

“A Magnificent Chain of Biological Stations”: American Marine Biological Stations and the Beginnings of Marine Science in the United States

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Beginning in the mid-nineteenth century, American scientists actively engaged in the study of the ocean. The federal government took the initiative in the effort with its practical aims of enhancing the country's naval, commercial, navigational, and fisheries capacities. The scientific work done at such institutions as the United States Coast Survey, the Depot of Charts and Instruments of the U.S. Navy, and later at the United States Fish Commission Laboratory as well as the U.S. Exploring Expeditions proved the interest and ability of the American scientific community in the domain of marine science. Their scientific contributions were well acknowledged also in Europe and were, indeed, valuable for emerging marine science as a whole. Nevertheless, the federal government was not a consistent supporter of science in the nineteenth century. Direct support to scientific work was often considered unconstitutional, and the scientific projects at the federal agencies could expect only indirect and limited financial backing from the government.¹

What proved to be more crucial to the development of marine science in the United States was the proliferation of marine biological stations, a notable phenomenon in the late nineteenth and early twentieth century. After the model of earlier, successful marine biological stations in both Europe and the United States, a considerable number of seaside biological laboratories were built in the North American continent in various shapes and sizes. Some emphasized education of school teachers and beginners in biological sciences while others put more emphasis on advanced research by university-trained professionals. Some stations became centers for experimental and laboratory biology whereas others were built with the more traditional aim of understanding the natural history of domestic fauna and flora. Some of these stations belonged to universities and some were open to everyone interested in marine biology. Whatever their characteristics, these seaside stations all reflected the great interest of contemporary biologists in marine

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¹ A. Hunter Dupree, *Science in the Federal Government: A History of Policies and Activities to 1940* (Cambridge, Mass.: The Belknap Press of Harvard University Press, 1957); Susan Schlee, *The Edge of an Unfamiliar World: A History of Oceanography* (New York: E.P. Dutton, 1973), 23-79; Thomas G. Manning, *U.S. Coast Survey vs. Naval Hydrographic Office: A 19th-Century Rivalry in Science and Politics* (Tuscaloosa and London: University of Alabama Press, 1988).

organisms, and they helped to turn the attention of young American scientists to the sea.

Among these American marine stations few showed any interest in the study of the ocean as a whole, and biology alone was studied and taught at most marine biological stations. Many marine biologists did not even care about the living environment of the organisms they studied in the laboratory. Still, the stations were very important in the history of the marine sciences, since they provided marine sciences with a permanent home for continuation of research for the first time in history without, in most cases, government interference. In the previous decades, and centuries, the development of ocean science often had to stop at important stages for lack of continued support and interest. After decades of gaps, followers always had to start from the beginning and do things all over again. Historian of oceanography Margaret Deacon aptly remarked on the meaning of the nineteenth-century marine biological stations:

Without facilities for collecting observations, without opportunities for work on shore and without a recognized career structure, it was difficult if not impossible for people to make marine science their life's work. Marine biology became an exception in the late nineteenth century when academic zoologists could specialize in marine life and there were opportunities for full time research in the marine stations and the fisheries laboratories. In the other branches of marine science such opportunities were almost nonexistent. H. R. Mill described how he had had to give up marine science to be able to earn his living and this dilemma faced most of his contemporaries as well.²

The situation was similar in Europe and in the United States. Establishment of biological stations signaled a new phase in the history of marine sciences.

This paper will explore the beginning of the marine science tradition in the United States with an emphasis on the seaside marine biological stations in the late nineteenth and early twentieth century. Attention will be given, first, to the Marine Biological Laboratory in Woods Hole, and then to a group of various smaller stations, such as the one at the Dry Tortugas in Florida, that formed a chain of marine stations in the United States. The Marine Biological Laboratory became one of the most important centers of experimental biology in the United States, and most historians who were interested in the American marine stations turned their attention to it. On the other hand, the smaller stations were diverse in their characters, and their modest scale made them less attractive objects of historical narrative. Yet, their diversity allowed scientists to perform various styles of marine biological research and, in many cases, they had the advantage in field work. From the perspective of marine sciences as a whole, such smaller stations had significant impact on the development of ocean sciences, and a few oceanographic institutes grew out of them.

² Margaret Deacon, *Scientists and the Sea, 1650-1900: A Study of Marine Science*, 2nd edition (Aldershot, U.K.: Ashgate, 1997), xiii.

Early Marine Biological Stations in the United States

The scientific work done at the U.S. Coast Survey and the Depot of Charts and Instruments was generally focused on physical aspects of the sea, although some biological and geological study was done in cooperation with scholars such as Louis Agassiz of Harvard University. After the marine scientific work had diminished considerably at those two agencies, the tradition of American marine science was succeeded by biologists who built seaside laboratories beginning in the early 1870s.³ It was the time when interest in marine biology boomed on both sides of the Atlantic, and many marine stations were built.

Revived interest in marine sciences in the mid-nineteenth century led to oceanic expeditions that culminated with the British *Challenger* Expedition.⁴ In these expeditions, studies in natural history were almost always pursued along with physical investigations of the sea. Old and new species collected at the sea intrigued naturalists and, moreover, the discovery that life existed under the deep sea led many scientists to study marine organisms. The problem of evolution made marine biology more important. Discoveries of marine biology were used both for and against the theory of evolution. For example, naturalists found in the ocean some organisms very similar to those species that were thought to have been extinct and could be found only in fossils. This finding led some scientists such as the British man Wyville Thomson to doubt the effectiveness of the evolutionary theory. On the other hand, Thomas Huxley's discovery of *Bathylagus haeckelii*, which was thought to be a form of protoplasm, was believed to be a key to understanding the history of life.

Likewise, Ernst Haeckel at the University of Jena, Germany, believed that studying marine biology would yield much benefit to evolutionary biology. He had a firm belief that animals and plants living in the sea were the key to solving the problem of evolution as they were considered to be very primitive living organisms having the simplest forms of life available to researchers. He advised one of his students, Anton Dohrn, to work on marine biology, and Dohrn built a marine laboratory at Naples, Italy, following his mentor's ideas.⁵ Dohrn's station, the

³ For general discussions on American marine biological stations, see Keith R. Benson, "Laboratories on the New England Shore: The 'Somewhat Different Direction' of American Marine Biology," *The New England Quarterly* 61 (1988), 55-78; and "Summer Camp, Seaside Station, and Marine Laboratory: Marine Biology and Its Institutional Identity," *Historical Studies in the Physical and Biological Sciences* 32 (2001), 11-18.

⁴ Deacon, *Scientists and the Sea*, 276-406; Schlee, *The Edge of an Unfamiliar World*, 107-138. See also Harold L. Burstyn, "Science and the Government in the Nineteenth century: The Challenger Expedition and Its Report," *Bulletin de l'Institut Océanographique, Monaco*, vol. 2, special no. 2 (1968), 603-611.

⁵ Christiane Groeben, "Anton Dohrn—the Statesman of Darwinism," *Biological Bulletin* 168 (Suppl.) (1985), 4-25. For the Naples Station's influence on American scientists, see Keith R. Benson, "The Naples Stazione Zoologica and Its Impact on the Emergence of American Marine Biology," *Journal of the History of Biology* 21 (1988), 331-341; and Jane Maienschein, "First Impressions: American Biologists at Naples," *Biological Bulletin* 168 (Suppl.) (1985), 187-191.

