TEAM RESEARCH IN COASTAL MICROBIOLOGY:

TEACHING THROUGH APPLICATION

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My special interest always has been to convey the excitement of my discipline to students. Original research can be a very effective way to teach students the method and application of biological science. For several years, I have sought new ways to foster teaching through research, and have found that team research, the organization of a class into a research team working together to investigate a topic, represents a different and powerful approach.

Traditionally, colleges use three approaches to introduce students to independent research: directed study, in which the student works independently under the direction of a faculty member; internship, in which a student works at a government or private agency for one quarter; and cooperative study, which usually is a supervised work experience for three or more quarters at a government or private agency. In each of these activities, the experience often focuses on the accomplishments of the individual student working independently. Team research adds an additional dimension, the interaction of students with each other as a group as they work to accomplish a common set of objectives. The research team is able to complete a more complex investigation than a single individual, and the group interaction can reinforce the learning of new concepts and technical skills.

In the summer of 1991, I had the pleasure of teaching a course at Kennesaw State College entitled Team Research in Coastal Microbiology. Six students and I conducted a research project that included a field trip to Sapelo Island, Georgia. In this article, I shall attempt to describe the objectives, organization, and administration of the course, and give my perceptions on how the course benefitted both the students and the instructor.

Course Background and Objectives: Several groups of microorganisms contribute to nutrient cycling and other processes in coastal environments. For several years, I have had an interest in the microbes found in estuaries and salt marshes. Many species of microorganisms inhabit the soil of salt marshes, contributing to activities such as nitrogen and sulfur cycles.

In particular, I was interested in determining if the distribution of certain salt marsh bacteria could be used as an indicator of human impact on estuarine ecosystems. As part of this study, the team research class focused on three major scientific objectives: 1) to develop methods of collecting salt marsh soil samples for bacterial analysis, 2) to develop methods for the enrichment and growth of selected groups of bacteria, and 3) to evaluate methods for the extraction and measurement of certain mineral components from the salt marsh samples.

To complete the scientific objectives of the course, the students would have to employ several skills. These included using scientific literature, adapting published procedures to a specific task, formulating hypotheses, collecting and analyzing data, and disseminating information in oral and written presentations.

Course Organization and Administration: The course was divided into three main parts: preparation, the field trip to Sapelo Island and the follow-up after returning to campus. During the first three weeks, we concentrated on getting ready for the field trip. Each week, I gave a background lecture covering the topics of barrier island formation, estuaries and salt marshes, microbial groups found in salt marshes, and the processes performed by microorganisms. In the laboratory, pairs of students performed standardization procedures for the chemical tests we would use on Sapelo. We planned to examine the marsh soil for ammonia, nitrate, phosphorus, potassium, sulfate, sulfide, iron, and manganese content. The students standardized the procedure for each chemical test, and we discussed the results during weekly class meetings.

