

History of American Marine Laboratories: Why Do Research At the Seashore?¹

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SYNOPSIS. Throughout the late nineteenth and twentieth centuries, researchers have gone in increasing numbers to the seashore to carry out biological research. Some people have chosen to study organisms in the sea, others life forms at the sea's edges. While not all of these researchers actually have needed to be at the seashore to do their work, a significant number of research programs have, in fact, depended on the ability to study marine life in its natural setting. The Marine Biological Laboratory pioneered in supporting the research functions in the United States, though the MBL also received inspiration from the successes of the Naples Zoological Station and other European laboratories. This paper explores the initial moves by researchers to study marine life and to set up stations in remote settings away from the comforts of home and of the home laboratories. It also outlines the sorts of work undertaken at the seashore.

INTRODUCTION

Today people gather at the numerous marine laboratories which line most ocean coasts for a variety of reasons. Generally, they like being at the seashore and would rather work there than in the middle of Kansas or Arizona, especially in the summer. But they do not all really need to be by the water. Many people could use grant money to set up running sea water systems and could order their preferred organisms by air delivery; after all, people keep live lobsters from Montana to Tennessee. They could then extract giant axons or trace cell lineages or make cell counts or chemical assays right at home, with all their familiar equipment and staff of assistants there to help. Why, then, do people do their research at the seashore?

For some of the same reasons that they attend national meetings like this one when they could be at home exchanging all the same words across their BitNet line: tradition, for the social and intellectual interaction, for the change of pace, and because it allows them to study the organism—or bearer of ideas—in its natural setting. Some kinds of questions can be addressed better if one finds the organism right there in its proper environment, using resources and

interacting with other organisms. Some kinds of organisms behave better or produce eggs better or whatever in their normal environment. And being able to walk down the hall or to the beach or to the local dining room and ask someone how he or she does something or other, or just to commiserate with other marine researchers about delayed results, offers significant attractions. There are many reasons to do research at the seashore today, some the same reasons that have existed since marine research began in the early nineteenth century.

ORIGINS OF MARINE RESEARCH

Tracing the origins of marine research in the United States requires looking backwards in time and toward Europe since the reasons for turning to the sea were parallel there. Actually, Aristotle probably dissected some marine organisms to begin marine research, but no one really followed his example for twenty-one centuries. Linnaeus included relatively few marine species in his classification system, for example, suggesting that he knew little about them and did not feel driven to investigate. Only in the late eighteenth century did people begin to explore the diversity of life in the seas as well as on land across the seas, as they did a bit of dredging to chart the ocean depths and to discover what was down there. Then two separate lines of study expanded understanding of

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marine life as the nineteenth century progressed. The laying of telegraph cables and the explorations by zoologists at the seashore both greatly influenced biological understanding of life in that nearly three-quarters of earth which lies under salt water.

Edward Forbes initiated the British enthusiasm for dredging, as he undertook a systematic study of the distribution of marine animals. Forbes believed that the diverse life in upper layers of the ocean gives way, because of increasing water pressure, to zones with no life in the deeper seas. Such a claim was obviously open to investigation, and others quickly challenged Forbes's conclusions. As the century progressed, various telegraph companies began to lay cable across broad expanses of water including the North Atlantic. As they studied carefully the deeper water, they learned that life did indeed exist at great depths. When they drew up their sounding line, they found new organisms attached. Then those transatlantic cables suffered breaks in various places. As the repair crew hauled the cable up to inspect the damage, they found fairly advanced animals securely attached with calcareous deposits. These clearly had not simply become entangled in the line as it moved toward the surface, as some had maintained. Life seemed considerably more diverse and more widely distributed than Forbes or earlier natural historians had thought. Study of marine life could be very productive for understanding distribution of life forms and for revealing the rich diversity within the natural plan. Scottish oceanographer Charles Wyville Thomson enthused in 1873 that the deep sea bed

is inhabited by a fauna more rich and varied on account of the enormous extent of the area, and with the organisms in many cases apparently even more elaborately and delicately formed, and more exquisitely beautiful in their soft shades of colouring and in the rainbow-tints of their wonderful phosphorescence, than the fauna of the well-known belt of shallow water teeming with innumerable invertebrate forms which fringes the

land. And the forms of these hitherto unknown living beings, and their mode of life, and their relations to other organisms whether living or extinct, and the phenomena and laws of their geographical distributions, must be worked out. (Wyville Thomson, 1873, pp. 690–691)

Many researchers working together in the different countries could successfully attack all these questions, Wyville Thomson thought.