Stazione Zoologica, was a great success and immediately became famous among biologists. It soon became a popular place where scientists from all around the world gathered to research, and among them were a number of American biologists such as Charles M. Child, Wesley R. Coe, Bashford Dean, Ross G. Harrison, Ida H. Hyde, Herbert S. Jennings, F. M. McFarland, G. H. Parker, Charles O. Whitman, T. H. Morgan, William M. Wheeler, and E. B. Wilson, to name but a few.⁶

Around the same time, marine stations began to appear in the United States. The first such attempt was by Louis Agassiz. In 1873, Agassiz opened a summer school on Penikese Island in Buzzards Bay.⁷ It was not the first time that he was engaged in the marine sciences as he had had prior research work done in connection with the U.S. Coast survey and, thus, he was the right person to begin the tradition of seaside biological activities in America. The summer school was funded by a wealthy businessman named John Anderson and was often called after him the Anderson School of Natural History.

The Anderson School, which might be labeled the first American marine biology station, had distinct features that could differentiate it from its European counterparts. While the stations in Europe such as the Naples Station were strongly research-oriented, Agassiz's summer school was devoted mostly to education. For the most part, biology teachers and other amateurs interested in biology were invited to the island for the summer program, and they had chances to work in the field. As Agassiz emphasized learning from nature and not from books, they usually collected and observed animals and plants by themselves during the day and attended Agassiz's lectures in the evening. It was a great success in the first year, but Agassiz died in the next year and the second year's session was led by his son Alexander. Thereafter, the school never opened again.

The Penikese school had a significant weakness within itself. Its whole program depended too heavily on the founder and instructor Louis Agassiz. He was an unusually talented teacher who possessed sufficient showmanship to satisfy those attending the school. His son unfortunately did not share his passion for the program for several reasons. Alexander disliked the isolated location of the island, and was more interested in advanced research in the study of marine biology than the teaching of amateurs. The school's heavily education-oriented character was often criticized, too, by others such as British scientist E. Ray Lankester. Alexander did acknowledge the value of a seaside biological laboratory, however, and built a private one at Newport, Rhode Island, a few years later. This research station was one of the marine stations that Lankester highly praised.⁸

Despite the very short existence of the Penikese school, Louis Agassiz and the summer school left a lasting impact on the American marine biology movement.

For early European marine stations, including the Naples station, see Charles A. Kofoid, *The Biological Stations of Europe* (Washington, D.C.: Government Printing Office, 1910).

⁶ Benson, "The Naples Stazione Zoologica," 335.

⁷ Jane Maienschein, "Agassiz, Hyatt, Whitman, and the Birth of the Marine Biological Laboratory," *Biological Bulletin* 168 (Suppl.) (1985), 26-34.

⁸ Benson, "Laboratories on the New England Shore," 65-66.

Agassiz had students who were no less interested in marine biology than himself, without whom the Anderson School would not have even existed. Three men, in addition to his son Alexander, were particularly important in the history of marine biology: Alpheus Hyatt, Nathaniel Southgate Shaler, and Addison Emery Verrill.⁹ Shaler was in fact the original source of inspiration for the summer program in marine biology, who suggested to Agassiz that a marine station devoted to natural history and geology would be beneficial. Hyatt served as an instructor at Penikese and later became the director of a marine biology station at Annisquam. Verrill also devoted a large part of his scientific career to the study of marine biology and worked in connection with the U.S. Fish Commission from 1871 to 1887. Among those who participated in the Anderson School's program were William Keith Brooks, another student of Agassiz's, Charles O. Whitman, Cornelia Clapp, and David Starr Jordan who later became leaders of several important marine stations in the United States.¹⁰

Another line of marine biological study began in the 1870s, led by Spencer Fullerton Baird of the Smithsonian Institution. Baird was assistant to Joseph Henry at the Smithsonian Institution when he was appointed Fish Commissioner by Congress.¹¹ His duty was to investigate the nation's fish stock and determine the cause of declining catches. After years of field study up and down the New England coast, Baird finally settled down in 1882 in the small town of Woods Hole where he built a permanent fishery laboratory.

At the U.S. Fish Commission Laboratory, Baird was mainly expected to lead pragmatic studies for the benefit of the nation's fishing industry. However, aided by his political skills and scientific influence, Baird managed to combine applied and pure science in the investigation of fishes. The Woods Hole laboratory was open to professors and students from the institutions that possessed a right to use its facilities in return for their donations for the building of the laboratory. So, researchers from Harvard, Johns Hopkins, Princeton, and Williams came to Woods Hole during the summer to study marine organisms that could be provided by the Fish Commission. At the same time, Baird himself pursued comprehensive studies of the coastal seas with colleagues and assistants, such as Addison E. Verrill of

⁹ Wesley R. Coe, "Addison Emery Verrill, 1839-1926," *National Academy of Sciences Biographical Memoirs* 14 (1932), 19-66, esp. 21-22; Benson, "Laboratories on the New England Shore," 56-58.

¹⁰ Maienschein, "Agassiz, Hyatt, and Whitman," 26-32.

¹¹ After Joseph Henry's death in 1878, Baird succeeded him as secretary of the Smithsonian. On Baird and the Fish Commission Laboratory, see Dean C. Allard, "The Fish Commission Laboratory and Its Influence on the Founding of the Marine Biological Laboratory," *Journal of the History of Biology* 23 (1990), 251-270; and Philip J. Pauly, *Biologists and the Promise of American Life: From Meriwether Lewis to Alfred Kinsey* (Princeton: Princeton University Press, 2000), 44-70. For Baird's biography, see Allard, *Spencer Fullerton Baird and the U.S. Fish Commission* (New York: Arno Press, 1978); William Healey Dall, *Spencer Fullerton Baird: A Biography* (Philadelphia: J. B. Lippincott, 1915); and E. F. Rivinus and E. M. Youssef, *Spencer Baird of the Smithsonian* (Washington, D.C.: Smithsonian Institution Press, 1992).

Yale University.¹² The Commission's research vessel *Albatross* brought in many new and previously-known marine species from the Massachusetts coast, but Baird's interest lay not only in taxonomical study of identifying and describing the species. He and his colleagues put no less effort into tracing their life history and relating their morphology and physiology to their environment.¹³ The fish commissioner believed that a full and comprehensive understanding of the life phenomena of the region was necessary in order to tackle the problems of the fishing industry.

The fish commission's comprehensive scientific study under Baird did not cause serious trouble with Congress, since Baird tried to balance it with practical researches more directly related to fishery studies. A large portion of the laboratory's effort was given particularly to experiments on fish culture and artificial hatchery work. For Baird, this line of study was in fact the only possible solution to the crisis of the fishery industry given the limited knowledge of his time. The work at the Fish Commission Laboratory was geared more and more towards this direction as time went by. The advent of the Grover Cleveland administration in 1885 was a crucial event that turned the direction of the fish commission's research away from comprehensive marine science. The Democratic administration which began investigations of government agencies tried to find cases of corruption under the long Republican reigns. Baird's influence in Washington and his close relationship with politicians helped to save the research programs at the laboratory eventually, but scientific study there had to shrink afterwards. Baird's death in 1887 was a fatal blow; within a few years scientific research at the Fish Commission was virtually eclipsed.

The case of the U.S. Fish Commission Laboratory gives another example of the federal government's failure to support long-term scientific programs. The destiny of comprehensive marine science at the laboratory rested, again, too heavily on one able leader. Following the precedents of the Coast Survey and the Depot of Charts and Instruments, the Fish Commission gradually became a narrowly focused institution for practical work.

Despite Baird's failed attempt, Woods Hole remained the center of marine biology in the United States. This was owing to the Fish Commission's new neighbor, the Marine Biological Laboratory. It was Baird himself who first suggested that the new institution be built in Woods Hole, next to his own laboratory. The Fish Commission Laboratory was essentially a research institution, devoted solely to advanced research in pure and applied sciences. Yet, Baird originally had a bigger plan. Well acquainted with Agassiz's program at Penikese,

¹² On Verrill's work at the Fish Commission, see Allard, "The Fish Commission Laboratory," 254, 258-259; and Coe, "Addison Emery Verrill," 23-25.

