

The Ocean Laboratory: Exploration, Fieldwork, and Science at Sea

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## **Dissertation Abstract:**

### **The Ocean Laboratory: Exploration, Fieldwork, and Science at Sea**

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#### **Abstract:**

In framing the history of field sciences most historians emphasize terrestrial sites rather than marine ones. But, to ignore marine spaces is to omit an extensive geography to which the abstract notion of “the field” has also been applied. While the importance of laboratories as a space for scientific work has been well established by historians, and though there has been a growing body of recent scholarship on the history of field science, the link between laboratories, ships, museums, and the development of oceanography as a field science has yet to be fully explored. Tracing this history sets the history of oceanography within the larger history of science in the field and thereby offers to the history of science a contribution which bridges two subfields, the history of the development of laboratory and field sciences and the history of the exploration of the marine environment. A central theme of this project is the shifting conception of the research vessel over the period from ca. 1830 to present, as it underwent a change from the ship as instrument, to the ship as laboratory, and finally, in its most recent incarnation, to the ship as invisible technician operating within an ocean transformed into credible scientific space. Beginning with a description of expeditionary science at the turn of the nineteenth century, this dissertation charts a gradual re-centering of spaces of scientific analysis from the metropole to the field, via the marine station and finally, the research vessel. In doing so, it examines the social, political, and cultural context in which these shifts took place, and reveals an emerging scientific and political discourse equating international cooperation, and progress in marine science. These were both goals of Prince Albert Ist of Monaco; his scientific program, and the oceanographic institutions he founded, helped permanently link these dual agendas. Thus, this study sheds light on the social and cultural processes involved in the emergence of global sciences framed in terms of large-scale systems, both physical and political. Furthermore, by tracing the development of oceans as scientific spaces, this work demonstrates how the idea of a "Pacific World," with roots in nineteenth-century expeditionary science, contributed to the self-conscious geopolitical construction of this concept in the interwar period. Public proclamations about the Pacific World, along with the development of museum exhibits focused on marine science and interpreting the results of oceanographic expeditions, demonstrate the ways in which popular culture and politics interacted with the cultures of marine science. Hence, in the twentieth century, world's fairgrounds on the west coast of the United States became an important venue for popularizing large-scale science and presenting appeals for scientific internationalism in the Pacific.

## **Acknowledgements:**

As a graduate student I have benefitted from the supportive community of staff, faculty, and students of the University of Washington Department of History. I am extremely grateful to have been part of a community where help is offered freely, criticism is constructive, and everyone's achievements are celebrated.

I must, however, give special thanks to the members of my dissertation committee: Drs. Bruce Hevly, Simon Werrett, Ray Jonas, Adam Warren, and Jody Bourgeois. "Dear Dr. Hevly," I wrote, in an email dated May 28<sup>th</sup>, 2008. "I plan to study the United States Exploring Expedition of 1838-1842 and investigate the ways in which the United States emulated European forms of scientific imperialism, during the expedition and afterwards, with the display of the ethnographic collections in the Smithsonian institution." Fortunately for me, Dr. Hevly, instead of balking at my run-on sentence, agreed to meet me to discuss my project. I didn't realize then – and I'm sure he didn't either – that he was taking on the task of being my primary graduate mentor for the next six years. I could not have asked for a better advisor; he has been an unvarying source of inspiration, guidance, and encouragement. Shortly after meeting with Dr. Hevly, I also began working with Dr. Werrett who, along with Dr. Hevly, served on my MA thesis committee. Dr. Werrett's enthusiasm for the history of science and STS is contagious, and I must give him a great deal of credit for my interest in the history of science and exploration. I like to remember one afternoon in London when he showed me the Cast Courts of the Victoria and Albert Museum, his "favourite" rooms. Dr. Jonas is an inspiring instructor and I have enjoyed the opportunities to work with him as a teaching assistant. Dr. Jonas' lectures set a standard to which I aspire in my own teaching. In the years that I have known Dr. Warren, never once have I passed him on campus without receiving a cheerful greeting and friendly inquiry about my work. I have always appreciated his kindness. Finally, I want to thank Dr. Bourgeois, who I met quite by accident on a taxi ride from the airport, for amiably agreeing to serve as the graduate school representative on my reading committee.

If I try to date the origin of this project, it might be when I sailed on the open ocean for the first time. An off-campus study program while I was a sophomore in college – SEA semester – sparked my interest in both oceanography and maritime history. I went on that great adventure on the suggestion of family friend and veteran sailor, Juan Corradi. However, while I have long been interested in maritime history and exploration, I would not have pursued a dissertation in the history of oceanography were it not for the wonderful community of scholars I encountered when I first became interested in this topic. In 2011 I wrote to Dr. Eric Mills, whom I had never met, explaining my interest and asking for guidance. He generously shared his teaching materials and encouraged me to pursue a research topic in this field. Since that introduction I have met many other scholars working on the history of oceanography and exploration whose work has been a source of inspiration and who have helped me in some form. To Drs. Keith Benson, Mott Greene, Jacob Hamblin, Helen Rozwadowski, Katharine Anderson, Jennifer Hubbard, Samantha Muka, Richard Burkhardt, and Alistair Sponcel, I wish to give special thanks.

