The “Art” of Ocean Exploration

Focus: The Role of Scientific Illustration in Oceanography

Grade Level: 5-12

Focus Question: How is scientific illustration used in the study of natural history, and how is it valuable in communicating concepts in the field of oceanography?

Learning Objectives

Students will be able to explain the importance of scientific illustration in preserving and recording natural history observations.

Students will learn about the different resources available and the methods used by modern scientific illustrators.

Students will practice several drawing methods used by scientific illustrators.

Materials:
Small sketchbooks or pads of paper
Computer with internet access
Pieces of marine organisms such as shells, crab shells, or corals

Audio/Visual Materials: None

Teaching Time: One 45-minute class period of instruction and practice with sketching exercises that may be done over a period of several days.

Seating Arrangement: As individuals

Maximum Number of Students: None

Keywords:
HMS *Challenger*
trawling
dredging
natural history
soft coral
seamount
multi-beam sonar
bathymetry
impressionistic (art term)
abstract (art term)

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Even before there was writing, there was art. Art historians have puzzled for hundreds of years about how to decipher what could be considered the first "scientific illustrations" which were recorded on cave walls in Altimara and Lascaux, France. These drawings, produced by primitive humans, depict many animals, including horses and bison. The drawing surface was stone; the materials were charcoal used to produce the color black, ground up shells to produce white, and red earth to produce the color red. Certainly, these were some of the first attempts made by humans to communicate with others and the language was, quite simply, art.

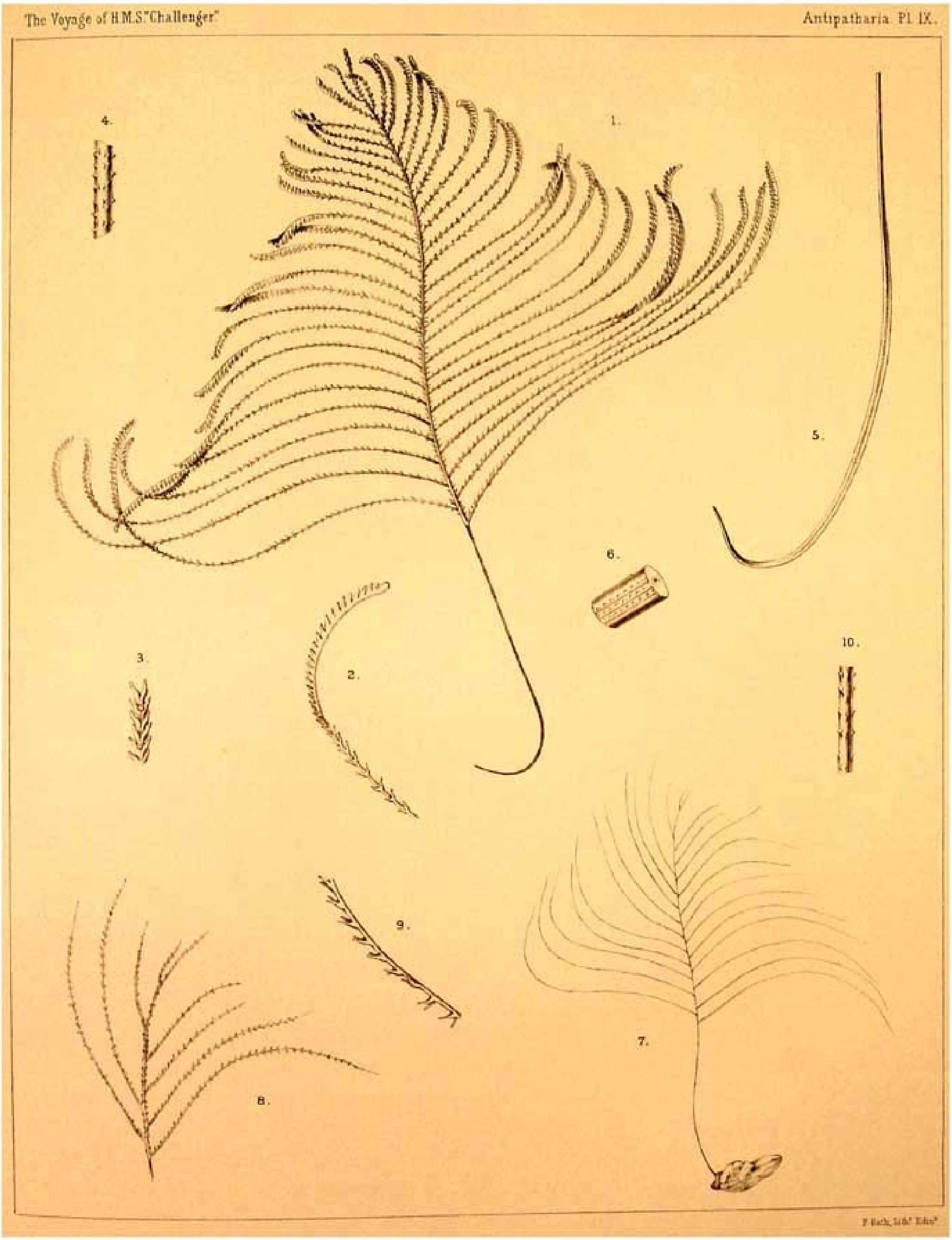
Herbals were one of the earliest uses of art in the service of science. Artists illustrated an herb and physicians recorded the medicinal use of plants. Herbals formed the first substantial "reference library" of scientific illustrations.