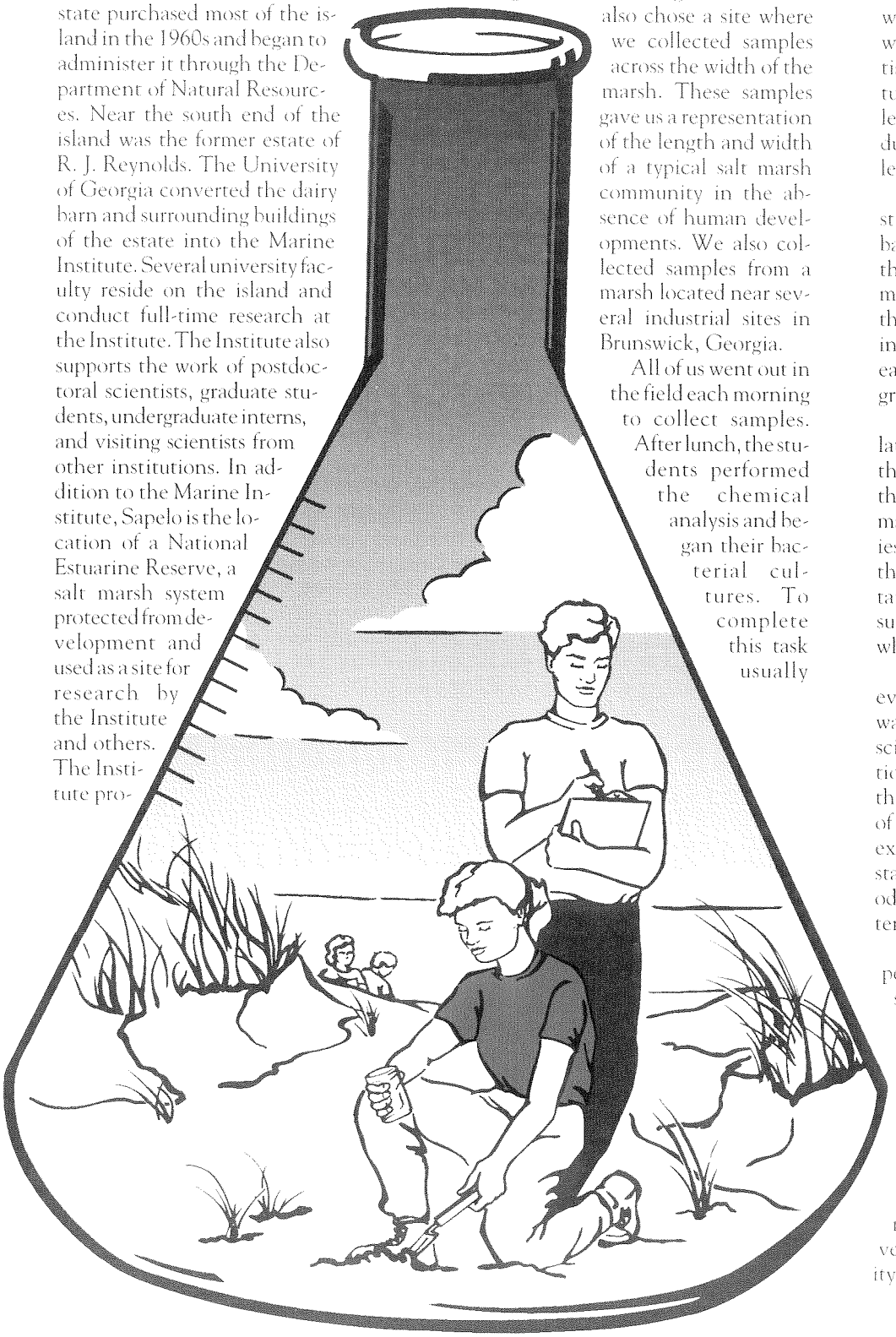
During the early stages of planning, each student chose a different type of bacteria to work with as an individual project. These included sulfate-reducing bacteria, photosynthetic bacteria, halophilic (salt-loving) bacteria, nitrogen-fixing bacteria, stalked bacteria, and marine spirilla. The students began collecting information about

their organisms, learning how to isolate and grow the bacteria. They assembled the materials and supplies they would need to isolate the organisms from soil samples during and after the Sapelo trip.

On July 10, we loaded up a school van with our equipment and gear and headed toward the coast for our one-week visit to Sapelo, one of the barrier islands off the coast of Georgia. The state purchased most of the island in the 1960s and began to administer it through the Department of Natural Resources. Near the south end of the island was the former estate of R. J. Reynolds. The University of Georgia converted the dairy barn and surrounding buildings of the estate into the Marine Institute. Several university faculty reside on the island and conduct full-time research at the Institute. The Institute also supports the work of postdoctoral scientists, graduate students, undergraduate interns, and visiting scientists from other institutions. In addition to the Marine Institute, Sapelo is the location of a National Estuarine Reserve, a salt marsh system protected from development and used as a site for research by the Institute and others. The Institute provided laboratory and dormitory space for us during our week-long visit.

During the first three days we selected samples from sites in the marsh along Dean Creek, a stream on the southern end of the island within the National Estuarine Reserve. Beginning at the mouth of the creek where it empties into Doboy Sound, we collected soil samples at 200 meter intervals along the creek during low tide. We also chose a site where we collected samples across the width of the marsh. These samples gave us a representation of the length and width of a typical salt marsh community in the absence of human developments. We also collected samples from a marsh located near several industrial sites in Brunswick, Georgia.

All of us went out in the field each morning to collect samples. After lunch, the students performed the chemical analysis and began their bacterial cultures. To complete this task usually required the students to work until late in the evening. The next morning, we would meet in the conference room in the dormitory to go over the data and make any necessary adjustments in procedure before starting the sample collecting for the day.