Within the Department of Oceanography at the University of Washington I have also found a supportive community. Drs. Paul Johnson, John Baross, Jody Deming, Russ

McDuff, Karl Banse, Billy Brazelton, and Karen Chan, all willingly (and patiently) entertained my questions about their work. Conversations I've had with them have informed this project and my thinking about the history of oceanography. They also welcomed me as a sort-of honorary member of their community, and for this I am deeply appreciative.

A transnational project, such as this one, required travel to archives in the United States, the U.K., France, and Monaco. Under financial and time constraints archival research can be frustratingly slow, and the help of library staff and archivists can mean the difference between a trip wasted or a gold mine of information recovered. Before beginning this dissertation I imagined that archival work was a solitary endeavor. I have since come to associate my time at various archives as time spent working closely with specialists able to navigate particular collections far more efficiently than I could have ever done alone. Of those who aided me with my archival work, I must thank first and foremost Mme. Jacqueline Carpine-Lancre, archivist at the royal palace of Monaco. Not only is Mme. Carpine-Lancre's expertise in the history of European oceanography unparalleled, she is also an extremely generous person. She freely shared with me her own extensive research notes, assembled over the course of her career and offered indispensable aid in navigating the palace archives. Much of my writing on both Prince Albert 1st and the history of oceanography in France derive from my conversations with her during one short week in Monaco. At the Roscoff marine station Dr. André Toulmand and his wife Claude graciously hosted me during my time working in the station's library. Thanks to them, I associate my time at Roscoff not only with nineteenth-century visitor logs, but also with savory crepes, cider, and good company. I found similarly friendly welcomes at the Scripps Institute of Oceanography archives at UCSD, where I was assisted by Heather Smedberg, in the University of Washington Special Collections where Sandra Kroupa helped me obtain images for journal publications, and in the Special Collections of the Imperial College of London, where Bryony Hooper provided me with scans of letters from the Huxley papers. Research abroad would not have been possible without the financial assistance provided in the form of a fellowship from the American Geophysical Union, and a Doctoral Dissertation Improvement Grant provided by the National Science Foundation. The University of Washington History department also provided funding for research and conference travel.

I want to also thank my friends and family. My time in Seattle would have been poorer without the camaraderie of my housemates over the years. Thanks to them, looking back on this period of my life, I will remember shared meals, hikes, and laughter. Michael Schrimpf, Emily Runnells, and Jane McCamant, thank you for helping to build a home away from home. My fellow student colleagues, who joined me for long hours in the library made the burdens of graduate school easier to bear, and I am especially grateful to other friends who have remained supportive over the years despite geographical distance – in particular, Matthew Grenning, Justin So, Matt Sternfeld, and Zachery Garland.

Isaac Newton famously wrote that he stood “on the shoulders of giants;” he referred to the scholars who had gone before him, but to me the statement always held more resonance when thinking of my family and the sacrifices that they made so that I could have the opportunities I've enjoyed. My grandfather, Nathan Adler, who dropped out of high school to support his parents, had the determination to eventually help finance

his grandchildren's education. My grandparents and great-grandparents knew how to reinvent themselves in the face of adversity, and I think of them when I need encouragement in my own life. I trace my interest in the history of exploration to my grandmother, Elizabeth Haverstock Adler, who gave me my first subscription to *National Geographic*. I remember her telling me, when I was very young, about expeditions to the summit of Everest, or about the ill-fated voyage of some nineteenth-century polar explorer. I am sure that, were she alive today, she would want me to tell her all about the history of oceanography.

I owe my love of history to my mother, Judith Adler. Together we have travelled, visited museums, and shared books. I treasure the memories of our adventures. She always encouraged my interest in history and I am a better historian because of our conversations and her insights. My entire life, I have also had the security of knowing that I could rely on my godfather, Volker ("Dopher") Meja. Together, my mother and my godfather have been the wind in my sails and the sturdy deck beneath my feet.

Finally, I am certain that I would not be completing this dissertation were it not for the support of my partner, Rika Anderson. We first spent time together during late nights of study in the Carleton College library, and in many ways she taught me what it means to be a disciplined scholar. She also opened, and continues to share with me, a world of science from which I might otherwise have been cut off. The universe became a far richer place after I met her, and I'm incredibly fortunate that she is my travelling companion in this life – the greatest of exploring expeditions.

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*They that go down to the sea in ships, that do business in great waters; these see the works of the Lord, and his wonders in the deep.*

- King James Bible, Psalm 107.

*With all its terror and mystery, The dim, dark sea, so like unto Death, That divides and yet unites mankind!*

- Henry Wadsworth Longfellow, *The Building of the Ship*, 1850.

*The sky o'erarches here, we feel the undulating deck beneath our feet, We feel the long pulsation, ebb and flow of endless motion, The tones of unseen mystery, the vague and vast suggestions of the briny world, the liquid-flowing syllables, The perfume, the faint creaking of the cordage, the melancholy rhythm, The boundless vista and the horizon far and dim are all here, And this is ocean's poem.*

- Walt Whitman, *In Cabin'd Ships at Sea*, 1855.

*The sea [...] affords an almost endless variety of subjects for pleasing and profitable contemplation, and there has remained in the human mind a longing to learn more of its wonders and to understand its mysteries.*

- Matthew Fontaine Maury, *A Physical Geography of the Sea*, 1856.