¹³ Baird's initiative in American marine ecology is well explained in John E. Hobbie and John B. Pearce, "Ecology in Woods Hole: Baird, Bigelow, and Redfield," in Robert B. Barlow, Jr., John E. Dowling, and Gerald Weissmann, eds., *The Biological Century: Friday Evening Talks at the Marine Biological Laboratory* (Woods Hole, Mass.: The Marine Biological Laboratory, 1993), 256-286.

he was aware of the need for a biological institution for education. Baird hoped to expand his laboratory into a larger institution which could be a center for both research and education in marine biology.¹⁴ As the prospect of such expansion became dim, he decided to make another attempt to build a separate institution at Woods Hole, which was the best location for the study of marine biology according to his previous experience. That new institution was the Marine Biological Laboratory. In Baird's scheme, the two neighboring stations would cooperate, not compete with each other, as they would have complementary functions of research and education.

Historians Keith Benson and Jane Maienschein have emphasized the educational function of the early American marine biological stations.¹⁵ They have argued that the marine stations in the United States had developed in a somewhat different way than the European ones, reflecting the situation of scientific education at that time. In fact, influences from Europe on American marine biology cannot be ignored. Particularly, the Stazione Zoologica at Naples was admired by a number of prominent American biologists who had had chances to visit and work there.¹⁶ And some of them tried, in fact, to make it a model for American marine stations. At that time, Germany was a leader in the world of science and many leading American biologists had ties to German scientific institutions. They often visited German universities and many earned their degrees there. Those people who had some experience of spending time at Dohrn's station were deeply impressed by the pattern and style of life and work at Naples and it is not surprising that they played a significant role in founding similar ones in the United States. Yet, the Naples station and other European stations, unlike their American counterparts, were research institutions, and no educational work, such as was done at Penikese or Annisquam, was done there. Therefore, Benson and Maienschein could argue that American marine biological stations were not merely copies of the European precedents, especially the one at Naples. This distinctly American characteristic found its full expression in the Marine Biological Laboratory at Woods Hole.

The Marine Biological Laboratory at Woods Hole

Alpheus Hyatt, former student of Louis Agassiz's and instructor at Penikese, founded a marine station at Annisquam, Massachusetts, in 1879 with sponsorship from the Boston Society of Natural History and the Woman's Education Association of Boston.¹⁷ He became the first director and B. H. Van Vleck, who

¹⁴ Allard, "The Fish Commission Laboratory," 266-270; Rivinus and Youssef, *Spencer Baird*, 148-149.

¹⁵ Benson, "Laboratories on the New England Shore"; Benson, "Summer Camp, Seaside Station, and Marine Laboratory"; and Maienschein, "Agassiz, Hyatt, Whitman."

¹⁶ Benson, "The Naples Stazione Zoologica"; Maienschein, "First Impressions."

¹⁷ Maienschein, "Agassiz, Hyatt, Whitman," 28-29; Frank R. Lillie, *The Woods Hole Marine Biological Laboratory* (Chicago: University of Chicago Press, 1944), 26-31. It must be noted

was working as assistant for the Boston Society of Natural History, was appointed instructor. Annisquam was from the onset modeled after the Penikese school, and concentrated on education rather than original research. Most participants were school teachers. This was exactly what the two sponsor groups intended. They wanted this seaside station to be a place for educating amateurs and teachers and giving them a chance to study nature. In this respect, this school was a success, having had a number of teachers every summer, about half of them women. However, Hyatt felt that the Annisquam station had to change somehow. As the coastal sea of Annisquam became polluted by nearby industrial facilities, it needed to move to an unpolluted area. Furthermore, Hyatt wanted his station to become an institution more independent and more research-oriented. He set out to search for a new home.

It was Spencer Baird who approached Hyatt at that time with the suggestion that he move his station to Woods Hole.¹⁸ Baird thought that there hardly existed a better place than Woods Hole as a location for marine biological stations. And Annisquam station was exactly the kind of institution that Baird wanted at Woods Hole right next to his Fish Commission Laboratory as it was almost entirely an educational marine station. The two stations would very likely benefit from each other with their complementary roles—research and education.

However, not everyone welcomed the idea of establishing another laboratory at Woods Hole.¹⁹ For example, William Keith Brooks of Johns Hopkins was opposed to the plan. His opinion was that it was better to build the new station at another location so that biologists would have a chance to investigate more regions. Brooks, who was professor of morphology at the Department of Biology, Johns Hopkins University, already retained the right to occupy tables of the Fish Commission Laboratory. Therefore, he and his students at the Johns Hopkins could visit Woods Hole whenever they wanted. Besides the Fish Commission, he also ran his own marine station, the Chesapeake Zoological Laboratory of the Johns Hopkins University.²⁰ Brooks also refused Hyatt's proposal to appoint him the first director of the new marine station. Alexander Agassiz, who also had access to Baird's facilities, disagreed with the plan for a new marine biological station at Woods Hole.

that the Annisquam station was not founded by Alpheus Hyatt alone. MIT Chemist Ellen Swallow Richards and other women at the Woman's Education Association of Boston were also active participants of the station, both as instructors and students. See Robert Clarke, *Ellen Swallow: The Woman Who Founded Ecology* (Chicago: Follett, 1973).

¹⁸ On the natural conditions of Woods Hole, see W. D. Russel-Hunter, "The Woods Hole Laboratory Site: History and Ecology," *Biological Bulletin* 168 (Suppl.) (1985), 197-199.

¹⁹ Maienschein, "Agassiz, Hyatt, Whitman," 29-30; Maienschein, *100 Years Exploring Life, 1888-1988: The Marine Biological Laboratory at Woods Hole* (Boston: Jones and Bartlett Publishers, 1989), 19-25, 179.

²⁰ Benson, "Laboratories on the New England Shore," 66-73; Philip J. Pauly, "Summer Resort and Scientific Discipline: Woods Hole and the Structure of American Biology, 1882-1925," Ronald Rainger, Keith R. Benson, and Jane Maienschein, eds., *The American Development of Biology* (New Brunswick: Rutgers University Press, 1988), 121-150, esp. 125-126.

Despite the minority opposition, the Marine Biological Laboratory opened at Woods Hole in 1888.²¹ Hyatt, the Boston Society of Natural History, and the Woman's Education Association had their reasons to decide for Woods Hole. First, Woods Hole was the appropriate site for a marine biological station both oceanographically and geographically. Cape Cod, where Woods Hole is located, was a comparatively less polluted region on the New England coast. And as both warm and cold currents exist, biologists could study two different groups of sea organisms residing in warm and cold currents, respectively.²² Moreover, Woods Hole had convenient means of transportation. Since some factories had been built near the town some time before, a railroad connecting Boston and Woods Hole was available. It did not take much time to travel from Boston to Woods Hole by train. Second, existence of the Fish Commission Laboratory at Woods Hole did not seem to be a real problem to the Boston Society and the Women's Association as they too, like Baird, believed in the division of roles between the two institutions. Unlike Hyatt, those sponsors wanted the MBL to remain an educational institution. They had every reason to welcome the existence of the Fish Commission which would possibly provide the MBL with facilities and even instructors. Baird himself had promised to give the needed land at a cheap price and let MBL use the facilities of his laboratory, and it was quite an attractive offer. The new station would not have to pay additional expenditures for such things as waterworks and expensive instruments, which meant for the sponsor groups saving much money.

