Marine Education

A COOPERATIVE EFFORT OF THE TEXAS A&M UNIVERSITY SEA GRANT COLLEGE PROGRAM AND DEPARTMENT OF EDUCATIONAL CURRICULUM AND INSTRUCTION

Three students share Sea Grant science awards

One seventh grade student and two ninth graders received Sea Grant Awards at the Regional Science Fair held at Texas A&M University in April. Barbara Saatkamp of A&M Junior High in College Station won the junior division award, while Alice Ehlers, a ninth grader at Stephen F. Austin in Bryan, received the senior division award. Bethany Merrell, also a ninth grader at Stephen F. Austin, was given a Special Sea Grant award.

The Texas A&M Sea Grant College Program selects exhibitors who demonstrate outstanding achievement in marine-related projects each year. Members of the University's Marine Fellows program act as judges.

Saatkamp's project, "The Effects of Acid Rain on Lilies," was designed to determine if a simulated acid rain had any effect on the growth or blossoming rate of paper white narcissus. She sprayed four ounces of water solutions with pH values of 7.0, 6.0, 5.0 and 4.0, respectively, on four groups of bulbs every other day. At the end of 29 days, Saatkamp concluded that

(See Awards, page 8)

Sea Camp Adventures set for Galveston

A series of *Sea Camp Adventures* are planned for young people aged 10 to 12 and 13 to 16 this summer at Texas A&M University at Galveston. The camps for younger students will be June 8-14, July 6-12, and August 3-9, while the teenage camps will be June 29 to July 5 and July 13-19.

Sponsored by Texas A&M University at Galveston and Sea-Arama Marineworld, the Sea Camp provides a five-day adventure in exploring the Galveston Island area marine environment. Students will learn about the ocean through first-hand, on-the-water experience using research vessels, oceanographic equipment, laboratory facilities, an oceanarium, an aquarium and a staff of marine professionals.

The program includes field trips to Galveston Bay and nearby marsh areas. These field trips consist of visits to shoreline study sites, such as marshes, beaches and the bay area where marine organisms, coastal plants and birds can be observed in their natural habitats, as well as laboratory and classroom programs.

Through the cooperation of Sea-Arama Marineworld, local marine organisms as well as exotic species from various oceans of the world will be available for observation and study. Sea-Arama also offers behind-the-scenes activities and study, programs on training marine mammals, and techniques for holding and maintaining marine organisms in captivity. Marineworld professionals also will present a slide tape series on the many varieties of fish, invertebrates and marine mammals.

There also will be entertainment as well as trips to local attractions and historical sites during Sea Camp.

Sea Camp's equipment and facilities include a 44-foot research vessel, THE ROAMIN' EMPIRE, a full array of oceanographic equipment such as nets, water samplers, bottom dredges and appropriate measuring instruments, and laboratory facilities at Texas A&M University at Galveston that are well equipped for conducting experiments and analyses. Sea Camp also will provide visits to other local

(See Camp, page 2)

Tinnin schedules three teacher workshops

Rick Tinnin, marine education coordinator at The University of Texas Marine Science Institute in Port Aransas, has announced two secondary teacher workshops in July and August and a Project Wild workshop for elementary teachers.

At the secondary level, a two- and a half-day workshop July 24-27 highlights the High School Marine Science Studies (HMSS) program designed and developed by the University of Hawaii Curriculum Research and Development Group. This is a modular general science course set in a marine context for high school students.

"This workshop will highlight five complete hands-on laboratory and field investigations," Tinnin said, "that have been selected to provide teachers with a sample of HMSS materials applicable to local needs and interests."

Tinnin also has scheduled a physical and chemical oceanography workshop Aug. 15-17, which includes an offshore research and collecting trip aboard the R/V LONGHORN. During the cruise, waters of the nearshore Gulf of Mexico will be sampled, using a variety of sampling devices including STD, Nanson bottles, a hydrolab, a Smith-MacIntyre mud grab and a spade-bit corer. Samples collected in the field will be returned to the laboratory for further analysis under the direction of the chemistry and benthic ecology faculty and staff of the Marine Science Institute.

The Project Wild session, conducted by Mary Judd, will be Aug. 15. Teachers who attend the full eight-hour session will receive a free activity guide which can be used in all school subject and skill areas—particularly science, social studies, language arts and mathematics. Project

(See Workshops, page 2)

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Aquarium plans 1990 opening

Since the 69th Legislature designated the public aquarium being built in Corpus Christi as the "Official Aquarium of the State of Texas," the Corpus Christi Aquarium Association, the non-profit sponsor of the project, has planned to open its doors in Summer 1990.

The association recently selected a new site that will allow more laboratory space, exhibits and education facilities. The first-phase building design has been increased to 33,000 square feet, and six acres of land have been purchased to allow future expansion and to provide for outdoor exhibits as well as those inside. The association now plans to include 40 to 50 inside displays, with tanks ranging from 45 to 75,000 gallons.

The larger facility has increased construction costs to $15 million. A statewide fundraising campaign continues through 1987, since the goal is to build the aquarium without using public funds. Once opened, the aquarium will be supported through admission fees, membership dues, gift shop sales, facility rental fees, and private donations and grants.