At the same time that Forbes and the cable companies were exploring the depths, other individual researchers were taking to the seashore with microscopes and boats. Probably, Georges Cuvier deserves credit for stimulating this move. Cuvier stressed the importance of assessing the functions as well as the form of body parts, so any way that one could better understand the functioning organism would also help to understand the structure. Unfortunately, sitting in large museums in Paris and staring at sets of dusty bones and preserved specimens did not reveal much about organic function. The young French students Henri Milne-Edwards and Victor Audouin therefore decided to study living, functioning organisms at the seashore. As Milne-Edwards reported later:

About the year 1826, two young naturalists, formed in the schools of Cuvier, Geoffroy and Majendie, considered that zoology, after having been purely descriptive or systematic and then anatomical, ought to take on a more physiological character; they considered that it was not enough to observe living objects in the repose of death, and that it was desirable to get to understand the organism in action, especially when the structure of these animals was so different from that of man that the notions acquired as to the special physiology of man could not properly be applied to them. (Russell, 1916, p. 195)

The two went to the seashore, where they could study a variety of relatively simple living organisms. When Audouin died, Jean Louis de Quatrefages took his place in accompanying Milne-Edwards.

The rich bounty of organisms made up for the continued difficulties of handling the sometimes delicate life forms, lack of facilities, minimal equipment, problems with arranging housing, and other hardships. Edward Stuart Russell later expressed his approval of this move to the seashore for:

This return to Nature and to the sea had a very beneficial effect upon morphology, bringing it out from the laboratory to the open air and the seashore. It saved morphology from formalism and aridity, and in particular from a certain narrowness of outlook born of too close attention paid to the details of microscopical anatomy. It brought morphologists face to face again with the wonderful diversity of organic forms, with the unity of plan underlying that diversity, with the admirable adjustment of organ to function and of both to the life of the whole. (Russell, 1916, p. 196)

Russell's praise for moving biology out of the laboratory into the open air is a bit ironic given that marine research by the time of his writing had, in fact, moved biology right back into the laboratory, albeit into a more sophisticated laboratory setting.

Such individual excursions as that of Milne-Edwards did remain difficult. First, the researcher had to have his own money sufficient to pay for all transportation, living costs, and equipment. And there were the supplies, simple as they were: small collecting boats, nets and buckets, microscopes, as well as food and clothing. Once the researchers located a place that provided basic shelter and access to the water, they then had to gather their organisms and either look quickly or preserve their organisms since they had nowhere to store their living specimens.

After the first explorers, researchers followed vacationers to favorite holiday spots at the North Sea or the Mediterranean, where they found the basic living needs supplied and where they began to deal with the storage problems as well. To Heligoland, a North Sea island off Germany, physiologist Johannes Müller went for the

summer months to collect specimens, occasionally taking students with him. Ernst Haeckel went along in 1854, for example, and there experienced Müller's particular research approach. As Haeckel's biographer Wilhelm Bölsche reported:

Müller taught his pupils his simple method of studying the living subject. There was no witchcraft in it, but it had had to be invented by someone. They put out to sea in a small boat. A little net of linen or fine gauze, with a wide opening and a short body, was fastened on a pole. The mouth of the net was thrust directly under the surface or a little deeper, vertically to the surface, and the boat was slowly rowed forward. The contents of the filtered sea-water remained in the meshes of the net, and were from time to time emptied into a glass containing sea-water. (Bölsche, n.d., pp. 69–70)

Haeckel enthused—as Haeckel was wont to do—about the beauty and variety of graceful, transparent organisms from the sea. These “pelagic sweepings,” as Müller called them, excited the young student collectors even while the whole process seemed very peculiar to the local fishermen and innkeepers, who had not yet learned the advantages of catering to the interests of this new clientele.