The plan to make the new MBL an educational institution soon met with a serious challenge. The conflict first arose in the process of selecting the first director.²³ The trustees of the MBL were divided between scientists, of whom Hyatt was the leader, and the people from the Boston Society of Natural History and the Woman's Education Association of Boston. While the trustees who had ties to the Boston Society and the Woman's Association hoped to maintain the education-oriented tradition of Annisquam, Hyatt and the scientist-trustees wanted to bring a substantial change to its character. The amateur members recommended van Vleck of the Boston Society, but the scientists wanted a prominent scholar such as Brooks to lead the MBL and make it a research institution. The scientists' opinion dominated and, at last, Charles Otis Whitman was selected as the director after Brooks refused the offer.

²¹ For general accounts of the MBL's early history, see Lillie, *The Woods Hole Marine Biological Laboratory*; Maienschein, *100 Years Exploring Life*; Maienschein, ed., *Defining Biology: Lectures from the 1890s* (Cambridge, Mass.: Harvard University Press, 1986); Pauly, "Summer Resort and Scientific Discipline"; Detlev W. Bronk, "Marine Biological Laboratory: Origins and Patrons," *Science* 189 (1975), 613-617; and articles in *Biological Bulletin* 168 (Suppl.) (1985).

²² Russel-Hunter, "The Woods Hole Laboratory Site."

²³ Maienschein, *100 Years Exploring Life*, 19-25; Maienschein, "Early Struggles at the Marine Biological Laboratory over Mission and Money," *Biological Bulletin* 168 (Suppl.) (1985), 192-196.

Whitman had participated in Agassiz's Penikese school and decided to pursue a career as a professional scientist.²⁴ When he was a 31 year-old high school teacher, he went to Europe to study biology. He went to Leipzig to study with Rudolf Leuckart after a visit to Dohrn's Stazione Zoologica at Naples. Whitman received his doctoral degree in zoology in 1878 and, then, worked two more years at Naples. Unable to find a job in the United States, Whitman went to Japan where he became professor of biology at Tokyo Imperial University. Two years later, he returned to America and was employed privately by Alexander Agassiz at Harvard's Museum of Comparative Zoology and, then, by a rich amateur zoologist of Milwaukee, E. P. Allis, Jr. His experience of directing the Allis Lake Laboratory was considered when the MBL trustees chose him. There Whitman founded the *Journal of Morphology* with the support of Allis. A year after accepting the MBL directorship, he was appointed as a faculty member at the new Clark University and, in 1892, moved to the University of Chicago where he remained until his death in 1910.

By the time Whitman was finally appointed the first director of the MBL, therefore, he had gone through a difficult career path and had experience of working at several biological institutions. It was natural for him, then, to be quite ambitious for the future of MBL. He intended MBL to be "one of the strongest and most productive biological stations in the world."²⁵ Such a grand goal inevitably led Whitman to emphasize research and expansion of the Laboratory. Whitman's leadership soon caused trouble with the MBL trustees. It was not what the amateur trustees wanted MBL to be. Their idea of the MBL was something not so different from the Annisquam station, both in size and in function. Their disagreement was intensified by financial deficiency. In 1896, for example, Whitman proposed to build a fifth building for the MBL. From the Trustees' point of view it was absolutely impossible. But the building was built, and the MBL had to face a severe financial crisis.²⁶

From the beginning, Whitman himself was aware of the shortage of funds. He made every effort to secure sufficient financial support to maintain his plan. He almost succeeded twice. In 1895, Miss Helen Culver, a rich woman of Chicago, told Whitman that she wanted to contribute five hundred thousand dollars each to the MBL and the biology program of the University of Chicago, where Whitman was the chair. In the end, however, all of her contribution went to the University of Chicago and none was given to the MBL, much to Whitman's disappointment. In

²⁴ On Whitman's life and career, see Ernst Mayr, "Charles Otis Whitman," in Charles C. Gillispie, ed., *Dictionary of Scientific Biography*, Vol. XIV (New York: Scribner, 1976), 313-315; Maienschein, "Introduction," in *Defining Biology*, 3-50; Pauly, "Summer Resort and Scientific Discipline," 129-130; and Maienschein, "Physiology, Biology, and the Advent of Physiological Morphology," Gerald L. Geison, ed., *Physiology in the American Context: 1850-1940* (Bethesda: American Physiological Society, 1987), 177-193.

²⁵ Maienschein, "Early Struggles," 193.

²⁶ On the MBL's financial crisis and Whitman's efforts, see Lillie, *The Woods Hole Marine Biological Laboratory*, 34-62; Maienschein, "Early Struggles"; Maienschein, *100 Years Exploring Life*, 49-72; Pauly, "Summer Resort and Scientific Discipline," 130-142; and Bronk, "Marine Biological Laboratory."

1896, during the controversy over Whitman's policy of expansion, the amateur trustees of MBL from Boston retired from the management of the Laboratory.²⁷ And now the issue was not whether to allow the expansion or not but how to support the expansion. Whitman did not have to consume his energy in quarrelling with the non-scientific people any more, but the financial situation of the MBL did not improve. Once again, the helping hand came from Chicago in 1901, when four businessmen of Chicago presented to W. R. Harper, the president of the University of Chicago, their intention to contribute to the MBL. The MBL trustees decided to refuse it, although Whitman was eager to secure the funds. The trustees, who were now comprised of only scientists, were afraid that the influence of the University of Chicago in the MBL might be too strong. Whitman was greatly depressed at this decision.

Whitman's position was reversed in the events of the next year.²⁸ The MBL trustees tried to get financial support from the Carnegie Institution of Washington. Henry Fairfield Osborn, the president of the MBL corporation, and Edmund Beecher Wilson, the chairman of the executive committee, were the leaders in this movement. Osborn was the chairman of the Carnegie Institution's Committee on Zoology, and Wilson was also a member of this committee along with Alexander Agassiz, W. K. Brooks, and C. Hart Merriam. They believed that the support from the Carnegie Institution would permanently relieve the MBL's financial difficulties, and to this Whitman did not object. Wilson and Osborn wrote to the other MBL trustees:

If the Laboratory is placed under the control of the Carnegie Institution, its future is assured on a splendid and permanent basis. We would have the opportunity to develop the Laboratory into one of the highest rank and to render a great and lasting service to the cause of American science.²⁹

What caused Whitman to change his mind and to object to this plan eventually was the fact, as implied in the above passage, that it demanded MBL's absorption into the Carnegie Institution, to become just one of its many branches. It resulted from the policy that the Carnegie Institution had to "be an operating, not a granting institution." It had to "carry on its own work, under its own name, and should publish the results in its own series of publications." Whitman could not allow the MBL's incorporation into the Carnegie Institution in spite of its financial merits, as it would inevitably destroy MBL's independence.

²⁷ Maienschein, "Early Struggles," 193-194; Pauly, "Summer Resort and Scientific Discipline," 132.

²⁸ Bronk, "Marine Biological Laboratory," 614-615; James D. Ebert, "Carnegie Institution of Washington and Marine Biology: Naples, Woods Hole, and Tortugas," *Biological Bulletin*, 168 (Suppl.) (1985), 172-182; Maienschein, "Early Struggles," 195-196.

²⁹ Bronk, "Marine Biological Laboratory," 614.