The students had free time during the week to explore Sapelo Island. They also took advantage of the Marine Institute library to finish some of the work on their reports. By the end of the week, we had met many of the scientists and interns at the Marine Institute, and had shared our ideas and learned about the research being conducted there. Certainly, we were sad to leave at the end of our trip.

After returning to Kennesaw, the students finished the analysis of the bacterial cultures they had started on the island. We continued our weekly meetings, with discussions focusing on the progress on individual projects. During the last two weeks of the course, each student gave a final report to the group and turned in a written report.

The students were successful in isolating the different types of bacteria that they studied. For the most part, the distribution of bacteria in the Sapelo marshes was consistent with other studies reported in the literature. We found that the samples from Brunswick contained significantly higher amounts of sulfide and sulfate-reducing bacteria when compared to the Sapelo samples.

Benefits of the Class: In the course evaluation, the students listed several ways the course had enhanced their science process and personal interaction skills. The technical skills that they used included critical evaluation of scientific literature, development of experimental approaches to test ideas, standardization of experimental methods with appropriate controls, and interpretation of results.

At least as important as science skills, perhaps, were the interactions of the students with each other and with personnel of the Marine Institute. By working together, the students usually were able to master technical skills much more quickly and thoroughly than when working alone. Our discussions, both in and out of the classroom, served to enhance our ideas and experiments. It seemed as if the group developed a sense of shared responsibility for the project. It was especially

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BRIEFLY NOTED

Preparing Course Syllabi for Improved Communication, by Malcolm A. Lowther, Joan S. Stark and Gretchen G. Martens. NCRIPTAL, Suite 2400, SEB, University of Michigan, Ann Arbor, MI 48109-1259.

Students are seldom if ever aware of the time faculty spend preparing a course. Still, one of the most often-expressed student expectations of a good teacher is that s/he be "well-prepared." The course syllabus provides the first impression of preparedness; but too often it is a poor indicator of just how much planning and organization has taken place before the students even register for the course. Also, according to the authors, most syllabi fail to communicate much information students need in their initial encounter with the course. Research has shown that students learn more effectively when they understand the instructor's intentions. In short, the syllabus should communicate far more than when assignments are due, a testing schedule and grading procedures.

The authors list ten items which, without being proscriptive, might be included in a typical syllabus: 1) Basic Information on the Instructor and the Course, 2) Course Purpose, Goals and Objectives, 3) Educational Beliefs, 4) Content Outline, 5) Assignments and Course Calendar, 6) Textbooks, 7) Supplementary Readings, 8) Methods of Instruction, 9) Student Feedback and Grading Procedures and 10) Learning Facilities and Resources for Students. Lest the reader be frightened away, all of this is covered in 24 pages, and many of the suggestions are presented in a "checklist" format.

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pleasing to me for the students to develop an attitude of ownership toward the project.

One example of the team research concept in action occurred during the Sapelo trip. Originally, we had divided the class into three teams of two students, with each team performing the chemical analysis on the samples for one day. After the first day, we met to discuss procedures and results. The team that analyzed the first samples reported many ways to carry out the procedures more efficiently. For example, they suggested that the others work together as one team of four students instead of two teams of two students each. The others used the suggestions and were able to complete their work more easily and in less time.

There were many opportunities to discuss their work with scientists and other students at the Marine Institute and to learn about their research. In particular, there was much interaction between our class and undergraduates participating in the Summer Internship Program at the Institute. In a couple of cases, it almost seemed as if we had "adopted" some new team members, because the interns would discuss their own projects with us and ask for our suggestions. In return, the interns made many helpful suggestions about our ideas and methods.

As the instructor, I found that I also gained a great deal from the experience. I discovered that the team research concept can be an effective and exciting way to integrate teaching and research. It is also a good way to launch a new research project. During the previous year, I had worked to begin a project on sulfate-reducing bacteria in coastal marshes. The data gathered by the team research class provided important background information and data for this project. The team research class also generated interest among students in the department for this research effort. Several of the students from the class, as well as other students, returned with me to Sapelo later in the year to gather more samples for the project.

I definitely recommend the team research concept for any instructor interested in student research. It represents an effective use of time and resources, and it brings the added dimension of cooperative student interaction into the student research experience.