The Gulf of Mexico and the Caribbean Sea serve as the two primary exhibit themes. "For example, one exhibit will trace the flow of water from the Nueces River watershed into the marshes of Nueces Bay and, subsequently, into the Gulf of Mexico," said Quenton Dokken, aquarium executive director.

Other exhibits will illustrate habitats such as coral reefs, hard bank reefs, communities around offshore rigs, and the pelagic Gulf and Caribbean.

A marine mammal exhibit will schedule demonstrations to help viewers better understand the intellectual and athletic abilities of dolphins and whales.

All exhibits are being designed to enhance visitors' understanding of marine ecosystems and illustrate man's inseparable ties to the oceans. Dokken said state-of-the-art techniques will enable the exhibits to create an impression that the viewer is in the ocean. Touch-tanks will allow visitors to handle various marine animals.

Exhibit design will use existing knowledge of animals and habitat display. "We want to duplicate the natural environment as closely as possible," Dokken said. "Our first criteria will be meeting the needs of the animals. To do this, exhibit designers will need detailed knowledge of each animal's behavioral, spatial and physiological needs."

Most of this technology exists, but some new techniques may need to be developed, Dokken said. The aquarium site has direct water access to Corpus Christi Bay, and facility designers are studying ways to incorporate bay water in the aquarium's saltwater system.

Other world-class facilities are being surveyed for the latest and most imaginative techniques in marine display.

Marine education will be an essential element. On-site and off-site programs are being developed for all age groups, from elementary students through senior citizen groups.

There also is considerable potential for cooperative research and study programs with Texas' universities. The physical size of the planned seawater life-support system presents research opportunities unavailable elsewhere.

"This type of facility is most conducive to research," Dokken said. "We hope eventually to have staff and guest scientists concentrating on research in areas such as animal behavior and physiology."

Anyone interested in more information about, or in working with, the Texas State Aquarium should contact Dokken at P.O. Box 331307, Corpus Christi, Texas 78404 (512/881-8220).

Camp . . .

(Continued from page 1)

organizations involved in marine research.

Sea Camp's instructors are experienced faculty members and graduate students from the University's Department of Marine Biology and Marine Sciences, and experienced members of the curatorial staff at Sea-Arama Marineworld. Dr. Sammy Ray, dean of Moody College of Marine Technology and graduate program coordinator at Texas A&M University at Galveston, is camp director.

Campers will stay in campus dormitories, and a fulltime counselor and recreation director will be in attendance 24 hours daily. Sea Camp's $425.00 registration fee includes housing, meals and all activities.

Further registration information is available by contacting Dr. Ray, Marine Biology Department, Texas A&M University at Galveston, P.O. Box 1675, Galveston, Texas 77553, (409) 740-4525. Registrations will be accepted until one week before the start of a specific session.

Workshops . . .

(Continued from page 1)

Wild workshops also are free; the only costs involved in this day will be $12.00 for meals and $7.50 for dormitory space.

"Since there will be no university classes at the Institute this summer, we also will be able to continue our visiting class program," Tinnin added. "We can conduct tours and field trips for organized science classes or organizations, and I am interested in working on in-service workshops for school districts."

Further information on any of these programs is available by contacting Rick Tinnin, Marine Education Services, The University of Texas Marine Science Institute, Port Aransas, Texas 78373 (512/749-6729).

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Marine Education is to inform elementary and secondary teachers about current research and activities in the marine environment. *Amy Broussard*, editor.

Marine Facts

Venn diagrams sort confusing data

by Gregory Black

Man benefits from numerous resources from the oceans. Among these are food, fuels, fertilizers, jewels, chemicals and minerals. Minerals such as zinc, maganese and cobalt exist in pockets in the seafloor, so it is logical to restrict fullscale mining activities to areas where an abundance of these pockets exist.

Scientists frequently take core samples to determine these concentrations, an effort that involves a multidisciplinary team of oceanographers, geologists, mathematicians and design engineers.

A hypothetical example illustrates this process—

A company hires a drilling team to sample a large area of the ocean's floor in order to determine the feasibility of mining for a certain material. For this example, this mineral can be called **magnetite**. After some complex investigations, company planners have determined that if 50 percent of the samples show evidence of magnetite, there is enough to make in-depth mining feasible. Records of the initial sampling reveal (all mineral names are hypothetical):

3 samples contain traces of magnetite alone
3 samples contain traces of marcasite alone
4 samples contain traces of pyrite alone
5 samples contain traces of magnetite and marcasite
5 samples contain traces of marcasite and pyrite
7 samples contain traces of magnetite and pyrite
4 samples contain traces of all three minerals
3 samples contain traces of none of these minerals