Haeckel, in his turn, took his own friends and students to Heligoland and also to Messina, a port town in northeastern Sicily, to collect and study the rich diversity of life available there. Among these students was Anton Dohrn, who later went to study marine arthropods in Millport, Scotland and who there met zoologist David Robertson. These two confronted the storage problem for living organisms by inventing a portable aquarium, supplied with running water but movable away from the beach as well. This portable aquarium Dohrn took with him to Messina, where it became the initial core of equipment for a more permanent facility. Aware of the nuisance of constantly transporting equipment back and forth from some inland university to the seashore for each summer, as well as the difficulties in arranging for

room and board, Dohrn sought a permanent facility and set up a "Messina Station" by persuading the Swedish Consul to watch over equipment and rooms during the academic year (Groeben, 1984, p. 62).

THE NAPLES ZOOLOGICAL STATION

Messina could have remained the base for the major permanent research facility that Dohrn envisioned, but instead he moved to Naples for that larger project. The public craze for aquaria stimulated that move, for Dohrn saw the possibility of providing a public aquarium to raise funds to support research. Since Naples attracted the requisite large tourist population, it was more likely to generate a larger income, Dohrn felt (Groeben, 1984). Dohrn persuaded the city authorities to give him sufficient land near the water, as he shared his vision of a beautiful and useful facility which would attract 120 research visitors for nine months of the year to study the "millions" of marine animals. The laboratory would support itself, he enthused, as he paid about three-quarters of the building costs himself and raised the rest through loans from friends. In fact that aquarium has done remarkably well into this century when rising costs and changing governmental control have caused problems.

Dohrn's aquarium did attract visitors and therefore money, but it also attracted other attention and indirect support as well. The Naples Stazione blended its public function with its role as the first major professional research facility in marine biology, closed to amateurs and to the public. The public was restricted at Naples to the lower floor and aquarium area and not allowed to interfere with the international research of the upper floors. The Stazione provided a very different atmosphere from that typical of the public aquarium and popular marine interest in England, where Dohrn sent for the equipment to install his modern aquaria.

In England, zoologists descended on the seashore with their families in tow. They collected animals and hauled them home in tanks to entertain the family. At first that meant that someone, generally a maid,

had to work painstakingly to sift the water to keep it clean and fresh, until people recognized by the 1850s that a mix of plants and animals could provide a self-sustaining balance. The parlor aquarium increased in popularity through the 1850s and 1860s as beach visitors also learned the fun of collecting exotic creatures during their summer holidays and taking them home to exhibit. The sea-anemone became a virtual family pet, according to G. H. Lewes in 1858, for

Since the British mind was all alive and trembling with that zoological fervour excited by the appearance of the hippopotamus in Regent's Park, no animal has touched it to such fine issues and such exuberant enthusiasm as the lovely Sea-Anemone, now the ornament of countless drawing-rooms, studies, and back parlours, as well as the delight of unnumbered amateurs. In glass tanks and elegant vases of various device, in finger-glasses and common tumblers, the lovely creature may be seen expanding its corona of tentacles, on mimic rocks, amid mimic forests of algae, in mimic oceans—of pump-water and certain mixtures of chlorides and carbonates, regulated by a 'specific gravity' test. Fairy fingers minister to its wants, removing dirt and slime from its body, feeding it with bits of limpet or raw beef; fingers, *not* of fairies, pull it about with the remorseless curiosity of science, and experiment on it, according to the suggestion of the moment. At once pet, ornament, and 'subject for dissection', the Sea-anemone has a well established popularity in the British family-circle; having the advantage over the hippopotamus of being somewhat less expensive, and less troublesome, to keep. (Barber, 1980, p. 121)

By the 1870s the British had turned from private to public aquaria, but interest soon waned as the amateur naturalists did not see the use of these aquatic collections which did not even provide the satisfaction of a private "pet." The emphasis shifted elsewhere, especially to Naples and to the professional research center Dohrn established there.

Probably the most remarkable feature of the Naples Station is its dominant research function. Nearly all the other marine stations have also had either a teaching or a practical function, both of which bring funds. Universities and private foundations have been willing to support coursework and training for advanced students. Governments have been willing to support practical fisheries research, with its promise of commercial benefits. In 1873, in contrast, it was not clear who would pay for a laboratory purely for research. Though obviously in the interest of the independent researchers, the laboratory could not expect to charge those individuals enough to pay for the buildings and equipment. Dohrn provided much of the initial building money himself, with the help of his friends, but he also had to find other forms of support—which he did very successfully. Universities, individuals, and foundations subscribed to research tables which then provided a place for researchers to do work which, in turn, in some sense represented those subscribers. In addition, the German government contributed a hefty sum, continued until recently when the Italian government took over. With this unusual combination of support mobilized by the uniquely energetic and persistent Anton Dohrn, the Naples Stazione very quickly became a remarkable attraction for the growing number of dedicated professional marine researchers.