*Unlike the earth, [the sea] cannot be subjugated at any cost of patience and toil. [...] [I]ts immensity has never been loved as the mountains, the plains, the desert itself, have been loved. Indeed, I suspect that, leaving aside the protestations and tributes of writers [...], the love of the sea, to which some men and nations confess so readily, is a complex sentiment wherein pride enters for much, necessity for not a little, and the love of ships—the untiring servants of our hopes and our self-esteem—for the best and most genuine part.*

- Joseph Conrad, *The Mirror of the Sea: Memories and Impressions*, 1906.

*How can the poem and the stink and the grating noise - the quality of the light, the tone, the habit and the dream be set down alive? When you collect marine animals there are certain flat worms so delicate that they are almost impossible to capture whole, for they break and tatter under touch. You must let them ooze and crawl of their own will onto a knife blade and then lift them gently into your bottle of salt water. And perhaps that might be the way to write this book - to open the page and let the stories crawl in by themselves.*

- John Steinbeck, *Cannery Row*, 1945.

*“For oceanographers the ocean itself is the laboratory, and the adequacy of the ships used will significantly affect the oceanographers’ ability to work at sea.”*

- Rear Admiral W. W. Behrens, Jr., USN, Oceanographer of the Navy, 1971.

*“I found that using scuba was like using a microscope...It made it possible for me to really use the ocean as a laboratory.”*

- Sylvia Earle, Former president of NOAA, January 27, 1991.

## **Introduction:**

### ***The Ocean Laboratory: Exploration, Fieldwork, and Science at Sea***

Oceanography is a science dedicated to studying three fourths of our planet. As such, it is one of the most interdisciplinary of sciences and difficult to encapsulate within a single definition.<sup>1</sup> Marine scientists have integrated geology, chemistry, physics, biology, and engineering in their investigations of the ocean depths. Yet, it is often said that we know more about the surface of the moon than we do about the bottom of the sea; indeed, the oceans are sometimes called “the *other* final frontier.” Thus oceanography, perhaps more than any other scientific discipline, is also a science of exploration.<sup>2</sup> But, as a science focused on a specific bounded geographical space, albeit an enormous one – the oceans (including their shores, surface, and depths) – oceanography can easily be designated a “field science.” Thus, a history of oceanographic science must be undertaken with attention to the distinction between “field” and laboratory scientific practices.

The history of oceanography is still a very young sub-discipline in the history of science. The founders of the field, working in the 1960s, were for the most part retired oceanographers. Those who sought to carry the history of oceanography beyond a

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<sup>1</sup> “Trying to define the history of oceanography is akin to finding the cat behind the gin,” wrote historian of oceanography Eric Mills; “the closer one looks, the more one sees the grin and the less the cat.” Eric Mills, “What is the History of Oceanography?,” *History of Oceanography*, No. 2, (July 1990), 2.

<sup>2</sup> On these grounds alone, oceanography falls within a categorical “way of thinking” often overlooked by historians of science, particularly in studies dealing with twentieth-century developments. As Vanessa Heggie writes: “the history of twentieth-century science is routinely written about (and taught) without much consideration of nonlaboratory sciences, and the role of extraordinary encounters between human bodies and the earthly environment is rarely discussed.” Vanessa Heggie, “Why Isn’t Exploration a Science?” *Isis*, Vol. 105, No. 2, (June 2014), 319.

teleological progressive narrative struggled to define to limits of their area of study. This debate continues to this day. Many historians studying marine science developments in the twentieth-century prefer to distinguish between “physical” oceanography and “marine biology.” However, I have take a *long durée* approach to the history of the marine sciences in this dissertation, and thus I employ the term “oceanography” to encompass a wide variety of scientific practices, unified by their concern with the marine environment. In taking this approach I am following the guidance of Eric Mills who, in 1990, wrote:

Oceanography, as a discernable science and professionalized field, hardly existed before about 1910. Late in the nineteenth century, when the ingredients that gave rise to oceanography – marine biology and fisheries science, physics and chemistry, scientific expeditions and international science – were being stirred together, marine scientists thought of themselves professionally in a variety of ways, but rarely as oceanographers. As historians of oceanography we can either confine ourselves to the past few decades, when a definable field of oceanography existed, or make the more daring and significant choice of looking back to earlier, more puzzling times. Definitions turn out to be cramping, inhibitory, and worst of all, an unadventurous aid to our scholarship. History of oceanography is what historians of oceanography write about.<sup>3</sup>

The history of oceanography has lagged behind some of the methodological shifts that have re-shaped other branches of historical scholarship. Notably histories of oceanography have only recently abandoned the “the great man” narrative; or, in the case of marine science, the “great ship narrative.” That the “great ship narrative” has persevered for so long is undoubtedly symptomatic of the source material that historians of oceanography have employed. Thus, the British *H.M.S. Challenger* expedition (1872 – 1876) has frequently been described as the singular event that signaled the birth of

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<sup>3</sup> Eric Mills, “What is the History of Oceanography?,” 2.