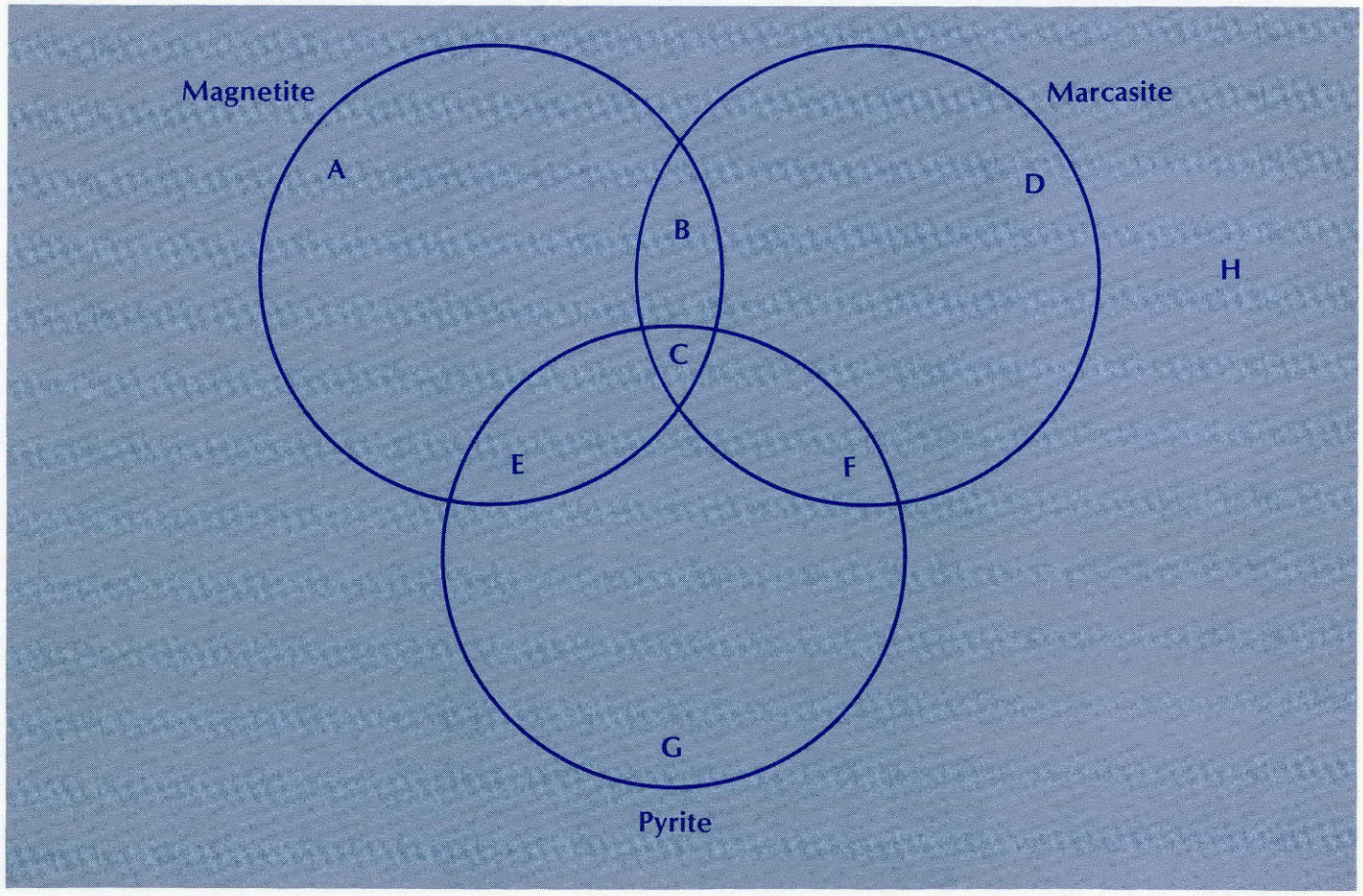
After sampling is completed and data analysis begun, the investigators discover that they have not recorded the total number of samples taken. They cannot calculate the needed percentage without this information. Since the categories listed do overlap, the scientists cannot simply add the numbers of samples containing various combinations to arrive at the total number.