But why did that number grow; what attracted researchers to marine research? The rich diversity of species, of course, but by the 1880s the focus had shifted from establishing the diversity and distribution or attempting classification of species to more detailed study of individuals. Examination of heredity, development, and physiology became primary attractive reasons to study living organisms at the seashore. At Naples, the visitor could request a particular organism and have it delivered to his research table. He (or she) then had available the best in microscopic equipment and techniques for staining, fixing, and observing specimens and even for preserving materials for further careful study back home. In fact, Naples gained a rep-

utation as *the* place to go and learn the latest in histological methods for its first decades (Whitman, 1882). One could learn what techniques worked from other visiting researchers and also from Salvatore Lobianco, the indispensable collector who developed impressive methods for preserving specimens for sale to distant museums and laboratories (Dean, 1894; Kofoed, 1910; Groeben, 1984, p. 66).

Using the advanced preparation methods, the eager researchers would examine development of organisms. During the nineteenth century, development gained a high place in zoology as the study of differentiation of form. Heredity was assumed to bring relative stability, while development brings the all-important variations which provide the material for evolutionary change (Sandler and Sandler, 1985; Maienschein, 1987). In addition, study of development should reveal ancestral relationships since organisms were thought to have diverged farther in later more than in earlier developmental stages. Even while denying the most radical statement of Haeckel's biogenetic law, the embryologist would allow that early developmental styles and patterns could reveal ancestral relationships. These people looked for the ancestors of vertebrates among the annelid worms, for example, or for relations of gastropods to crustaceans. The wealth of organisms as well as the vital research group gathered also provided ample material for comparative study which went beyond descriptive details for any single organism. Study of the wide variety of individual marine organisms, using the latest in histological and microscopic techniques, could illuminate many of the time-honored biological problems, then.

The atmosphere at Naples probably thrilled the researchers, especially the American visitors, as much as the research possibilities (Manning, 1983; Maienschein, 1985). By 1900 fifty American researchers had travelled to Naples, mostly in the 1890s, and many, stimulated by their early experiences at the Marine Biological Laboratory at Woods Hole, to work at the fabled premier European research station (Groeben, n.d.). Many went with the

encouragement of earlier visitors. Several women went during that time and contributed to setting up the American Women's Table in 1898, which introduced many leading American women zoologists to the international research community.

As they visited Naples, American visitors each experienced the unique blend of Neapolitan life and preeminent scientific research. William Morton Wheeler's reactions exemplify the wonder at this exciting mix. While some were enthralled by the colorful lifestyle, Wheeler claimed to recoil from the supreme degradation of the Neapolitan people. "I never could learn to like [the Neapolitans] if I remained here the rest of my days," Wheeler wrote to a friend. "And worst of all, the charming weather with its endless sunshine and deep blue sky is telling on me. I feel like a lazzaroni and would rather be on a rug and eat macaroni and smoke cigarettes than work in the laboratory." Further,

Of all the filthy places! It is here where they sell the oysters with their gills full of cholera bacilli—the sea urchins—think of eating a sea urchin! and nasty little squids that have been out of water so long that they deliquesced. It is interesting to study the faces of these people in Santa Lucia or, in fact, anywhere in Naples. Not a line that tells of any better feeling or trace of intellectuality. The men look as if they were capable of stabbing anybody for a few liras. The women are no women at all. And then watch them when a few priests carry the consecrated host through the street! What a kneeling and bowing and taking off of hats!