oceanography – a practice that continues in contemporary oceanography textbooks.<sup>4</sup> Perhaps the best example of this approach is Georg Wüst’s 1964 article, “The Major Deep-Sea Expeditions and Research Vessels 1873 – 1960.”<sup>5</sup> However, Margaret Deacon, in her now-classic 1971 account of the early development of marine science, critiqued this tendency. She argued that to cite to the *Challenger* expedition as the origin point for marine science was “to misjudge its significance,” to neglect “the work of earlier scientists,” and to underestimate “the strength of the parallel movement in other countries.”<sup>6</sup> Nevertheless, in the many expedition accounts written by oceanographers, upon which historians of oceanography have relied, the research vessel is given both prestige and agency; thus historians have brought research vessels to the foreground in their own accounts. I am not arguing that an attention to ships as scientific spaces is to be avoided; it is critical.<sup>7</sup> Rather, ships must be incorporated into broader accounts of the many different spaces in which marine science was carried out. When we describe the first naturalists to travel out into the field, we must remember that in the vast majority of

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<sup>4</sup> Other “great ships” of marine science – to name but a few – might include the British *Porcupine* and *Lightening*, the French *Talisman* and *Travailleur*, the German *Meteor* and *Valdivia*, or the American *Blake* and *Albatross*

<sup>5</sup> Georg Wüst, “The Major Deep-Sea Expeditions and Research Vessels 1873 – 1960,” *Progress in Oceanography*, Vol. 2, (1964), 1 – 52. Furthermore, topics covered in histories of oceanography, overlapping with maritime and naval history, have often focused on particular national contexts.

<sup>6</sup> Margaret Deacon, *Scientists and the Sea, 1650 – 1900: A Study of Marine Science*, (Brookfield, VT: Ashgate Publishing Company, 1997), 368 – 369.

<sup>7</sup> The need to incorporate ships in histories of oceanography was one of the conclusions of the Maury III conference in 2001. See footnote 13 in Keith Benson, Helen Rozwadowski, and David K. van Keuren, “Introduction,” *The Machine in Neptune’s Garden: Historical Perspectives on Technology and the Marine Environment*, ed. by Helen Rozwadowski and David K. van Keuren, (Sagamore Beach, MA: Watson Publishing International, 2004), xxvi.

cases we are speaking of passengers on ships. Ships facilitated the work of science in the field long before they became primary platforms for fieldwork.

Only with the “spatial turn” in the early 1990s, did scholars begin developing new interpretive frameworks for dealing with scientific practice in the natural world. Thus, while the importance of laboratories as spaces for the production of scientific knowledge has long been recognized, it is only in the past two decades that historians have begun to recognize the “field” as another site of knowledge production. Still, most treatments of the field sciences have dealt with terrestrial topics rather than marine ones.<sup>8</sup> This dissertation sets the history of oceanography within the larger context of the history of Western science in the field and thereby offers to the history of science a contribution that engages three important themes in the history of modern science: the history of the development of laboratory and field sciences, the history of the exploration of the marine environment, and the history of scientific instruments and material culture. The science of oceanography has been carried in many different settings, the laboratory and field, but also, as this dissertation will show, in the museum, the marine station, the fair ground, and on ships at sea.

As with any scientific discipline, developments in oceanography have been shaped by the economic, social, and political contexts in which marine science has been carried out. Historians of science have long acknowledged that science does not operate within a vacuum, and marine science is no exception. The actions and interests of governments, institutions, and individuals all influence the course of marine science. Yet,

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<sup>8</sup> See for instance, “Science in the Field,” *Osiris*, Vol. 11, (1996), and *Knowing Global Environments: New Historical Perspectives on the Field Sciences*, ed. by Jeremy Vetter, (New Jersey: Rutgers University Press, 2011).

while it is important to move beyond nationally encapsulated histories of oceanography, historians can still – as demonstrated by Eric Mills – gain important insight by identifying national styles of marine science. British marine science, upon closer investigation, does not entirely resemble French marine science, nor does French marine science precisely mirror the American marine case. While the chapters of this dissertation deal primarily with different types of spaces, they also seek to explore different national contexts. Thus, it provides a transnational view of the development of the marine sciences in three different national contexts: the United States, France, and Britain.

Scholarship in the history of oceanography published within the last two decades has demonstrated the important links between developments in oceanography, changes in State and military support, institutional developments, and broader cultural shifts in western society.<sup>9</sup> This dissertation integrates these insights with an attention to wide range of scientific practices and the various spaces in which such practices are carried out.

*Methodology:*

As historians of science have long recognized, scientists have frequently struggled to establish the legitimacy of the knowledge they produce. Spaces in which scientific experiment can be considered legitimate have developed only gradually over time. Scientific knowledge generated without attending witnesses, or in spaces removed from accepted places for scientific work, must be carefully presented so as not to lose

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<sup>9</sup> I refer here in particular to the work of Eric Mills, Helen Rozwadowski, Jacob Darwin Hamblin, Jennifer Hubbard, Michael Reidy, Keith Benson, Gary Weir, and Naomi Oreskes.

legitimacy.<sup>10</sup> The geography of science – the place in which it is made, and the space through which it circulates is thus an important component of scientific knowledge production. Papers must be published and circulated, instruments must be installed in laboratories, and data has to be gathered in the field and brought elsewhere before it can be processed and legitimized. However, the transportation of scientific information and instruments is problematic. Thus, one of the principle obstacles for scientific fieldwork has been the transport of information.