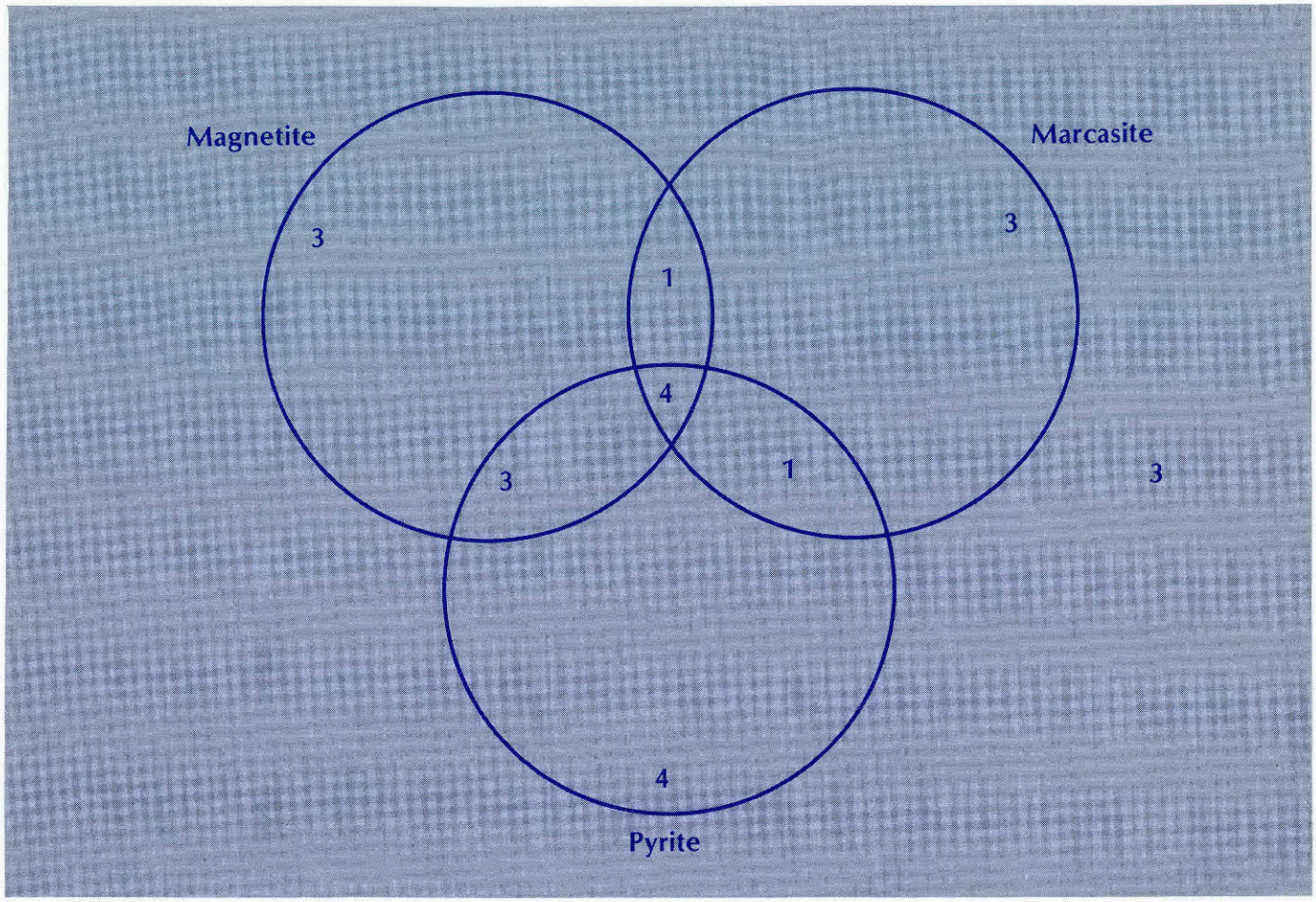
The drilling company is faced with a dilemma. The expense involved in re-sampling is prohibitive, but the research completed thus far is meaningless. What can be done?

There is a method available to sort the confusing data, one already known by many high school math and science students. By analyzing the data available, students can determine the total number of samples taken, figure the percentage of samples containing traces of magnetite, and determine if mining the area in question is economically feasible.

Samples might contain traces of only one of the three minerals, a combination of two of the three, all three, or none of the three. All these sampling possibilities can be illustrated by using a Venn diagram (Figure 1).

After assigning letters to the different regions, it is apparent that region C represents samples containing traces of all three minerals. Region B represents samples containing traces of magnetite and marcasite, but not pyrite. What about regions E and F? If the area labeled "A" represents sam-





ples containing traces of magnetite alone, what about regions D and B? Is it clear that the area outside the three circles (H) represents samples without any of the minerals?

The diagram now can be filled in. Regions A, D and G are relatively easy, and can be assigned numbers 3, 3 and 4, respectively. According to the data, four samples contain traces of all three minerals (C), and three contained none (H). This leaves regions B, E and F unassigned. There may be a temptation to put a "5" in region B, since five samples contained traces of magnetite and marcasite, but four of these samples are already represented in region C. Simple math shows that 5 - 4 leaves just one sample for region B. Using similar reasoning, regions E and F are represented by 3 and 1, respectively.

By consulting the completed diagram (Figure 2) and adding the numbers, it is apparent that 22 samples were taken. Of these 22, 11 contained traces of magnetite. This is exactly 50 percent, which indicates that mining should be economically feasible.

Completing a Venn diagram can be difficult when there is a large amount of data. It can be a useful tool, however, when it is completed one step at a time.

Ideas for the Classroom

Using Venn diagrams to analyze data

Materials

Aquarium or other large glass container
Pea-sized gravel
Three colors of marbles
One-fourth cup measuring cup

Procedure

1. Cover the bottom of an aquarium with pea-sized gravel, and scatter three colors of marbles throughout the gravel.
2. Fill the aquarium half full of muddy water (so the bottom of the aquarium is not visible).
3. Use the measuring cup to collect samples of the gravel and marble mixture.
4. Illustrate the results of this sampling with a Venn diagram.

Field Study

If it is possible to conduct a field study, data obtained by seining in a large pond or small lake can be analyzed. Students can determine what types of fish might be caught in a given area, or what types of vegetation might be found in specific locations. This can be either a class or team activity.