One early science illustrator was Leonardo da Vinci. It was da Vinci who first dissected the human body in a systematic way, recording and illustrating everything he found. It was also da Vinci who drew the first design for a helicopter and a diving bell (a bell-shaped structure that allowed early divers to breathe while underwater).

With the invention of the printing press, Europeans began writing and illustrating the natural world. Communication of this information through scientific publications began in earnest. From the 1500s on, Europeans explored the world, and artists often accompanied them on expeditions. Vancouver explored the west coast of the United States with a science illustrator. Scientific illustration is a visual way of communicating scientific research. It helps scientists better understand their own work and helps them to share it effectively with colleagues, students and the public. Sir Walter Raleigh employed John White to draw species from the Chesapeake and Virginia area. Mark Catesby was sent from England in 1724 to explore the East coast of "the colonies” by members of the Royal Society in England. He created over 220 water colors and sent back countless specimens during his four-year collecting journey. During the Lewis and Clark Expedition, Merewether Lewis recorded his discoveries though his own scientific illustrations.

In the late 1800’s, scientists aboard HMS *Challenger* helped to define the natural history of the oceans through their illustrations throughout a four-year voyage. The *Challenger* expedition was one of the first concentrated deep ocean explorations. It was completely underwritten by the British government and its explorers were charged with investigating the physical and biological conditions of the world’s oceans. In addition to the ship’s approximately 200 officers and crew, six civilian staff were on board *Challenger*. The inclusion of an official artist in that small civilian group is evidence of the importance of art to the field of natural history. The artist was responsible for creating many images of previously unknown ocean dwellers, as well as the people and lands that the ship visited. The scientists on board also created drawings, since art was part of their education and training as naturalists. When inspired, even the ship’s officers and crew members helped capture details of never before seen specimens hauled up in the nets, or the landscape of icebergs in the northern oceans. The sampling technologies used on *Challenger* to collect organisms were primarily trawling and dredging, and many times the organisms would be damaged from the weight of the catch, or from the stress of being hauled to the surface. If this happened, it was difficult to imagine what the whole organism looked like, because it could be missing entire parts of its body. The artist's job was critical in helping to create a complete picture of an organism by being able to draw various sections of it, and putting it together as a whole specimen. *Challenger* also had a photographer on board, but photography was a relatively new field at that time, and the scientists still relied heavily on illustrations for helping to define natural history.

Below is a sketch created by the *Challenger's* artist. He produced numerous illustrations of the thousands of different species that the *Challenger's* nets sampled.



An illustration of a soft coral species from the *Challenger*

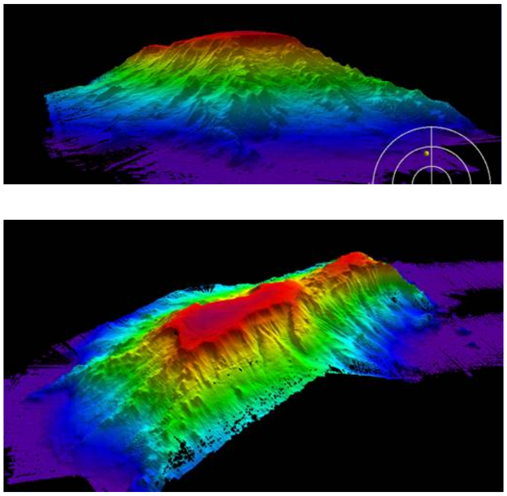
A sample from the *Challenger*. Photo courtesy of Scripps Institution of Oceanography.

The scientific results of the *Challenger* voyage were published in a 50-volume, 29,500-page report that took 23 years to compile. Many of the detailed drawings of flora and fauna provide much of the basis for modern marine biology. Today, many of the actual specimens from the *Challenger* voyage are archived in various museums around the world.