But you will think I am very blue, and dissatisfied with Italy. I assure you that I am delighted with the country, i.e. with the scenery. To see the changing colors on the land and sea for a single evening more than pays me for coming here. I wish I could give you some idea of the wonderful tones that shift and melt on the sand and water and dull green trees, on the white houses and rocks where the sun sets off near Ischia in a glory of orange and vermilion. Last Sunday from

the heights where the ruins of the Acropolis of Annae stand, I watched the sunset. I have never seen anything so beautiful. The sand was a delicate pink and the Mediterranean where it forms the lovely Bay of Circe was so blue, and the trees of the Royal Preserve were flushed with tones of purple and brown. This alone was worth a journey to Naples. (Evans and Evans, 1970, p. 91)

In contrast, others such as Edmund Beecher Wilson found life in Naples as fascinating as the scenery. Wilson loved the excellent classical music and the concerns with culture and art that Naples offered and which Anton Dohrn encouraged at the Stazione. The international mix of reactions and of different enthusiasms within the dedicated research environment made Naples unique.

At Naples during the 1890s the focus of research shifted somewhat. Originally housing departments of traditional morphology (stressing comparative embryology), physiology, botany, and bacteriology, Naples in the 1890s became a center of controversial discussion and excitement in experimental embryology. In particular, Hans Driesch and Curt Herbst attracted attention to this work as they urged the wonderful promise of causal analytical work in experimental embryology, following the neopreformationist program advocated by Wilhelm Roux in his arguments for *Entwicklungsmechanik* (Churchill, 1969; Allen, 1978, chapter 3; Maienschein, 1985c). Driesch and Herbst, like Roux, assumed that manipulative experimentation is the appropriate approach to biology and that such pathological conditions can perfectly well provide information about normal life processes. In order to learn about normal development, then, one can carry out such manipulations as killing one of the first two blastomeres of a developing embryo. What follows will parallel normal developmental processes and will reveal the causes of development, Driesch and Roux assumed. This line of analytical research took place beside more traditional morphological study of organic structures and evolutionary relationships among organisms, on the one hand, and physiological

study of the processes of development on the other.

For all these areas of research, marine organisms proved particularly valuable. For experimental work, it proved useful to work with simpler marine organisms, with visible eggs, and with organisms found in water. These factors made observations as well as surgical techniques simpler. For the study of structure and evolution, the ability to examine the early stages of development, before metamorphosis, was considered important since morphologists regarded these early stages as more basic and closer to the ancestral forms. For physiologists, study of development, and especially study of the range of relatively simple marine organisms, offered distinct advantages. At Naples and elsewhere zoologists turned to marine study.

THE MARINE BIOLOGICAL LABORATORY

The United States likewise witnessed an enthusiasm for zoology at the seashore but stressed the central importance of instruction as well as research. Given the paucity of trained zoologists in the 1870s and 1880s, as well as the need to raise money, it is not surprising that Americans would concentrate on the sorts of educational efforts at Annisquam, Penikese, and elsewhere that Ralph Dexter and Keith Benson have discussed (Dexter, 1956–57, 1974, 1980, 1988; Benson, 1987*a*, 1988). While the Johns Hopkins Chesapeake Zoological Laboratory provided the first opportunity for independent research by graduate students, at the same time it introduced the students to basic natural history study, thus also combining research and teaching functions.

British zoologist Edwin Ray Lankester responded to these initial educational efforts critically. Agassiz's Penikese school was not really a zoological station, he concluded. In fact it was no more than an attempt "to make bricks without straw" because it had no program to guide research. Brooks's efforts at the Chesapeake Laboratory were more legitimate, Lankester thought. If that peripatetic laboratory could be made permanent, then "it is, perhaps, pardonable for Transatlantic

colleagues to express the opinion that such a step would be one of great and serious importance for the welfare of zoological study." Yet above all zoologists need more to guide their research. Lankester was not alone in maintaining that "The spasmodic descent upon the sea-coast in a summer vacation, which is all that many a naturalist can, under present conditions, afford, is a very delightful thing, and may sometimes lead to the collection of a few new species of one group or another: but it is not in this way that the zoology of to-day can be forwarded" (Lankester, 1880, p. 498).

Zoology of the day could have been forwarded by Spencer Fullerton Baird's efforts to found a full-scale research program and laboratory at the United States Fish Commission in Woods Hole, Massachusetts. He did have adequate resources—at first—and a program to guide research—at first. In fact, Baird had high ambitions for the Fish Commission laboratory. He recruited support from several universities in the form of table subscriptions like Dohrn's at Naples. These schools then received permission to send a few researchers each summer to the Fish Commission in exchange for their subscriptions (Galtsoff, 1962).