References

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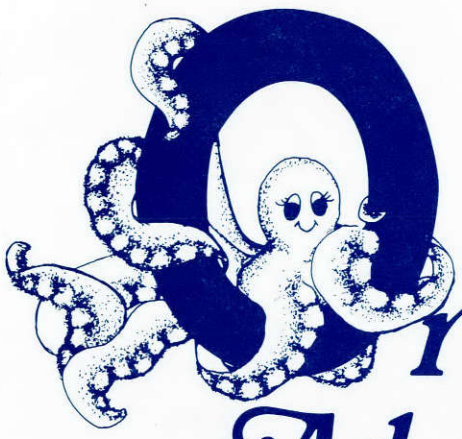


Orville's Adventure

Orville was a young and curious octopus who loved to swim around the cave where he lived with his parents. He would swim round and round in circles, testing new ways to turn and swirl the eight long tentacles that an octopus has instead of arms and legs.

Sometimes Orville's parents worried that he spent too much time swimming and not enough time learning to be an adult.

One day Father Octopus said, "Orville, today I'm going to teach you how to hunt like I do."

"No, thanks, Dad," was Orville's reply. "I'm having too much fun swimming around the cave." And off he swam in a perfect circle.

"But, son, you must learn that the many talents of an octopus go further than swimming about in perfect circles."

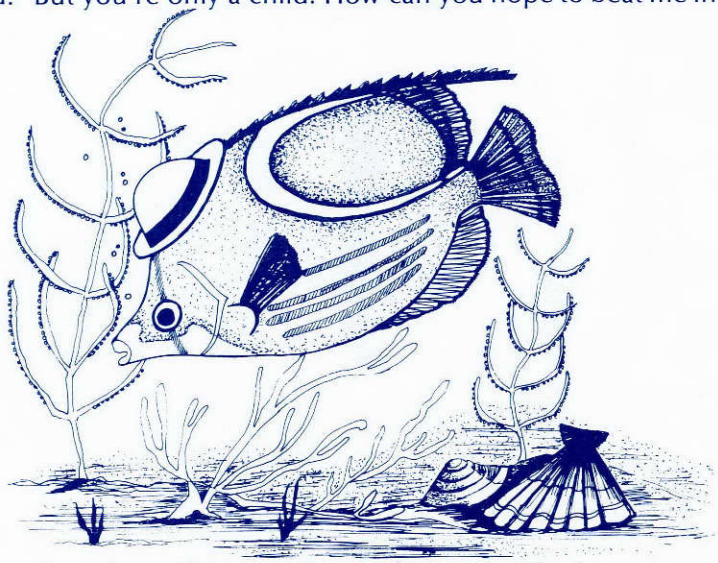
But Orville wasn't listening. He just continued his swimming practice.

As Orville swam, he noticed a large butterfly fish swimming by and he called out, "I'll bet I can swim faster than you, Mr. Butterfly Fish."

Mr. Butterfly Fish just looked at Orville and laughed. "But you're only a child. How can you hope to beat me in a race?"

"I'm very fast," replied Orville. "I practice a lot."

"Very well, Orville, I'll race you," said Mr. Butterfly Fish.



With that, Orville darted off, leaving Mr. Butterfly Fish bewildered. "I wonder if that boy will ever learn," sighed Mr. Butterfly Fish.

Not knowing that Mr. Butterfly Fish wasn't racing him, Orville swam along rapidly, smiling all the time, for he was sure that he would win the race.

When Orville finally slowed down and looked around, he was confused. "Oh, Mr. Butterfly Fish, where are you?"

But Mr. Butterfly Fish was nowhere to be found.

Suddenly, Orville was scared, for he didn't know exactly where he was. He had strayed too far from home!

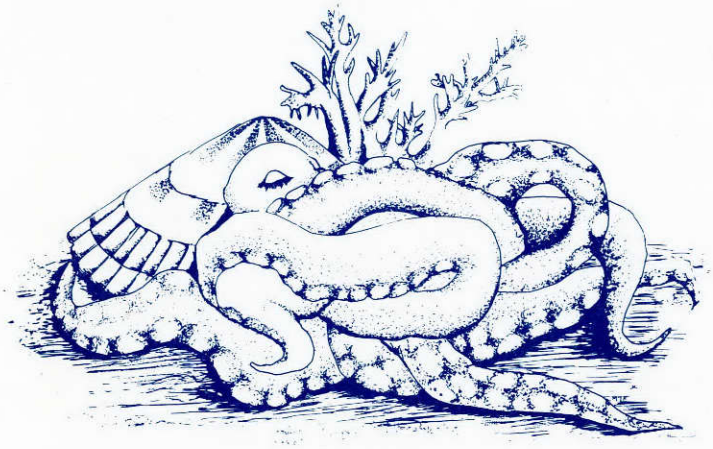
Orville swam around aimlessly, wishing he had not been so foolish. It was getting late and he began to worry that he would have to spend the night away from the safety of his cave. Not only that--Orville also was very hungry. His parents always fed him crabs, but he never imagined he would have to catch one for himself.

Orville remembered his father's words, "The many talents of an octopus go further than swimming about in perfect circles."

If only he had gone hunting with his father, he would be enjoying a big meal right now.

Instead, he was lost--and scared--and without a bit of food.

