Time
One or two 45-minute class periods

Seating Arrangement
Classroom style if students are working individually, or groups of two to four students

Maximum Number of Students
30

Key Words
Pelagic realm
Benthic realm
Sea ice realm
Sympagic
Brine channel
Arctic Ocean
Canada Basin

Background Information
The Arctic Ocean is the most inaccessible and least-studied of all the Earth's major oceans. Although it is the smallest of the world's four ocean basins, the Arctic Ocean has a total area of about 14 million square kilometers (5.4 million square miles); roughly 1.5 times the size of the United States. The deepest parts of the Arctic Ocean (5,441 m; 17,850 ft), known as the Canada Basin, are particularly isolated and unexplored because of year-round ice cover. To a large extent, the Canada Basin is also geographically isolated by the largest continental shelf of any ocean basin (average depth about 50 meters) bordering Eurasia and North American. The Chukchi Sea provides a connection with the Pacific Ocean via the Bering Strait, but this connection is very narrow and shallow, so most water exchange is with the Atlantic Ocean via

the Greenland Sea. This isolation makes it likely that unique species have evolved in the Canada Basin.

Exploration of the Arctic Ocean, especially the Canada Basin, has become increasingly urgent because the Arctic environment is changing at a dramatic rate. A 2004 report from the Arctic Council states that temperature in the Arctic is increasing at nearly twice the rate of increase as the rest of the world. One visible result is rapid loss of glaciers and sea ice. Less visible are the impacts on living organisms that depend upon glaciers and sea ice for their habitat. Loss of these habitats can also have direct effects on human communities. The Greenland Ice Sheet, for example, holds enough water to raise global sea levels by as much as 7 meters. Sea level increases at this magnitude would be sufficient to flood many coastal cities, including most of the city of London.

The 2002 NOAA Ocean Exploration expedition to the Arctic Ocean focused specifically on the biology and oceanography of the Canada Basin. These explorations included three distinct biological communities:

- The Sea-Ice Realm includes plants and animals that live on, in, and just under the ice that floats on the ocean's surface;
- The Pelagic Realm includes organisms that live in the water column between the ocean surface and the bottom;
- The Benthic Realm is composed of organisms that live on the bottom, including sponges, bivalves, crustaceans, polychaete worms, sea anemones, bryozoans, tunicates, and ascidians.

These realms are linked in many ways, and food webs in each realm interact with those of the other realms.

Sea ice provides a complex habitat for many species that are called sympagic, which means "ice-associated." The ice is riddled with a network of tunnels called brine channels that range in size from microscopic (a few thousandths of a millimeter) to more than an inch in diameter. Diatoms and algae inhabit these channels and obtain energy from sunlight to produce biological material through photosynthesis (a process called "primary production"). Bacteria, viruses, and fungi also inhabit the channels, and together with diatoms and algae provide an energy source (food) for flatworms, crustaceans, and other animals. In the spring, melting ice releases organisms and nutrients that interact with the ocean water below the ice. Large masses of algae form at the ice-seawater interface and may form filaments several meters long. On average, more than 50% of the primary production in the Arctic Ocean comes from single-celled algae that live near the ice-seawater junction.

When sea ice melts, more sunlight enters the sea, and algae grow rapidly since the sun shines for 24 hours a day during the summer. These algae provide energy for a variety of pelagic organisms, including floating crustaceans and jellyfishes called zooplankton, which are the energy source for larger pelagic animals including fishes, squids, seals, and whales. When pelagic organisms die, they settle to the ocean bottom, and become the energy source for inhabitants of the benthic realm. These animals, in turn, provide energy for bottom-feeding fishes, whales, and seals.

In contrast to hard-bodied animals like crustaceans, relatively little is known about the delicate gelatinous zooplankton. This lack of knowledge is partially due to the fact that the "jelly animals" are usually damaged or destroyed by oceanographic sampling equipment, and also because these animals historically have been considered unimportant to the functioning of marine ecosystems. Recent research, however, has suggested that gelatinous zooplankton may be significant consumers of primary production, competing with other organisms for this resource, and may also provide an important source of nutrition to benthic organisms. In this lesson, students will investigate some of the "jelly animals" observed in the Canada Basin by the 2002 Arctic Exploration expedition.

Learning Procedure

1. To become more familiar with the Hidden Ocean expedition, you may want to visit the expedition's Web page (http://oceanexplorer.noaa.gov/explorations/05arctic/welcome.html) for an overview of the expedition and background essays. You should also review the "Spineless Wonders" and "An ROV Dive" essays from the 2002 Arctic Exploration expedition (http://oceanexplorer.noaa.gov/explorations/02arctic/background/fauna/fauna.html and http://oceanexplorer.noaa.gov/explorations/02arctic/logs/aug31/aug31.html).

2. Briefly review the geography of the Arctic Ocean, highlighting the location of the Canada Basin and the activities of the Hidden Ocean expedition. You may want to briefly discuss Arctic climate change and why it is so important to gather information on species that presently inhabit the three realms as soon as possible. Introduce the "three realms" of marine life in the Canada Basin. Be sure students understand the concepts of primary production, phytoplankton, and zooplankton.

3. Divide students into groups in multiples of four. Assign one of the following groups of gelatinous zooplankton to each student group:
   Cnidaria
   Ctenophora
   Larvacea
   Chaetognatha

   Tell students that their assignment is to
   - Find out what animals in their assigned group are planktonic "jelly animals"
   - Find out how these animals obtain food
   - Obtain a picture of a member of their assigned group; and
   - Prepare a brief written report summarizing the information they have found.