A growing body of work in the history of science explores the question of circulation – how have individuals, specimens, and scientific data been transported across geographical space in order to produce scientific knowledge?<sup>11</sup> However, there is another question regarding scientific circulation that has less often been posed, one perhaps more evident now than ever before, and that is: how has the circulation of scientific knowledge shifted over time? Or, to be more specific given the examples laid out above, how has the distance between field and laboratory been compressed? What motivations and practices drove this shift? And finally, what are the implications of this change on the production and format of scientific knowledge? It is these questions that I seek to answer by studying the history of the compression between lab and field within the context of the history of oceanography.

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<sup>10</sup> See for example, Steven Shapin and Simon Schaffer, *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life*, (Princeton: Princeton University Press, 1985); Owen Hannaway, “Laboratory Design and the Aim of Science: Andreas Libavius Versus Tycho Brahe,” *Isis*, Vol. 77, (1986), 585 – 610; Steven Shapin, “The House of Experiment in Seventeenth-Century England,” *Isis*, Vol. 79, (1988), 373 – 404.

<sup>11</sup> Bruno Latour, *Science in Action: How to Follow Scientists and Engineers Through Society*, (Cambridge: Harvard University Press, 1987); Benjamin Schmidt, “Accumulating the World: Collecting and Commodifying ‘Globalism’ in Early Modern Europe,” *Centers and Cycles of Accumulation in and Around the Netherlands in the Early Modern Period*, ed. by Lissa Roberts, (Berlin: LIT Verlag Münster, 2011).

In its methodological approach, this dissertation is influenced primarily by the work of Robert Kohler. Building on the work of Owen Hannaway and Steven Shapin, Kohler recognized that one of the cultural practices western scientists brought into the field was their conception of the “laboratory.” As Kohler explains: “laboratory and field are different cultural terrains, to be sure, but they are contiguous, and there is a steady traffic across the border; and field scientists regularly mix and match lab and field methods.”<sup>12</sup> Kohler raises the following question: how can an audience not present in the field (a place with questionable cultural standing as a space for the production of scientific knowledge) be persuaded that the knowledge produced in the field is as valid as that produced in a laboratory? Kohler argues that field scientists felt compelled to bring laboratory practice into the field because it brought with it an authority that had become associated with laboratory spaces in metropolitan centers. Kohler’s model works well for terrestrial areas, which are relatively easy to demarcate – Kohler uses the example of ecologists’ use of islands for animal population studies. But can Kohler’s model be applied to the more difficult-to-discipline marine environment – a dynamic, three-dimensional field in constant flux?<sup>13</sup>

To understand the development of oceanography as a modern science, we need to attach our histories about changing instruments, ships and places of work more closely to histories of the practices that invent, choose, deploy, and interpret them. “Science in practice” turns our attention to the cascade of instruments and technologies that bring

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<sup>12</sup> Robert Kohler, “Place and Practice in Field Biology,” *History of Science*, Vol. 40, (2002), 189.

<sup>13</sup> Keith Benson, Helen Rozwadowski, and David K. van Keuren, “Introduction,” *The Machine in Neptune’s Garden: Historical Perspectives on Technology and the Marine Environment*, xvi.

oceanic phenomena into view. But it also emphasizes the conditions of their use - the local circumstances, tacit knowledge, and improvisations that define scientific work. A focus on practice can help introduce a different range of practitioners into our histories. It points to continuities and discontinuities within the series of activities that forge knowledge about the ocean – from observation to analysis to communication. Finally, it prompts more careful attention to the words we use to describe knowledge and what is involved in those vocabularies: apparatus, observing, looking, tracking, synthesis.

I investigate the specific practices that allowed the movement of scientific knowledge from the field to centers of calculation by close examination of a variety of case studies. Each case reveals a particular facet of the circulation network, and the practices naturalists employed to move scientific knowledge from field to metropole, or from metropole to field. My aim is to study the movement of marine scientists, and scientific knowledge, across the lab/field boundary. Using multiple case studies reveals the different types of spaces (ocean, ship, field station, and museum) in which oceanographic knowledge has been legitimated. Each required its own context-specific adaptations and hybridizations. With these accounts, I hope to add depth to our understanding of what Kapil Raj has termed “the vectors of knowledge transmission,” the spaces of negotiation and hybridization in which marine science was produced.<sup>14</sup>

Recently historians investigating the history of science in the field have given increasing attention to the large-scale field sciences first developed in the nineteenth century - notably oceanography, meteorology, and climatology. Helen Rozwadowski, Robert Marc Friedman, Michael Reidy, and James Roger Fleming are among the scholars

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<sup>14</sup> Kapil Raj, *Relocating Modern Science: Circulation and the Construction of Knowledge in South Asia and Europe, 1650 – 1900*, (New York: Palgrave Macmillan, 2007), 10.

who have contributed to this new focus. As Robert Kohler explains in a review essay of the field: “perhaps the most noteworthy recent trend in the history of field science is the burgeoning interest in large-scale scientific practices, in sciences of space, science pursued on a regional or global scale. It’s history of the ‘long degree,’ one might say [...] and it’s becoming a major feature of the history of science.”<sup>15</sup> I will argue that this conflation of the field and the laboratory, which has taken place over the course of the past two hundred years, has been a salient feature of oceanographic science. Kohler’s model of the lab / field boundary can be used to better understand scientific practices in marine spaces much in the same way that it can be used to model scientific practice in terrestrial environments. However, it is only in examining the history of oceanography from its beginnings to its present state that the applicability of Kohler’s model becomes evident.