Orville sighed. He had no hope of getting home that night. He settled himself as best he could on the ocean floor and fell fast asleep.



Orville woke with a start the next morning. He was surprised by a deep voice behind him.

"Oh, Orville, is that you, son?"

Father Octopus was out for his morning hunt. Orville leaped from his ocean floor bed and wrapped his eight tentacles around his father in a great big octopus hug.

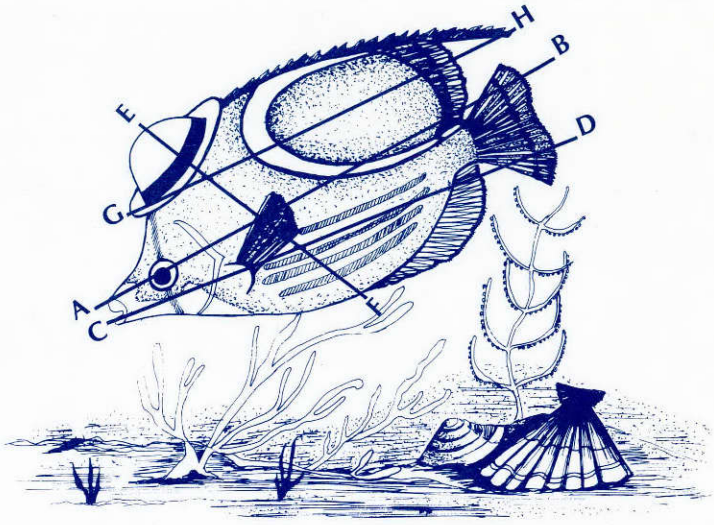
"Oh, Father, I will never ignore you again. I have truly learned that the many talents of an octopus go further than swimming about in perfect circles," exclaimed Orville with a big tear of joy in his eye.

All that day, Orville's father taught him how to hunt and how to protect himself from enemies.

And that night, Orville had a gigantic meal of crabs that he had caught all by himself.

An elementary view

Making Mr. Butterfly Fish bigger



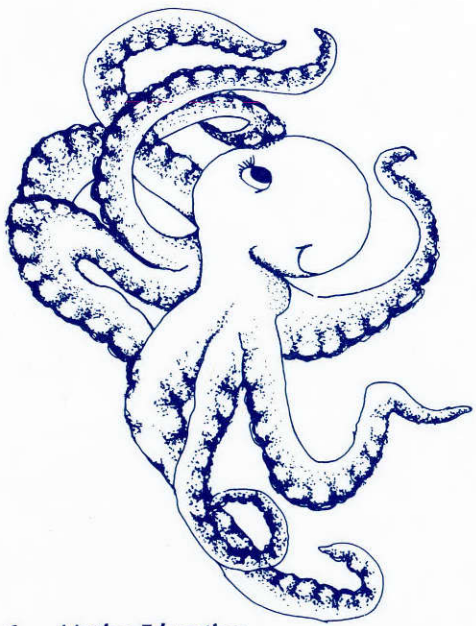
Objective: To scale up a drawing.
Materials Needed: String
Paper
Pencil

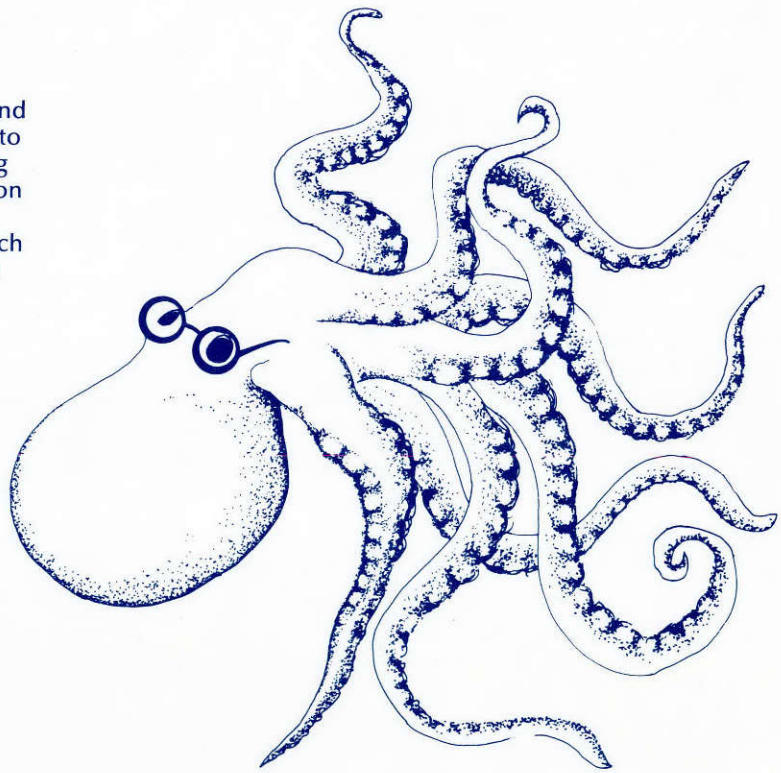
You are going to draw Mr. Butterfly Fish to scale, making it three times larger than the size on this page. Using your string, measure the length of Mr. Butterfly Fish along the A-B line; triple this length. Now mark your paper showing this length. Measure the drawing along the C-D line and mark your paper. Repeat this procedure using lines E-F and G-H. See if you can draw Mr. Butterfly Fish three times larger than this original. When you finish, compare your drawing with that of the person next to you. Are the two drawings about the same size?