   You may want to refer students to the "Spineless Wonders" essay which has a link to many references about gelatinous zooplankton (http://oceanexplorer.noaa.gov/explorations/02arctic/background/fauna/refs.html). The photo and video log for the 2002 Arctic Exploration expedition also has some nice images of these animals.

4. Have each group present an oral summary of their written report, then lead a discussion of students' findings. The following points should be included:

   - The phylum **Cnidaria** includes corals, sea fans, sea anemones, and hydroids as well as "jellyfishes." Many animals in this phylum have a life history that includes an attached anemone-like stage (called a polyp) and a free-swimming jellyfish-like stage (called a medusa). All members of this phylum have stinging cells (called nematocysts or cnidocysts) that are used for defense and to capture prey. Some cnidarians, such as the Portuguese man-of-war and the Australian box jellies, can be harmful or even deadly to humans. Jellyfishes are voracious predators, and can feed more or less continuously on other zooplankton, particularly small crustaceans and ctenophores.

   - **Ctenophores** are also known a "comb jellies" because they have eight rows of fused cilia resembling combs arranged along the sides of the jelly-like animal. Many ctenophores are bioluminescent. Ctenophores do not have stinging cells, and instead use sticky cells called colloblasts to capture prey. Their prey consists of small crustaceans, larvae of various species, and in some cases other ctenophores. Some ctenophores feed on cnidarian jellyfish and are able to store nematocysts from the jellyfish for their own use! A startling example of extremely efficient ctenophore predation occurred in the Black Sea in the early 1980's. An American species of ctenophore accidentally transported into the Black Sea by a ship's ballast water multiplied rapidly and consumed so much zooplankton that there was very little left to feed the larvae of native fishes. In less than ten years, fisheries in the Black Sea had almost totally collapsed.

- **Larvaceans** are a class of Urochordata, a phylum that is believed to be related to the Chordata, which includes vertebrate animals. Larvaceans are free-swimming filter feeders, and are capable of capturing particles as small as one micron. A gelatinous bubble of protein and cellulose surrounds all of the animal except the tail, which is used for swimming. This bubble allows water currents to be concentrated onto mucous mesh filters that are extremely efficient. Because they are so efficient, they often become clogged, and filters as well as the surrounding bubble are discarded and replaced on a regular basis.

- **Chaetognaths**, also known as arrow worms (although not true worms), are long and thin with fins that are used for propulsion and stabilization during swimming. These animals do not appear to be closely related to other organisms, and are entirely marine. They are active swimmers and migrate up and down in the water column. Chaetognaths are voracious predators, and have a series of movable spines on their head which are used to capture prey. They feed on other species of plankton, and larger Chaetognaths have been known to attack small fishes. In some planktonic communities, Chaetognaths are the primary predator.

Be sure students understand that seemingly fragile animals like the gelatinous zooplankton can have significant impacts on other species and entire ecosystems (remember the Black Sea example!). Also point out that organisms may be regarded as "insignificant" solely because they haven't been adequately studied (you may want to point out that inadequate understanding can lead to misconceptions about many things in addition to jellyfish). Gelatinous zooplankton are more difficult to study than other kinds of organisms, and until recently this difficulty has caused them to be ignored. The Hidden Ocean expedition is using new technology including submersibles, remotely operated vehicles, and video imaging equipment to overcome some of these limitations; and has discovered that these jelly animals are much more abundant—and possibly more ecologically significant—than was previously believed.

The BRIDGE Connection

www.vims.edu/bridge/polar.html

The "Me" Connection

Have students write a brief essay describing how information about species that presently appear to be "unimportant" might eventually be personally beneficial.

Connections to Other Subjects

English/Language Arts, Geography

Evaluation

Student reports prepared in Learning Procedure Step 3 and group discussion in Step 4 provide opportunities for assessment.

Extensions

1. Have students visit http://oceanexplorer.noaa.gov/explorations/05arctic/welcome.html to keep up to date with the latest 2005 Hidden Ocean Expedition discoveries.
2. Visit http://oceanexplorer.noaa.gov/explorations/02arctic/background/education/media/arctic_lessonplans.html for more lesson plans and activities related to the 2002 Arctic Exploration expedition.

3. Visit http://jellieszone.com/ for more information about jellyfishes, including the deadly cubomedusae of Australia, as well as how jellyfish can be kept in aquaria (with a lot of work!).

Resources

Raskoff, K. A., J. E. Purcell, and R. R. Hopcroft. 2005. Gelatinous zooplankton of the Arctic Ocean: in situ observations under the ice. Polar Biology 28:207-217 – The technical journal article on which this lesson is based.

http://www.arctic.noaa.gov/ – NOAA's Arctic theme page with numerous links to other relevant sites.

http://maps.grida.no/arctic/ – Thematic maps of the Arctic region showing populations, ecoregions, etc.

http://www.thearctic.is/ – A Web resource on human-environment relationships in the Arctic.

http://www.dfo-mpo.gc.ca/regions/central/index-eng.htm — Web site produced by Fisheries and Oceans Canada on the Arctic.

National Science Education Standards

Content Standard A: Science As Inquiry
- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Content Standard C: Life Science
- Structure and function in living systems
- Populations and ecosystems
- Diversity and adaptations of organisms

Content Standard E: Science and Technology
- Abilities of technological design
- Understandings about science and technology

Content Standard F: Science in Personal and Social Perspectives
- Populations, resources, and environments
- Natural hazards
- Science and technology in society

Content Standard G: History and Nature of Science
- Nature of science

For More Information

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