“Independence” was, as Jane Maienschein pointed out, one of the keywords in understanding Whitman’s directorship at MBL.³⁰ He had stressed that the MBL had to be a national, public institution managed by the scientists working at the Laboratory without any interference from outside. He firmly believed that that was the only way to maintain the free spirit of scientific investigation at the MBL. For example, Whitman wrote to Helen Culver in 1895:

The Marine Biological Laboratory had already become an intercollegiate centre for research and instruction. Some over twenty colleges and universities are now contributing to the support of the Laboratory by subscriptions to rooms and tables, and no less than eighty-five institutions were represented in our membership last summer. The national character of the Laboratory is the chief glory and that I am sure will be wisely guarded in the foundation you have bestowed.³¹

To Whitman, therefore, the Carnegie plan was a serious threat to his ideal, which endangered the MBL’s independence. Whitman was strongly opposed to Wilson and Osborn’s proposal even though he had but a few supporters, including Edwin Grant Conklin and Frank Lillie. The majority of the MBL trustees were on the other side. He publicly promoted the importance of MBL’s independence on the pages of *Science* magazine and, finally, succeeded in annulling the incorporation.³² Instead, the MBL trustees accepted the Carnegie Institution’s generous offer to grant 80,000 dollars for buying MBL’s new facilities, and another 10,000 dollars each year for the next three years.³³

Whitman succeeded in defending MBL’s independence, but he became exhausted. He soon decided to retire from the MBL directorship, and was succeeded by his former student and colleague Frank Rattray Lillie. Lillie later expanded the MBL even more with the aid of his brother-in-law Charles R. Crane. Lillie could also get support from the Rockefeller Foundation through the National Research Council.³⁴

With his clear vision, Whitman thus managed to overcome the financial difficulties and succeeded in making the MBL a major research institution. By the end of the nineteenth century, it became one of the centers of biological investigation in the United States. In particular, MBL was the headquarters of cell lineage study, and researches in embryology, cytology, and physiology flourished

³⁰ Maienschein, *Defining Biology*, 17-21; Charles O. Whitman, “The Impending Crisis in the History of the Marine Biological Laboratory,” *Science*, 16 (1902), 529-533.

³¹ A Letter from Whitman to Helen Culver (December 20, 1895), quoted in Maienschein, “Early Struggles,” 193.

³² Whitman, “The Impending Crisis.”

³³ Bronk, “Marine Biological Laboratory,” 614; Ebert, “Carnegie Institution of Washington,” 174-180.

³⁴ Bronk, “Marine Biological Laboratory,” 615-617; Maienschein, *100 Years Exploring Life*, 70-71; Lillie, *The Woods Hole Marine Biological Laboratory*, 63-84.

there.³⁵ Emphasis on research was not the only way in which the MBL differed from the previous Annisquam station, however. The style of doing biology changed as well. Marine biology at the MBL was very different from the natural history done at Penikese, Salem, Annisquam, and the Fish Commission Laboratory. The MBL biologists put more and more emphasis on laboratory work and spent less time collecting and observing animals and plants at sea. They were seeing their organisms through microscopes inside the laboratory and did not care about the living conditions of those animals they worked with. Where and how the marine organisms lived simply did not matter to them. Some of the active members of the MBL did mention the need to study elsewhere and a few did in fact spend summers at other American seaside stations and in Naples. But they did so not because they were interested in different marine environments but because they wanted to try their theory with the species not found at Woods Hole. MBL thus broke from the natural history tradition in marine biology, yet the tradition of natural history did survive at other, smaller marine biological stations throughout the coasts of the United States.

Controversy over the Tortugas Marine Biological Station: An Example of the Small-Sized Marine Biological Stations

In many coastal regions of the United States, other marine stations appeared in the 1890s and 1900s. In January 1903, Alfred Goldsborough Mayer at the Museum of the Brooklyn Institute of Arts and Sciences proposed a plan for yet another marine biological station in the tropical Atlantic region.³⁶ Having had considerable experience of working at different places, Mayer knew quite well the advantages and disadvantages of possible marine station sites, and his choice was the Tortugas in Florida. He reported that extremely rich tropical marine fauna could easily be found in the region, which had not been carefully studied until that time except by some “cursory visits of the United States government expeditions in the *Bibb*, 1869; *Blake*, 1877-78, and *Albatross*, 1885-86,” and by “the explorations of Louis Agassiz, 1850-51, and Alexander Agassiz, 1881.”³⁷ In more recent years, non-governmental expeditions were conducted by the University of Iowa led by C. C. Nutting in 1893, and by the Museum of the Brooklyn Institute of Arts and Sciences in 1902 where Mayer himself participated. Having emphasized the natural advantages of the Tortugas and the insufficient amount of biological research done there, Mayer argued for the need to build a permanent station. He concluded:

³⁵ For the early scientific work at the MBL, see Maienschein, *Defining Biology*, 3-50; Maienschein, *100 Years Exploring Life*, 93-99, 117-150; Lillie, *The Woods Hole Marine Biological Laboratory*, 115-156; and Benson, “The Naples Stazione Zoologica.”

³⁶ Alfred Goldsborough Mayer, “The Tortugas, Florida, as a Station for Research in Biology,” *Science* 17 (January 30, 1903), 190-192.

³⁷ *Ibid.*, 190.

The time has come when American men of science should awaken to the fact that we have at our very door a tropical fauna far surpassing in richness that of Naples. With our great wealth and many able and energetic workers, we should begin to perform the task for science which is being so ably done at Naples. The great monographs of the Naples Laboratory should be our incentive to do even more and better things in the development of knowledge concerning the marine life of tropical America.³⁸

Mayer lamented that “we know more of the life of the Red Sea than we do of that of the Caribbean and Gulf of Mexico.”³⁹ American biologists read and knew very well the results of their European colleagues’ researches, and they themselves often went to Naples and other parts of Europe to study biology of those regions. But until that time only a meager amount of study had been done on the marine fauna and flora of the new world, and the tropical region on the east coast was certainly one of those unexplored places. Mayer explained that the “cause of this neglect has been that none of our educational institutions has been able to afford to maintain a permanent laboratory in the tropics, and no cooperation has yet been, or is likely to be, effected which could bring such a laboratory into being.”⁴⁰ At that time, there was no academic institution in the region which could carry out long-term biological surveys, and this distant and isolated location prevented major American institutions from establishing a permanent biological station there.

Mayer thought that the situation could somehow change with the establishment of the Carnegie Institution of Washington. It seemed that this new institution would be a strong supporter of scientific research, and Mayer thought that his idea of building a marine biological station at the Tortugas was a perfect project that the Carnegie Institution would be willing to support. His proposed station would cost 6,000 dollars for the construction of a “well-ventilated wooden laboratory building capable of accommodating from six to twelve investigators” and its accessory buildings alone, Mayer estimated, and there had not been a possible source of such a large amount of money before the advent of the Carnegie Institution. In addition to the buildings, he wanted the station to have a “seaworthy launch at least 55 feet in length and of light draft” provided with “sails, auxiliary naphtha for power, and sounding and dredging reels” which would enable the “study of the life of the Gulf Stream . . . and of numerous reefs at the Tortugas and its neighborhood.”⁴¹

In order to submit the proposal to the Carnegie Institution, Mayer had to make sure that its usefulness for science was strongly backed by a wide consensus of opinion among leading scientists of the country. He argued that the station had to be “national in character” and “meet with the entire approbation of our leading naturalists,” and “be visited by an able and numerous clientage.” He sent out letters

³⁸ Ibid., 192.

³⁹ A. G. Mayer, “A Tropical Marine Laboratory for Research?” *Science* 17 (April 24, 1903), 655-660, quotation on 655.

⁴⁰ Ibid., 655.

⁴¹ Mayer, “The Tortugas, Florida,” 191-192.

asking for opinions first to “leading zoologists of the United States and Canada,” and later to marine botanists as well.⁴² In the *Science* article of April 24, 1903, Mayer reported that he received replies from 43 zoologists: “M. A. Bigelow, Chapman, Conklin, Dall, Davenport, Dean, Dodge, Edwards, Evermann, Gill, Hargitt, Herrick, L. O. Howard, Jennings, H. P. Johnson, D. S. Jordan, V. L. Kellogg, Kingsley, Lillie, Lucas, MacBride, McMurrich, Metcalf, Mills, Minot, Montgomery, Morgan, Neal, Nutting, Ortmann, G. H. Parker, Rathbun, Ritter, Sedgwick, Springer, R. M. Strong, Treadwell, Verrill, H. B. Ward and four others whose names we are not at liberty to reveal.” All of these zoologists agreed on the need for a tropical marine station even though there was some disagreement upon the exact location.⁴³ Jamaica, the Bermudas, the Bahamas, Puerto Rico, and Miami were among the alternative places proposed by some.