In fact Baird hoped to establish a summer research university as well as a laboratory, following along with Alpheus Hyatt's and Agassiz's educational goals for their laboratories. Unfortunately for Baird's ambitions, President Grover Cleveland's administration evidently did not favor such educational or independent research development for government facilities; Baird revised his plans to include only space for a small number of independent researchers (Schlee, 1973, p. 74). Yet Baird still wanted a laboratory for Woods Hole, and he encouraged Hyatt to move the Boston Society of Natural History's program southward from the polluted waters of Annisquam to Cape Cod and Woods Hole. The Marine Biological Laboratory (MBL) resulted, opening its doors in 1888 with Hyatt as President of the Corporation and Charles Otis Whitman as director.

Historians have fairly completely cov-

ered the story of the founding and early years of the MBL, so we need not retrace those steps here (Lillie, 1944; Dexter, 1974, 1980; Maienschein, 1985a). Most importantly, Whitman and the MBL researchers generally regarded the place as a center for both morphological and physiological study, with a strong emphasis on study of individual organisms to address questions of heredity, development, and evolution (Maienschein, 1986; Rainger *et al.*, 1987). The group almost uniformly ignored population studies as they also rejected the more extreme statements of Weismannian preformationism and Weismann's and Roux's mosaic theory of development, which held that the initial whole embryo is divided mechanically into separate, self-differentiating cellular units. The MBLers felt that something about the organization of the whole organism and its inherited ancestral past also directs embryonic development, which is therefore more epigenetic than preformationist. Yet it remained important to steer clear of both the Scylla of extreme epigenesis and the Charybdis of extreme preformationism, they maintained (Whitman, 1895; Wheeler, 1899). In many ways Whitman reinforced the pursuit of a shared research program into development/heredity/evolution by the group of students, teachers, and investigators at the MBL.

The question remains, why did these researchers go to the seashore and what did they gain by doing so? What kinds of organisms did they study, what kinds of questions did they ask, and what kinds of methods did they adopt? Furthermore, how did the emphases change with time?

They went to the seashore for the variety of organisms at first, then for the particular organisms with their visible eggs and their floating and easily accessible embryonic and larval forms. They went to study those simple organisms which supposedly more closely resembled the primitive ancestral forms. They went to look for the ancestors of vertebrates and hence of man. By the 1880s, they went to find eggs with easily observable cleavage stages and easily manipulated cell organization. They went

to observe how changes in environment (such as salt content of water) affect development and differentiation. They could have stayed at home and studied frogs or salamanders, for example, as others did. But the seashore provided such a variety of usable organisms. And by the 1880s in Naples or the 1890s in Woods Hole, one could obtain expert advice on where to look for organisms or could request them and have them reliably appear at one's lab table.

This convenience probably provided a significant attraction for the leading marine laboratories. Researchers such as physiologist Jacques Loeb did not really like collecting his own specimens; such individuals enjoyed the Naples style where specimens just appeared in the morning, procured from fishermen and collectors who had learned of this unique market for inedible and otherwise unsaleable marine organisms. While the MBL encouraged collecting by its own researchers, it did hire a collector as well. John Veeder served in this role for forty-four years. For a short time he had an assistant who called himself "Colonel" Walmsley for no verifiable reason. The entrepreneurial Colonel learned the best places and the demands of the MBL researchers while serving as Veeder's assistant, then quit and set out in business for himself. Mornings found Walmsley and Veeder out along the beaches or on the water vying to gather the best or the most specimens before the other could do so (MBL Archives). A variety of organisms found their way to the marine research tables, then, more often animals than plants and more often simpler and smaller invertebrate forms.

The questions asked primarily focused on determining how the organisms developed both under normal conditions and, with time, under an increasing variety of manipulated experimental conditions. These questions involved a range of morphological and physiological factors, a mix of factors internal and external to the organism, and the combination of whole organism interactions and cellular and sub-cellular analyses. In addition to developmental and related evolutionary questions,

Naples came to include work on botany and ecology, while the MBL added a neurobiology course which attracted both researchers and advanced students from traditionally medical fields. In the late 1890s Whitman invited a series of speakers to address the relationships of biology to the physical sciences and another to consider behavior as a biological phenomenon, though such interests apparently died out as Whitman stopped pushing them. Most of the work at Naples and the MBL, in contrast to some of the teaching-oriented laboratories, centered on individual organisms rather than populations or classification questions more typical of traditional natural history study (Benson, 1987*b*; Kohlstedt, 1987).