*Prologue:*

Writing in 1671, Robert Boyle, the English natural philosopher celebrated for his air-pump experiments, wrote: “I do not pretend to have visited the bottom of the sea, [...] and [it is a] great rarity in these cold parts of Europe to meet with any men at all that have

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<sup>15</sup> Robert Kohler, “History of Field Science: Trends and Prospects,” in *Knowing Global Environments: New Historical Perspectives on the Field Sciences*, ed. by Jeremy Vetter, (New Brunswick: Rutgers University Press, 2011), 216. A recent example of this approach is the work of Helen Tilley. In her study of nineteenth-century fieldwork on the African continent she describes how, in the late nineteenth century, scientists evoked “the authority of laboratory knowledge.” By doing so, she argues, scientists “simultaneously challenged the physical boundaries and natural validity on which that authority was based.” The effect, Tilley explains, was that scientific work in the field became “organized around a range of concepts that resisted the tendency to examine parts separately from the whole: they highlighted interrelations, interdependence, and the ‘bird’s-eye view.’” Helen Tilley, *Africa as a Living Laboratory: Empire, Development, and the Problem of Scientific Knowledge, 1870 – 1950* (Chicago: University of Chicago Press, 2011), 12.

had at once the boldness, the occasion, the opportunity and the skill to penetrate into those concealed and dangerous recesses of nature[.]”<sup>16</sup> Boyle made no such claims himself, explaining that he had relied instead on the testimony of “divers,” “pilots,” and “other navigators.”<sup>17</sup> Even so, Boyle’s scientific attention to the oceans was unusual for his time period.<sup>18</sup>

A little over a century later scientists still relied on the testimony of others to gain knowledge about the oceans. On the other side of the Atlantic, Benjamin Franklin relied on the testimony of mariners in order to produce his three (1768, 1782, 1786) charts of the Gulf Stream.<sup>19</sup> But an important change had also begun to occur; the burgeoning age of global scientific exploration meant that, for the first time, naturalists were traveling far afield and, as result, themselves increasingly spending time at sea. But, despite entering the maritime world, naturalists still viewed the oceans as a terrain better understood by sailors whose expertise was firmly established by the accumulated experience of a centuries-old profession. Thus, we find a similar perspective to Boyle’s in the writings of Johann Reinhold Forster (1729 – 1798), naturalist on Captain Cook’s second voyage around the world. Writing in 1778, Forster apologized to his readers that he had not done more to record scientific information relating to the oceans:

I might here have subjoined many other particulars relative to the ocean; I might have given some account of its currents, and of the different constitution of its

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<sup>16</sup> Robert Boyle, *Relations About the Bottom of the Sea*, (1672), 1.

<sup>17</sup> *Ibid.*, 2.

<sup>18</sup> See the discussion of Boyle’s work in Margaret Deacon, *Scientists and the Sea, 1650 – 1900: A Study of Marine Science*, 117 – 129. Also Steven Shapin, *A Social History of Truth: Civility and Science in Seventeenth-Century England*, (Chicago: Chicago University Press, 1994).

<sup>19</sup> See Joyce E. Chaplin, “Knowing the Ocean: Benjamin Franklin and the Circulation of Atlantic Knowledge,” *Science and Empire in the Atlantic World*, ed. by James Delbourgo and Nicholas Dew, (New York: Routledge, 2008), 73 – 96.

bottom, where we had any soundings; of various tides; and of the dipping and variation of the magnetical needle; but I forbear to speak on these subjects, as they are partly the objects of the nautical observations, made by the officers[.] [...] [T]o make accurate observations [...] would therefore be very improper, to attempt a business so ably discharged by others; who with proper instruments for that purpose, more leisure, and with more command of assistance, had better opportunities of making more perfect observations on these subjects.<sup>20</sup>

As naturalists gained confidence in their abilities to conduct observations at sea the overlap between two realms of maritime expertise, “oceanography” and “hydrography,” became a point of lasting conflict between naturalists and the mariners upon whom they relied in order to go to sea. And, going to sea, naturalists found themselves in a decidedly hostile environment.<sup>21</sup> “[I]t is a curious fact,” wrote Thomas Henry Huxley, “that if you want a boat for dredging, ten chances to one they are [...] otherwise disposed of; if you leave your towing-net trailing astern in search of new creatures, [...] it is, in all probability, found to have a wonderful effect in stopping the ship’s way, and is hauled in as soon as your back is turned; or a careful dissection waiting to be drawn may find its

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<sup>20</sup> Johann Reinhold Forster, *Observations Made During A Voyage Round the World*, ed. by Nicholas Thomas, Harriet Guest, and Michael Dettelbach, (Honolulu: University of Hawaii Press, 1996), 78. It should be noted that Forster did include in his final report a series of seawater temperature measurements and the positions at which they were taken, though it is unclear whether he made these measurements himself. Margaret Deacon suggests that the expedition’s astronomers, William Wales and William Bayly, made the temperature measurements. Margaret Deacon, *Scientists and the Sea*, 186 - 188.