Why, then, did so many biologists unanimously express their approval of this plan of building another marine biological station when there already existed several such stations, especially the most popular Marine Biological Laboratory at Woods Hole? Charles B. Davenport, one of Mayer’s correspondents and a strong supporter, explained the situation well in his letter dated June 12, 1903.⁴⁴

In the marine biological stations (which carry on, it must be remembered, only a portion of all biological work) two tendencies, opposite at first sight, but really directed toward the same high aims, are discernible. The one tendency is to investigate the phenomena of structure, development and function in the individual; the other is to consider individuals in masses as species, as form-units bearing the imprint of environment, and adapted thereto, and as constituents of faunas. For students of the first sort of marine zoology what is required is one large central laboratory, with an extensive library and the requisite cytological and physiological apparatus, where students of anatomy, embryology and physiology may work together and give mutual aid and stimulus. The needs of the workers on the other side of marine zoology call for

⁴² Mayer, “A Tropical Marine Laboratory,” 656.

⁴³ *Ibid.*, 656-660. This article contains letters from Frank M. Chapman, Charles B. Davenport, Bashford Dean, Frank R. Lillie, C. C. Nutting, Henry B. Ward, E. G. Conklin, Francis H. Herrick, Herbert P. Johnson, A. E. Verrill, and T. H. Morgan. See also, C. C. Nutting, William E. Ritter, and David S. Jordan, “The Proposed Biological Laboratory at the Tortugas,” *Science* 17 (May 22, 1903), 823-826; J. E. Duerden, “A Tropical Marine Laboratory for Research,” *Science* 17 (May 29, 1903), 862-864; E. W. MacBride, “The Proposed Biological Laboratory at the Tortugas,” *Science* 17 (June 5, 1903), 909-910; C. B. Davenport, Robert Payne Bigelow, and B. W. Barton, “The Proposed Biological Laboratory at the Tortugas,” *Science* 17 (June 12, 1903), 945-947; Hubert Lyman Clark, “The Proposed Biological Laboratory at the Tortugas,” *Science* 17 (June 19, 1903), 979-980; P. H. Rolfs and J. Fred. Clarke, “The Proposed Biological Laboratory at the Tortugas,” *Science* 17 (June 26, 1903), 1008-1010; Conway MacMillan and Herbert M. Richards, “The Proposed Biological Laboratory at the Tortugas,” *Science* 18 (July 10, 1903), 57-58; R. T. Colburn, “The Proposed Biological Laboratory at the Tortugas,” *Science* 18 (July 17, 1903), 86-87; and Mayer, “The Bahamas vs. Tortugas as a Station for Research in Marine Zoology,” *Science* 18 (September 18, 1903), 369-371.

⁴⁴ Davenport, “The Proposed Biological Station,” 945-946.

several laboratories, widely separated, in diverse environments. These will assist the first sort of laboratory by furnishing particular kinds of material found only in the locality. But their chief work will be to study the fauna, determining the laws of geographic distribution of organisms, the variation of species in different environments and the interaction of organisms. Such laboratories will, of course, be exclusively for research, and should be equipped with everything requisite for the collection, the study alive and the rearing of organisms.⁴⁵

Davenport then mentioned Woods Hole's MBL as the representative of the first kind of marine stations. At the same time, it was obvious where Mayer's proposed station would belong. Despite his contention that the Tortugas station would also serve the researchers of physiology and embryology, it was obvious to everyone concerned that it would be primarily a station for field biologists.

Davenport went on to articulate more about the idea of the "several laboratories, widely separated, in diverse environments."⁴⁶ He mentioned "a magnificent chain of biological stations" in Europe "reaching from Tromsø, Norway, and even the White Sea, along the North Atlantic, the Baltic and North seas, the Irish Sea, the Channel, the Bay of Biscay, and the Mediterranean, Adriatic and Black seas." The European stations forming the chain were founded and run by "individual enterprise[s] or universit[ies] backed by government support." The American biologists, too, Davenport wrote, were "planning a chain of marine stations." He named those American marine stations that already existed, including "the Woods Holl Laboratory."⁴⁷ On the east coast there were a series of stations at Harpswell, Woods Holl, Cold Spring Harbor, Beaufort and Bermuda. And on the west coast, there were the Hopkins Laboratory and the University of California's marine station. To this list Conway MacMillan added the Minnesota Seaside Station at Port Renfrew, British Columbia.⁴⁸ This station, although located in Canada, was "managed in connection with one of the American Universities and [had] drawn its clientele principally from the western United States." In this respect, MacMillan argued that it also had to be considered "one of the Pacific coast stations of America" and that Davenport had had to include it in his list of the marine biological stations of the U.S. biologists. In order to complete the chain, Davenport wrote about the possibility of establishing more stations at Jamaica, Porto Rico, the island of Grand Manan or the coast of Newfoundland, and Puget Sound; and of

⁴⁵ Ibid., 945.

⁴⁶ Ibid., 945-947.

⁴⁷ The spelling of Woods Hole varied, and at this time both "Woods Holl" and "Woods Hole" were used. Pauly, "Summer Resort and Scientific Discipline," 145, n. 24.

⁴⁸ MacMillan, "The Proposed Biological Station." For a general account of the marine biology on the west coast of the United States, see Keith R. Benson, "Marine Biology or Oceanography: Early American Developments in Marine Science on the West Coast," Keith R. Benson and Philip F. Rehbok, eds., *Oceanographic History: The Pacific and Beyond* (Seattle: University of Washington Press, 2002), 298-302.

“exploring in successive years the fauna of Davis Strait, Hudson Bay, Bering Sea and the Gulf of California.”⁴⁹

In the United States, the situation was less favorable than in Europe as, without substantial governmental support for marine biology, except the case of the Fish Commission, the establishment of such marine stations had been impossible at places far away from major university centers. Only those universities, which had been slowly becoming research institutions, were able to run their own marine biological stations. On the tropical Atlantic coast, there was no such research university at the time and American biologists could not afford to have a permanent station there until the emergence of the Carnegie Institution had given them the hope. Alfred Mayer quickly noticed the chance, and all the biologists that he consulted supported his plan. It was the time when C. O. Whitman struggled to defend the MBL’s independence from the Carnegie Institution plan of incorporation. In fact, MBL was Carnegie’s first consideration, though the incorporation of MBL into Carnegie did not happen in the end.

The Carnegie Institution favorably accepted Mayer’s proposal and, in 1904, the Marine Biological Laboratory at the Dry Tortugas, Florida, was established.⁵⁰ The Dry Tortugas Laboratory of Mayer constituted, with Davenport’s Station for Experimental Evolution at Cold Spring Harbor, New York, the Carnegie Institution’s biology program. Later, the Station for Experimental Evolution merged with the Eugenics Record Office to form the Department of Genetics. The Dry Tortugas Laboratory, however, was not a mere alternative to the MBL as it had been included in the Carnegie Institution’s initial plan. The Committee on Zoology had strongly advocated in its report “the establishment of a permanent biological laboratory as a central station for marine biology in general, with branches at such other points as may seem desirable; also affiliated or independent experimental stations for the study of physiological zoology and problems relating to heredity, evolution, etc.”⁵¹ The members of the committee had certainly had the MBL in mind when they mentioned the “central station,” while the Tortugas fit well into the “branches at such other points.”

Mayer, who was just 36 years old at that time, was an able man very suitable for the job. He had grown up in a scientific family and, having been trained under Alexander Agassiz at the Museum of Comparative Zoology and having worked as a curator at the Brooklyn Institute of Arts and Sciences, he had already built a strong career as a scientist.⁵² He spent summer months at the Dry Tortugas often

⁴⁹ Davenport, “The Proposed Biological Station,” 946.