Give an octopus a hug

Materials Needed: Construction paper
Pencil
Scissors

If Orville has eight tentacles instead of arms and legs, and Father Octopus also has eight tentacles, what happens to all those tentacles when Orville gives Father "a great big octopus hug"? Copy the pictures of Orville and Father on construction paper. Cut out your pictures and then fit them together to show Orville giving Father a hug. Punch a small hole in the top and hang your hugging octopi in the window or in your room.





Several summer courses available for teachers

Elementary and secondary teachers have a number of educational opportunities this summer, either in regular summer sessions or in special short courses scheduled at several of Texas' universities. Many of these courses will be offered at Texas A&M University's College Station campus.

Survey of Oceanography (OCN 600), taught by Capt. T.K. Treadwell, is designed for graduate, or upper level, students. Treadwell devotes approximately half the time to an overview of the basic principles of oceanography and the remaining time to applying these principles to practical uses. A minimal background in the sciences and math is required; the course is concept-oriented. Each application is treated as a separate topic entity, from pollution to fishing and energy to coastal management.

Special supplemental information (slides, reference materials, lab suggestions, etc.) are available for those involved in teaching earth or marine science at the pre-college level.

Marine Biology (BIO 440), taught by Dr. Mary Wicksten, is a general course that emphasizes marine environments and their inhabitants along the Texas coast. Plants and animals are presented in the context of their natural habitat; general ecological concepts are stressed rather than memorization of names. The laboratory work includes a field trip to marine habitats along the northern Texas coast.

The prerequisites for the course are a class in introductory biology and an ability to handle upper division course work. The course is open to non-majors in general science education, geology, wildlife and fisheries, and related disciplines. Further information is available from Dr. Wicksten, Department of Biology, Texas A&M University, College Station, Texas 77843 (409/845-3388).

Texas A&M's Department of Wildlife and Fisheries Sciences offers four courses for teachers this summer, **Ecology for Teachers** (WFS 420), **Lab and Field Techniques** (WFS 600), **Special Topics: Integration of Natural Resources into the Classroom** (WFS 489), and **Museum Programming** (WFS 630). The special topics offering is a new course that implements nationally developed programs, while WFS 630 will instruct teachers in integrating museum resources into the classroom.

Further information on these courses is available by contacting Dr. Clark Adams, Department of Wildlife and Fisheries Sciences, (409) 845-5777.

Three computer education courses will be offered, two in the first summer session only and one in both sessions. **Creative Application of Technology to Education** (EDCI 605) is designed for teachers in grades 5 through 12. **Classroom Applications of Microcomputers** (EDTC 645) is an introduction to the use of microcomputers, and many class activities will be directed toward the students' areas of application and expertise.

Computer Assisted Instruction (EDTC 651) will be offered both summer sessions, and is intended to provide experience in the design and development of material for educational applications.

Conducting Educational Field Trips (EDCI 689) will address all aspects of field trips, and may involve a one-week trip for participants. Further information is available from Dr. Delmar Janke, Department of Educational Curriculum and Instruction (409) 845-7088.

Dr. Robert James of the same department will teach **Laboratory Methods and Management in Science Teaching** (EDCI 689), and discuss procedures for effective laboratory instruction as well as planning, conducting and evaluating lab activities.

Two shortcourses will be offered for physics teachers, **Enrichment Course for Physics Teachers with Life Science Backgrounds**, beginning July 14, and **Advanced Placement Physics**, beginning June 2. Two earth science courses may be taught for teachers or others who are seeking certification in this subject. These courses are contingent on funding approval.

Further information on any of these courses is available through Texas A&M's Admissions Office or by contacting the specific department.

Texas A&I University

Texas A&I University's Department of Biology offers two, three-week summer workshops (BIOL 341 and BIOL 342) June 2 through June 20 and June 23 through July 11, respectively. Participants may enroll in either for four hours credit, or in both for eight; the latter option is advised since the second workshop is a continuation of the first.

The workshops stress aquatic and near-aquatic organisms, both plant and animal, how to study them, their places in the natural scheme, how "people pressures" affect them, how they came to be, and what they are. More than half of each workshop deals with the marine environment. The courses are open-ended; there are no reprequisites and persons with no biology background can work at their own level while those with biology majors can advance as far as they wish with any of the topics covered.

A number of all day and overnight field trips are included, to the Padre Island National Seashore, Port Aransas jetties and the Welder Wildlife Foundation.

Further information is available from Dr. Allan H. Chaney, Department of Biology, Texas A&I University, Campus Box 158, Kingsville, Texas 78363 (512/595-3803).

Texas A&M University at Galveston

Texas A&M University at Galveston has two summer sessions, and graduate-level, marine-related courses will be offered each session. These include Problems in Biology, Research in Biology, Problems in Wildlife and Fisheries Sciences and Research in Wildlife and Fisheries Sciences.