<sup>21</sup> This is not to diminish the difficulties of land-based collecting in the late-eighteenth century. Forster likened botanizing in New Zealand, threatened by attack from hostile natives, to “pulling burning embers out of a fire.” Quoted in Glyn Williams, *Naturalists at Sea: Scientific Travelers from Dampier to Darwin*, (New Haven: Yale University Press, 2013), 106. On the difference between hydrography and oceanography see also, Helen Rozwadowski, *Fathoming the Deep: The Discovery and Exploration of the Deep Sea*, (Cambridge: Harvard University Press, 2005), 34. It is important to note that early naturalists working at sea adapted some of the practices of hydrographers. Alistair Sponsel, “An Amphibious Being: Why Darwin’s Theories Depended Upon His Practical Experience in Maritime Surveying,” [unpublished manuscript, presented at history of oceanography workshop, *Place and Practice: Doing Science on and in the Ocean 1800 – 2012*, Halifax, Nova Scotia, June 14 – 17, 2014].

way overboard as a ‘mess.’” Naval crews resented the imposition of work they regarded as outside the purview of military science and lacking the honor associated with naval service:

[T]he men of easy routine – harbour heroes – the officers of ‘regular’ men-of-war, as they delight to be called, pretend to think surveying a kind of shirking – in sea-phrase, ‘sloping.’ It is to be regretted that the officers of the surveying vessels themselves are too often imbued with the same spirit; and though, for shame’s sake, they can but stand up for hydrography, they are too apt to think an alliance with other branches of science as beneath the dignity of their divinity – the ‘Service.’

“[S]cience is not the service,” Huxley lamented.<sup>22</sup> As a result, “adventures ashore were mere oases, separated by whole deserts of the most wearisome *ennui*.”<sup>23</sup> Other naturalists lamented the discomforts of life at sea. “I hate every wave of the ocean, with a fervor, which you, who have only seen the green waters of the shore, can never understand,” wrote Charles Darwin to his cousin while aboard the *Beagle* in 1837.<sup>24</sup>

Working at sea was both uncomfortable and dangerous. But, despite these difficulties, as the terrestrial field sciences became increasingly crowded, and the areas for land-based field collection ever more well travelled, naturalists turned to the seas as spaces where discoveries might yet be made. As Charles Wyville Thompson, lead scientist of the *Challenger* expedition recalled in 1873: “I had long previously had a profound conviction that the land of promise for the naturalist, the only remaining region where there were endless novelties of extraordinary interest ready to the hand which had

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<sup>22</sup> Thomas Henry Huxley, “Science at Sea,” *Westminster Review*, Vol. 5, (January 1854), 58. Huxley drew from his experience as assistant surgeon aboard the *H.M.S. Rattlesnake* (1846 – 1850).

<sup>23</sup> *Ibid.*, 60.

<sup>24</sup> Darwin to Fox, 15 February 1836. Charles Darwin, *The Beagle Letters*, ed. by Frederick Burkhardt, (Cambridge: Cambridge University Press, 2008), 383.

the means of gathering them, was the bottom of the sea.”<sup>25</sup> Furthermore, important technological advances were soon to reshape travel to and from this field.

Robert Lewis Stevenson described the engineering marvels of the nineteenth century as having “broken down the barriers of time and space.”<sup>26</sup> Technological advances like steam ships, submarine telegraphy, and improved navigation, were turning the seas into more accessible spaces. The rise of a new middle class also meant that the seaside was increasingly becoming a space for recreation, health, and leisure. Yet, the depths of the world’s oceans remained unexplored, and the physical properties of the seas poorly understood. In order to investigate marine life, naturalists turned to a new means for collecting marine organisms: dredges.

Commercial fishermen were the first to invent and use dredges, mechanisms first developed to catch valuable, bottom-dwelling mollusks, like clams and oysters. The first naturalists to adopt dredging as means of collecting marine organisms simply appropriated unmodified fishermen’s’ dredges – or better yet, hired fishermen to go dredging for them. In essence, the procedure involved dragging a weighted net along the seabed and scooping up whatever happened to be caught in its path. The technique produced a bounty of specimens, and quickly became the favored field collecting technique for aspiring marine naturalists. As one British naturalist wrote in 1849, “among the amusements of the sea-shore there is, perhaps, none so capable of yielding a varied pleasure to a person whose taste for Natural History is awakened, as dredging, where it

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<sup>25</sup> Charles Wyville Thomson, *The Depths of the Sea [...]*, (London: Macmillan and Co., 1874), [2<sup>nd</sup> Edition], 49.

<sup>26</sup> Robert Louis Stevenson, “Records of a Family of Engineers,” *Letters and Miscellanies of Robert Louis Stevenson*, (New York: Charles Scribner’s Sons, 1896), 265.

can be carried on under favourable circumstances.”<sup>27</sup> But, while shallow coastal dredging was relatively easy to do, deep-water dredging remained a difficult undertaking. Deep sea dredging, unlike coastal, shallow-water dredging done by rowboat, required a much larger ship.<sup>28</sup> Still, scientists such as Edward Forbes extended the technique to ever – greater depths.