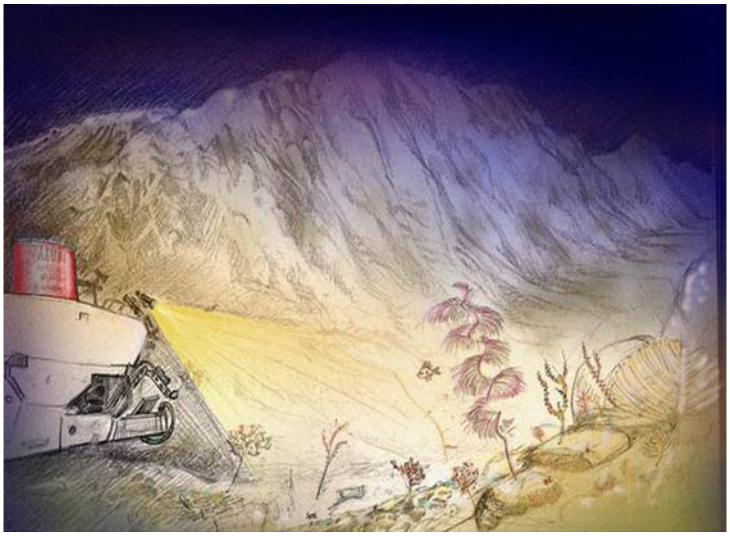
"Drawing" the Oceans Today

Similar to the *Challenger* expedition, a scientific illustrator accompanied the scientists on the 2003 "Mountains in the Sea" Expedition to the New England seamount chain with the primary objective of exploring these mountains that rise up from the sea floor for several thousand meters. Their summits, or the tops of the mountains, remain under an additional 1000-1500 meters of water.

Why did the crew for this mission include an artist when state-of-the-art photography was available? Photographs alone cannot capture a full image of the seamount, so the artist reviewed video tapes recorded during submersible dives in an attempt to piece together single images into a mosaic that would more accurately portray an Atlantic seamount. The submersible's lights illuminate only about a 120-foot square area, so many hours of videotapes are reviewed in order to sketch even a very small section of the seamount. Instead of having pictures from an area over five square miles, the artist can then produce a single image that shows almost the entire seamount, including geological features, and the life forms that exist there.



Multibeam digital terrain models of a seamount. Images by N. Forfinski



An artist's rendition of a seamount and its surrounding habitat. Sketch by M.J. Brush.

Another piece of the artist's puzzle is revealed by a technology called multibeam sonar which can show features of the ocean floor. The multibeam sends out a sonar "ping" and measures the speed with which it travels through the water column and then is "bounced" back to the ship. Since the speed of sound in water is known (by measuring salinity and temperature), the depth can then be determined and translated through computer software to produce images like those pictured above (left). These images can help the artist produce a sketch like the one above (right).

Another critical component of the scientific illustrator's job is to present a complete picture of an organism that may have been damaged or crushed during the collection process. A camera cannot repair that damage, but an artist can! For example, if divers collect three damaged specimens of the same species of coral, the artist can often create a picture of what an undamaged piece of that coral looked like by forming a composite of the samples. There are sometimes very subtle and specific characteristics that separate one species from another. It is the job of the artist to highlight and bring out these unique features. Scientific illustrators can also show what the inside of an organism looks like, while the hand-held camera focuses only on the external characteristics. Scientific illustrators produce most of the diagrams in science textbooks and, in a very real sense, become the "eyes" of the scientists.

According to M.J. Brush, the scientific illustrator aboard the Mountains in the Sea Expedition, "Scientific illustrators have a curiosity for how things work and how they are put together. It is most interesting to uncover the symmetry, design, and purpose of structures. It is indeed the key factor that makes it such an interesting career choice."

Today, the scientific illustrator works for a variety of groups including scientists, universities, book publishers, conservation groups and natural history museums. Many of today's scientific illustrators have become technicians (so to speak), using computer formats such as Photoshop to help them do their jobs. Although the same drawing and painting skills are used in both traditional formats and computer-generated formats, the publisher often requires the work to be presented in digital form. Using the computer does not detract from the artist's work. It is simply another tool used in creating a work. In scientific illustration, the artist must still provide the same perspectives, creativity, and individual skill that any other artist would use in any other field.

Learning Procedure

1. As an Assigned Reading for homework the night before this lesson, hand out pages 2-6 (The Art of Ocean Exploration) to the students.