Other marine laboratories have embraced different sorts of work, then, so that Stanford's Hopkins Marine Station has moved away from traditional embryology and Scripps has encouraged wider ranging oceanographic work, while the Mount Desert Island Station has embraced a range of studies, for example (Dexter, 1988). Yet embryological study has remained traditional to many, in part because the material available is so well suited to studies of development and since the tradition of developmental work is so strongly entrenched.

The methods used have been those appropriate to the questions at hand, not surprisingly. In particular, this meant at the beginning that such equipment as Müller's fine nets and such techniques as his pelagic sweepings proved most valuable. Then with Naples' shift of focus to embryos and to morphological structures and their relationships to other organisms, histological techniques gained prominence. The improved apochromatic microscope found its place at Naples, as did His's improved microtome capable of producing a regular and complete set of serial sections. In addition, the latest in vital stains appeared immediately at the marine laboratories (Bracegirdle, 1978). Very likely the availability of new techniques and equipment, coupled with the interest in evolutionary relationships, initially stimulated the strong

embryological bias at Naples and then the MBL. Using the collecting, fixing, sectioning, staining, and observation techniques available provided a tremendous amount of new information about developing organisms and the details of how they changed as they underwent differentiation. The introduction into embryology of a strong physiological impulse in the 1890s also brought the use of those microscopic and staining techniques to the study of living as well as prepared organisms. Marine organisms suited these purposes admirably.

Thus, it made sense to work on marine organisms to address many of the problems of interest. It also made sense to work at the seashore after the establishment of first rate facilities at Naples, the MBL, and many other places. The convenience of having all necessary materials, the availability of specimens during the summer months, the presence of other experienced researchers to share insights and to help overcome frustrations, and the atmosphere of excitement about doing biological research that all this created: such factors led researchers to the seashore. They could accomplish much more, in a supportive environment which was also fun for themselves and families, than they could back home in their urban universities (Pauly, 1987). They could talk to people engaged in similar research as they generally could not back home where they were the only ones with their particular marine emphasis. Many of these are still the primary reasons that people do their research at the seashore.

CONCLUSION

In the beginning of marine research people began to look into the ocean depths to determine what variety of life existed there, to discover and classify new organic forms. They also sought to understand the functioning of those exotic and seemingly simple organisms and the relation of function to form. With time, they focused more on individual organisms and their development, on what developmental patterns could tell about ancestral evolutionary relationships. This led to an emphasis on

development, heredity, and evolution, especially at the strongly research-oriented laboratories such as the Naples Stazione and the MBL. Yet other interests have emerged as well, in other places, and at later times. Ecology has gained considerable support in recent years, but beginning in the early twentieth century. Neurobiology has gained a strong foothold, supported by the availability of research funding which has allowed medically based researchers to carry their laboratories to the seashore each summer.

A quick survey of the sorts of research work published in the MBL's *Biological Bulletin* reveals some of the changes. Though not in any sense a set of proceedings of marine study at the MBL, in the early years represented in Volumes I and II the *Bulletin* was strongly biased toward marine work and MBL researchers (*Biological Bulletin*, 1931). A study of those contributions reveals a move toward greater concern with the nucleus and chromosomes and less with the cytoplasm; an interest in discovering the physiological mechanism of the fertilization process; a move toward more biochemistry and more chemical physiology and less traditional embryology of the more descriptive and morphological sort; a disappearance of cell lineage work; a move away from concern with whole organisms toward interest in reduction to parts, especially to a molecular focus; and a steady decline in the number of women represented from 1890 to 1930. Statistics could back up these vague observations, but even so they would not produce many surprises.

The work has steadily become more analytical and more molecular and biochemical, while retaining a background of more traditional work as well. Much of the work represented by 1930, even that done at the MBL by MBL regulars, no longer needed to be done at the seashore. It could have been done in artificial settings in Kansas or Arizona, even if at increased initial expense. Yet the MBL and Naples and the numerous other thriving marine stations fill their laboratories every summer and are even forced to turn people away. Many people want to work not only on marine organisms but also actually at the seashore, for a vari-

ety of scientific as well as extrascientific reasons, which produces pressure on the limited and often underfunded facilities.

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