⁵⁰ Ebert, “Carnegie Institution of Washington,” 180-182; Patrick L. Colin, “A Brief History of the Tortugas Marine Laboratory and the Department of Marine Biology, Carnegie Institution of Washington,” in Mary Sears and Daniel Merriman, eds., *Oceanography: The Past* (New York: Springer-Verlag, 1980), 138-147.

⁵¹ Ebert, “Carnegie Institution of Washington,” 173.

⁵² C. B. Davenport, “Alfred Goldsborough Mayor,” *National Academy of Sciences Biographical Memoirs* 21 (1926), 1-10; Davenport, “The Researches of Alfred Goldsborough Mayor,” *Science* 56 (1922), 134-135; Colin, “A Brief History of the Tortugas Marine Laboratory”; Ebert, “Carnegie Institution of Washington,” 180-182.

sailing on the laboratory's yachts *Physalia* and *Anton Dohrn*, and during the rest of the year he went on expeditions to various regions of the Pacific and Atlantic Oceans. He worked on a wide range of biological topics, from coral reef studies to physiological experiments on marine animals. Visiting researchers also did important work at the Dry Tortugas Laboratory. They included L. R. Cary, E. G. Conklin, H. S. Jennings, William K. Brooks, R. P. Cowles, Jacob Reighard, U. Dahlgren, R. A. Daly, C. H. Edmondson, E. N. Harvey, W. H. Longley, D. H. Tennent, and T. W. Vaughan. It is reported that around 146 different investigators worked at the station from 1905 to 1939.⁵³

Mayer began to have difficult times in 1918 when the Laboratory had to close because of the First World War. His family name caused unbearable trouble to him during the war, which eventually led to his decision to change the family name from the German "Mayer" to English "Mayor."⁵⁴ The laboratory opened in 1919 but had to be closed again in 1920 because of a severe hurricane that seriously damaged the station's facilities. Mayer soon had tuberculosis after an expedition to the Pacific and had to spend some time in a sanatorium. He returned to Tortugas in 1922 in spite of his doctor's warning, and on June 24 was drowned while bathing in shallow water. Mayer was succeeded by William H. Longley of Goucher College, yet not as director but as administrative officer as the Carnegie Institution did not want to continue its Department of Marine Biology in the same way.⁵⁵ Longley died in 1937, and David Tennent of Bryn Mawr College worked as executive officer until 1939 when the laboratory finally closed by the decision of the Carnegie's new president, Vannevar Bush. The station's equipment went to the Smithsonian Institution at Washington, and the *Anton Dohrn* was donated to the Woods Hole Oceanographic Institution.

Despite the considerable scientific contributions produced at the Dry Tortugas Laboratory, it turned out that Mayer's selection of location had not been perfectly appropriate. There had been some reasonable opposition to the Dry Tortugas from the beginning.⁵⁶ Among the scientists Mayer consulted, some people favored Jamaica and others preferred the Bermudas, for example, as a better location for a subtropical marine station. There were two reasons for their distaste for Tortugas.

⁵³ On the scientific work done at the Tortugas Laboratory, see Colin, "A Brief History of the Tortugas Marine Laboratory"; J. S. Kingsley, "Papers from the Tortugas Laboratory," *Science* 30 (1909), 368-369; Davenport, "The Researches of Alfred Goldsborough Mayor"; A. A. Schaeffer, "Research at the Tortugas Laboratory," *Science* 56 (1922), 468-470.

⁵⁴ Here, I will use "Mayer" throughout for the sake of consistency.

⁵⁵ Colin, "A Brief History of the Tortugas Marine Laboratory," 143-145; Ebert, "Carnegie Institution of Washington," 182. For examples of the discussion on the fate of the laboratory after Mayer's death, see Davenport, "The Researches of Alfred Goldsborough Mayor"; Schaeffer, "Research at the Tortugas Laboratory"; W. J. Crozier, "Research in Marine Biology," *Science* 56 (1922), 751-752; Crozier, "Marine Zoological Stations," *Science* 57 (1923), 498-499; W. K. Fisher, "Research in Marine Biology," *Science* 57 (1923), 233-235; W. E. Allen, "A Program of Oceanic Investigations," *Science* 57 (1923), 499-500; and A. A. Schaeffer, "The Marine Laboratory at Tortugas," *Science* 58 (1923), 160-161.

⁵⁶ See the *Science* articles listed in n. 43.

On the scientific side, Tortugas did not offer chances to study land biology despite its ideal conditions for the study of marine biology. Some visitors would want to investigate the local animals and plants on land, or perhaps the geology of the region, in their spare time while staying at the station. The other, probably the more important, reason for the opposition was Tortugas's unfavorable living conditions. Most such problems were caused by Tortugas's isolated location. Even though Mayer tried his best to assure his colleagues that their concerns were groundless, they still had doubts.⁵⁷ They pointed out, first, that transportation to the Dry Tortugas was extremely inconvenient. It took a long time, and much money, to get there from many academic centers of the country, and once they arrived at the Tortugas they would have to stay isolated from civilization as it was very difficult to make short visits to nearby towns. Visiting scientists could thus hardly expect their families to accompany them to the Tortugas. Some people even worried about the possibility of tropical diseases. Living conditions certainly were an important factor, since many of the visiting researchers would have to stay there for several months. The Tortugas could offer almost nothing to them during the time of each day when they were out of work. It should also be remembered that work was not the only thing American biologists had in mind when they visited marine biological stations during summer. As Philip Pauly rightly pointed out, marine stations were "summer resorts" for American biologists of that time.⁵⁸ It is understandable that they did not want a summer resort at a place like the Dry Tortugas.

In the end, Mayer managed to silence this opposition, and the Tortugas marine station was established as a part of the great chain of stations. Yet, it did not take long for everyone to realize that the problems were real. The most serious trouble was the recurring hurricanes. Every year the hurricane season in the region seriously shortened the period of the station's operation. Moreover, some hurricanes were so powerful as to even destroy the laboratory facilities, as was the case in 1919. Even Mayer came to consider moving the laboratory to another region because of the problematic location of the Dry Tortugas, when he thought enough work had been done there. Officials of the Carnegie Institution were also aware of the problems, which led to their decision to not continue the laboratory at the same scale as before when Mayer died in 1922.

Despite the final closure of the station at the Dry Tortugas in 1939, marine biology, or marine sciences more generally, did not cease in Florida. In 1943, F. G. Walton Smith of the University of Miami at Belle Isle, Florida, opened the Miami Marine Laboratory.⁵⁹ Since Smith had learned from the experience of the Tortugas Laboratory, it was built at an easily accessible place. Unlike Tortugas, this university-based station continued to operate well and grew into a major center of

⁵⁷ Mayer, "The Bahamas vs. Tortugas."

⁵⁸ Pauly, "Summer Resort and Scientific Discipline."

⁵⁹ Thomas Barbour, "Marine Biological Laboratories," *Science* 98 (1943), 141-143; F. G. Walton Smith, "Functions and Development of a Tropical Marine Laboratory," *Science* 103 (1946), 609-611.

marine science. The magnificent American chain of marine stations, therefore, did not lose its branch in Florida in the end.

Conclusion: A New Direction in the Historical Study of American Marine Stations

The science of the sea began as a government activity in the United States. Its fate depended on the capricious decisions of the congress which was often reluctant to provide governmental scientific programs with steady financial support. Therefore, those scientific projects undertaken under the auspice of the federal government always had to have practical aims. They were often very successful, and the work done at the Coast Survey and the Depot of Charts and Instruments was very highly rated even by European experts. Those high-level scientific investigations could not be steadily pursued, however, because of politics. In this respect, the American marine biological stations that began to emerge in the late nineteenth century were noteworthy as they came to provide, for marine scientists, more stable institutional settings sufficiently apart from political fluctuations.