2. The next day in class, circulate at least one copy of these pages that is in color, so students can see the detail in the graphics. Introduce the topic of scientific illustration by asking students what it means. Ask them to give examples of scientific illustration (most likely, some examples can be found in the classroom and in textbooks.) List their answers on the board. Ask why they think illustrations were used in these examples, instead of photos.

3. Have students brainstorm why scientific illustration is important to ocean science and what other applications it has (e.g., anthropology, astronomy, human anatomy). Why would someone refer to an illustration, even hundreds of years after the illustration was created? Ask students to present their ideas to the class, list answers on the board and compare them.

4. Have students look at the *Challenger* drawing of the coral on page 3 of the lesson. Ask them to pretend they are a scientist, and write about why it would be useful for them to have so many different views of a single species, particularly if their trawl nets were not able to capture an undamaged specimen.

5. If internet is available in the classroom, ask students to find other sketches from the *Challenger* volumes (in addition to the soft coral drawings in this lesson). Then ask them to find several modern scientific illustrations (egg., from textbooks or field guides). Have them write a paragraph that compares the *Challenger* illustrations with the modern ones. Ask them to include their thoughts about which illustrations (*Challenger* or modern) they think are better, and explain their answers. If internet is not available in the classroom, this activity could be assigned as homework.

Art Activities

As time permits, these activities may be done in the classroom or as homework.

6. The art of learning to see begins with small steps. Have students sit with a blank piece of paper in front of them. Have them look out the window and write a clear description of what they see (e.g., The sky is cloudy and gray with wind pushing the clouds around). Have them record the location, date and time. Have them write about what they are seeing like the trees, buildings, birds, or squirrels. Emphasize seeing over drawing. Now have them look away from the window and draw what they have just seen. Compare the drawing to the scene out the window.

7. Ask students to obtain a marine specimen, or a photograph or picture of a marine organism, and then create a sketch from it. They should try making a line drawing (no shading) and then try to sketch it with shading.

8. Provide three damaged samples of the same object (example: shells of the same species, or a crab shell of the same species). Ask students to draw that object and try to portray what it would look like if it were complete and undamaged. Then ask them to portray that object in any form

that they choose (computerized, abstract, watercolors, markers, impressionistic, etc.) As a class, have them compare the differences in the styles of their drawings.

9. Give students a small sketchbook, and ask them to draw one object every day for about two weeks (or whatever length of time the teacher chooses.) They should start with drawing their thumb (this is handy as you always have it with you) or a pencil or book. They should keep sketching the same object every day. This activity trains the mind to measure what the eyes are seeing, and helps the artist to see volume and contour. The drawing should become more refined and students will notice more details each time they draw.

Evaluation

Review the students' writeups from the activities in the Learning Procedure.

The BRIDGE Connection:
http://www.vims.edu/bridge/index.html
Click on Navigation Bar, Ocean Science Topics, Human Activities, Heritage, Maritime Heritage

The "Me" Connection: Give students two or three days to be aware of, and create a list of any examples of scientific illustration (e.g. in their textbooks, classroom posters, on television) they see in their daily lives. Ask them to write a paragraph explaining how the use of scientific illustration is important in the examples they site.

Connections to Other Subjects: Art, English/Language Arts, History, Social Studies

Extension

Have students do library and internet research to find specific examples of some of the *Challenger's* illustrations of marine species. Ask each student or group of students to choose one illustration and write a paragraph about the organism. Note: Some of the species names may have changed over the years through the evolution of the field of marine biology.

Resources:

NOAA Ocean Explorer Website (Mountains in the Sea Mission)
http://www.oceanexplorer.noaa.gov/explorations/03mountains/welcome.html

Examples of Scientific Illustration
http://www.scientificillustrator.com/artists/illustrators.html

Sierra Club Guide to Sketching in Nature, by Cathy Johnson, Sierra Club Books, California, 1997.

The Art of Field Sketching, by Clare Walker Leslie, Gibbs Smith Publisher, Utah, 1993.

How to Draw Animals, by Jack Hamm, A GD Perigee Book, Putnam Publishing Group, New York, 1983.

Scientific Illustration: A Guide for the Beginning Artist, by Zbigniew JastrzebskiTT, Prentice Hall Trade, New Jersey, 1985.

Bird Egg Feather Nest, by Maryjo Koch, Collins Publications, Chino Hills, CA, 1994.

List of Additional Books on Scientific Illustration
http://www.calacademy.org/research/library/biodiv/biblio/natillus.htm

National Science Education Standards:
Content Standard G: History and Nature of Science

- Nature of scientific knowledge (9-12)
- Historical perspectives (9-12)
- Science as a human endeavor (5-8)
- History of science (5-8)