Other courses include Biology of the Mollusca, Research in Oceanography, Biology of Invertebrates, Special Topics in Marine Invertebrate Embryology, and Statistical Methods in Ecology.

Further information is available through the Student Records Office, Texas A&M University at Galveston, P.O. Box 1675, Galveston, Texas, 77553.

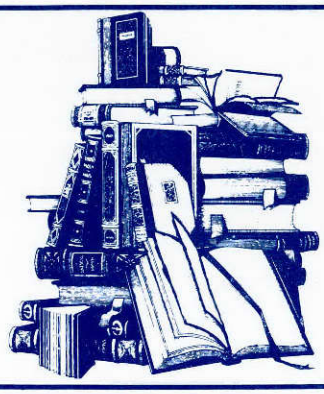
Gladys Porter Zoo

The education department at the Gladys Porter Zoo in Brownsville, Texas, is sponsoring an eight-day teacher training institute and nature expedition to Belize. Participants will conduct several studies and learn about the Belizean jungle ecosystems, visit crocodile ponds, follow a jungle stream, and snorkel at Ambergris Cay, a mangrove swamp and the world's second largest coral reef. Several Mayan ruins and Belizean villages also will be explored.

The trip includes educational activities designed especially for teachers. Graduate credit is available, and the trip is applicable to science teachers' career ladder plans.

More information is available from Sandra G. Skrei, Curator of Education and Information, Gladys Porter Zoo, 500 Ringgold St., Brownsville, Texas 78520 (512/546-7187).

books & things



With all the field guides that have been published through the years on various types of marine organisms, barnacles have received, perhaps, the least attention. Much of the information available to students or researchers dates from the last century.

A new **Annotated Guide to the Barnacles of the Gulf of Mexico** is designed to fill this void. The 49 species of thoracican barnacles (the goose and acorn barnacles) that are known to occur in the northern Gulf of Mexico are differentiated by a taxonomic key based on external characters, with extensive illustrations and a glossary. The guide also includes an annotated list of those species and three systematically questionable ones, with areal range, bathymetry, substratum type and other data; a list of 16 species that have been found in the southern Gulf of Mexico but not in the northern Gulf; directions for collecting and examining specimens; and a list of references especially useful for further study of particular groups.

The guide was prepared by Stephen R. Gittings, George D. Dennis and Harold W. Harry and published by the Texas A&M University Sea Grant College Program. The 36-page, paperbound book is available for $3.00 by writing Marine Information Service, Sea Grant College Program, Texas A&M University, College Station, Texas 77843-4115 (specify TAMU-SG-86-402).

A wide range of new educational materials published by Mystic Seaport Museum is now available to elementary and secondary school teachers. These study guides, resource packets and other miscellaneous materials are specifically designed to supplement and enrich classroom studies about 19th Century life at sea and on shore.

Two versions of the study guide **Voyaging** are available. **Voyaging—19th Century Life at Sea and Ashore** ($10) is intended for upper elementary and middle school classes. It includes six themes: Wind and Wave, Shipboard Community, Harvesting the Sea, the Carrying Trades, Shoreside Industries and Occupations, and Family and Community Life. **Voyaging—U.S. History Through Its Maritime Experience** ($12), for secondary students, explores areas of U.S. history that pertain to immigration, the Civil War, the clipper ship era, women's roles, and blacks at sea.

Mystic also has resource packets (ranging from $6 to $9) that supplement studies in regional or national history by focusing on singular topics relevant to the past century. Two miscellaneous materials that may be of interest to teachers are **Vocabulary Booklet** ($1.00) and **Sea Chanteys and Fo'c's'le Songs at Mystic Seaport Museum** ($10.98).

Further inquiries should be addressed to Education Department, Mystic Seaport Museum, Mystic, Conn. 06355.

Awards . . .

(Continued from page 1)

acid rain had only long-term effects on the growth rate. There was significantly more growth in the 7.0 pH group, and no significant difference in the blossoming rates of the four groups.

Ehlers wanted to determine the effect of saltwater on the growth of radishes grown in a hydroponic garden. She selected radishes because they are easily grown and mature rapidly. Seeds were germinated in five-gallon plastic buckets that were connected to reservoirs of either saltwater from the Gulf of Mexico or distilled water.

She reported that the seeds irrigated with distilled water germinated within two to three days, while those in saltwater took five days. Seedlings in distilled water developed into healthy plants, while those in saltwater never showed vigorous growth and never matured.

Ehlers concluded that the hypothesis that plants can be grown in saltwater is incorrect, but said the depth of the sand in the growth chambers is critical to success. She used 40 cm of sand in the saltwater experiment, and concluded that this was too shallow to fully drain the saltwater from the growth chamber.

Merrell's project, "The Effects of Light Intensity on the Productivity of Phytoplankton," was based on the hypothesis that if diatoms receive three different light intensities, growth rate will correspond with the amount of light received. She conducted three experiments with the diatom **Thalassiosera eccentrica** and three boxes equipped with different light intensity filters comparable to 0, 50 and 100 meters below the ocean surface. She concluded that the hypothesis is correct at the end of her experiments.