Historians of science have paid considerable attention to the American marine biological stations, mostly with emphasis on their role in the development of American biology. They have tended to focus disproportionately on the Marine Biological Laboratory at Woods Hole. MBL certainly was the largest, most popular and, probably, most successful marine station, and the one which no doubt has occupied the most influential place in the history of American biology. Morphological and physiological study done at laboratories of the MBL became the dominant methodological models of biology throughout the country. The combined focus of embryology, cytology, genetics and evolution shaped the main research problems for the younger-generation researchers. Moreover, the summer community of biological scientists gathered from all around the country brought about the formation of a social network and a professional identity among generations of American biologists. In short, it may not be an exaggeration to claim that without the MBL American biology would have looked quite different.

MBL was by no means an isolated phenomenon, however, as it was a part of the great chain of American marine stations. It is important to see, first, the whole picture instead of paying too much attention to just one or two major marine stations. MBL did not represent all the American biologists at the time. A number of biological scientists who belonged to the older tradition of natural history were also studying marine biology in different ways at other, usually smaller, marine stations throughout the coasts of the United States at the same time. In most cases, these marine biologists, unlike their colleagues at the MBL, emphasized field work, and they believed that comprehensive understanding of the marine organisms and their living conditions in their natural habitats were indispensable for the true science of biology. These field-oriented biologists usually had critical attitudes toward the MBL-style marine biology done at laboratories without much attention

to where and how those animals and plants lived in the sea. The more or less naturalistic marine biology at the smaller marine stations by no means remained stagnant. Those researchers of marine biology tried various new methodologies and studied diverse aspects of the phenomena of marine life. It is, therefore, wrong to see the history of marine biology as a linear development from natural history of the sea to laboratory biology that used marine organisms to tackle important biological problems of the day. Marine biology was developing into several different directions, and the MBL represented only one of these. Only by looking at both sides of American marine biology would we be able to get the full picture. Presenting MBL as the representative model of American marine biological stations would inevitably lead to a distorted understanding of the history of American biology of this period.

Another tendency of the current historiography of American marine biological stations is to emphasize their educational function as a distinctive characteristic of the American marine biology tradition as opposed to the European. Keith Benson, for example, pointed out that "American biologists confronted a problem much different from Dohrn's. Whereas he recognized an opportunity to provide an additional research facility for professional researchers, Americans found a need to train researchers when they had no facilities."⁶⁰ The emphasis on the educational function of the marine stations, thus, reflected the unique situation of American science. Jane Maienschein also stressed this point and argued that the American marine biological stations, including MBL, were not mere replicas of the Naples zoological station.⁶¹ She showed how the American tradition was begun at Penikese, transmitted to Alpheus Packard's Salem station and Annisquam, and finally reached the MBL. Despite Whitman's strong drive towards research, MBL remained for long an institution devoted to both education and research.

What this historiography has neglected is the fact that the other marine biological stations that formed the majority of the chain did not have much room for education of teachers and amateurs. Many of these stations were connected to universities, and they were devoted primarily to research. Education of graduate and undergraduate students who worked there was done through research. These stations usually had a strong leader, often director or professor, who led a group of researchers and students working on carefully planned research areas. For example, William K. Brooks of the Chesapeake Laboratory and William E. Ritter of the University of California's marine biological station fit well into this category; Spencer Baird at the Fish Commission Laboratory, Alexander Agassiz at his own Newport station, and Alfred Mayer of the Carnegie Institution's Dry Tortugas Laboratory may also be mentioned as leaders of research-oriented marine stations even though their stations were not affiliated with universities. Visitors to these stations were also coming for research.

The smaller stations that constituted the chain become even more important if we see the place of the marine biological stations within the historiography of

⁶⁰ Benson, "Summer Camp, Seaside Station, and Marine Laboratory," 14.

⁶¹ Maienschein, "Agassiz, Hyatt, Whitman."

marine sciences in general, or of oceanography in particular. Although all the American stations began as marine biological stations, these stations had some room for scientific fields other than marine biology. At the MBL, on the other hand, interest in the sea itself and ecology diminished soon after its establishment and laboratory biological work prevailed.⁶² For example, William Libby of Princeton University, who had worked at the Fish Commission, gave a lecture at MBL titled “The Study of Ocean Temperatures and Currents” in 1890 and another, titled “The Physical Geography of the Sea,” in 1892.⁶³ He was the only person who lectured on the physical sciences of the sea, and after him no lecture at MBL dealt with non-biological aspects of the ocean. Biometry and quantitative method in biology were not welcome at the MBL, either. Davenport once had a chance to lecture on this method in the study of variation, but he himself did not find MBL a good place to do research in that direction. Such diverse approaches could be tried at other seaside stations, however.

It was much easier at the small marine stations to change the direction of research when necessary. Their small size and strong leadership made such a shift comparatively easy. When a station turned out to be inappropriately situated at a certain time, a decision could be made to close it, as was the case with Agassiz’s Newport Laboratory and the Dry Tortugas Laboratory, or to move it to another, more desirable, place. Some stations shifted their main field of study from marine biology to other scientific fields. A few turned to oceanography. In California, William Ritter had been aware of the need for knowledge of physical properties of the sea, and had a physical scientist accompany him whenever he led seaside investigations from very early times. In the 1920s, his station, the Scripps Institution of the University of California, was officially changed to an oceanographic institution, the first one in the United States. In the 1930s, the University of Washington’s Puget Sound Laboratory also incorporated oceanography in its program. The Miami Marine Laboratory is another such example. Its prospectus, quoted by Thomas Barbour, clearly showed that when it was established in 1943, this station was intended to be devoted only to marine biological studies. Yet, three years later, its director Walton Smith wrote that the laboratory had oceanographic as well as marine biology programs. In fact, leading oceanographers such as Columbus Iselin had noticed the station’s usefulness very soon after its establishment, and it was indeed used as one of the centers of wartime oceanographic work.⁶⁴

American marine biological stations were, therefore, important in the history of oceanography not only because they were homes of marine biology, one branch of marine sciences, but also because they were the roots of later oceanographic institutions. As many oceanographic institutions grew out of marine biological stations, it is necessary to know the full story of early American marine biology in

⁶² Maienschein, *100 Years Exploring Life*, 126-149.

⁶³ Maienschein, *Defining Biology*, 51-56.

⁶⁴ Barbour, “Marine Biological Laboratories”; Smith, “Functions and Development of a Tropical Marine Laboratory.”

order to understand the history of American oceanography. At the same time, getting a better understanding of the “magnificent chain of marine biological stations” would also benefit the history of biological sciences, as it would allow us to have a better view of the larger picture of American biology in the late nineteenth and early twentieth century.

Abstract

Until the mid-nineteenth century, marine sciences developed in a discontinuous manner because stable economic support for that expensive scientific venture was often impossible. It was the marine biological stations that flourished in Europe and the United States that eventually provided a home for marine scientists. In the United States, as well as in Europe, various marine biological stations were built on both coasts that formed a “magnificent chain of biological stations.” The stations that constituted the great chain differed from one another in their characters. For example, the Marine Biological Laboratory at Woods Hole, which was the largest of all American biological stations, tended to be geared more and more towards laboratory biology. Biologists belonging to a more naturalist, field-science tradition often favored a number of stations, mostly of modest scale, located here and there throughout the coastal regions. This paper explores the early history of American marine biological stations, and tries to reconsider the historiography of the biological stations

Key words: marine science, marine biology, marine biological station, Marine Biological Laboratory at Woods Hole, Marine Biological Laboratory at the Dry Tortugas