*Edward Forbes (1815 - 1854) and the Dredge: Scientists Turn to the Sea:*

In his classic 1923 history of marine science, the oceanographer William Herdman devoted his first chapter to the life and work of the Manxman Edward Forbes.<sup>29</sup> Though a foundational work, Herdman’s account of marine science was decidedly Anglo-centric. Adopting a more inclusive perspective, Forbes’ work can be read as evidence of a larger movement reshaping European science during his lifetime.<sup>30</sup> It is worth examining Forbes’ work in brief as a prologue to this dissertation because it exemplifies a larger scientific reorientation to the oceans occurring in the early and mid-nineteenth century and provides important context for the period in which this dissertation begins.

Born in 1815, surrounded by ocean on the Isle of Man, Forbes spent much of his youth studying a wide diversity of subjects. His studies included forays into art, medicine, botany, and geology. He also travelled widely, visiting Ireland, France,

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<sup>27</sup> W. H. Harvey, *The Sea-Side Book: Being an Introduction to the Natural History of the British Coasts*, (London: John Van Voorst, Paternoster Row, 1849), 116.

<sup>28</sup> The deeper the dredge descended, the stronger and heavier the attached rope needed to be. And, because dredging scooped up mud and stone along with marine life, the heavier the equipment, the more difficult it was to recover samples.

<sup>29</sup> William A. Herdman, *Founders of Oceanography and Their Work: An Introduction to the Science of the Sea*, (London: Edward Arnold & Co., 1923).

<sup>30</sup> For instance, the French scientist Georges Aimé (1813 – 1846) retrieved animals from a depth of up to 1800 meters while working off the coast of Algeria in the early 1940s. Margaret Deacon, *Scientists and the Sea*, 282.

Algeria, and Norway. Yet, he remained fascinated by the study of the ocean. As he later wrote, “there is no finer field for discovery in natural history, than that presented by the bed of the ocean [...] The difficulties which attend the inquiry add to the zest of the research[.]”<sup>31</sup> Taking up the challenge of uncovering the mysteries of the marine environment, Edward Forbes set out to master the work of dredging, and he quickly became an expert. In a letter written in 1851, Charles Darwin described Forbes as knowing, “more about dredging than all the other naturalists in Europe put together.”<sup>32</sup>

An outspoken promoter for the use of dredges for scientific work, Forbes persuaded the British Association for the Advancement of Science to form a “dredging committee” in 1839. This committee, which included Forbes, oversaw a coordinated effort to investigate marine life in the seas surrounding Great Britain. They produced what became known as “dredging papers,” blank forms on which naturalists could note the time and place dredging was undertaken, and the organisms recovered. In this way, data gathered through dredging work could be recorded and aggregated. Forbes also organized classes in marine biology for students, which included practical training in the work of dredging.<sup>33</sup>

The success of these efforts encouraged the Association to fund dredging expeditions further afield. As luck would have it, an opportunity arose in 1841 when Edward Forbes was offered a berth on the *H.M.S. Beacon* on a survey expedition to the Aegean. Forbes spent the next year and half conducting dredging surveys in the

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<sup>31</sup> Edward Forbes, *The Natural History of the European Seas*, (London: John Van Voorst, Paternoster Row, 1859), 10.

<sup>32</sup> Charles Darwin to J. S. Disnurr, 13 June 1851. *The Darwin Project*. [Accessed online 15 October 2014], <http://www.darwinproject.ac.uk/letter/entry-1436>.

<sup>33</sup> Philip Rehbock, “The Early Dredgers: “Naturalizing” in British Seas, 1830 - 1850,” *Journal of the History of Biology*, Vol. 12, No. 2, (1979), 328.

Mediterranean. It was the most extensive dredging survey ever undertaken at the time. From this field experience Forbes became increasingly interested in mapping the distribution of marine life. He realized that depth was an important factor in determining the distribution of species and he developed a new system for classifying the regions of depth from which organisms were recovered. Based on his findings in the Aegean, Forbes designated eight zones in which marine life could be found. These were not static areas, rather, Forbes believed that each was the “scene of incessant change” continually reshaped by fluctuations in marine organism populations and shifting geological processes.<sup>34</sup>

The Aegean report, however, included a critical flaw. Forbes observed that fewer organisms were recovered at greater depths and based on this observation he hypothesized that a zone with “zero animal life” “probably” existed below 300 fathoms. This he named the azoic zone. As historian Philip Rehbock has argued, “none of Forbes’ generalizations was hazarded with so little fanfare and had such far-reaching influence[.]”<sup>35</sup> The Azoic Theory would dominate discussions of marine life distribution for the next decade.

It would be mistaken to imagine that Forbes had recklessly developed his hypothesis without considering the evidence available to him. He had observed, for instance, that marine plants could not grow at depths where light no longer penetrated. He also observed sedimentary deposits on land lacking fossils, concluding that these layers “might have been formed in the very deep sea” where life was not prolific.<sup>36</sup>

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<sup>34</sup> Ibid., 332.

<sup>35</sup> Ibid., 349.

<sup>36</sup> Ibid.

Unknowingly, Forbes had also been dredging in one of the most oligotrophic regions of the Mediterranean – an area poor in nutrients and thus low in biodiversity. Perhaps most consequentially, he had been hindered by the technological limitations of the dredge itself, which could not easily reach below 300 fathoms.

The Azoic Theory seemed entirely logical. How could life exist in darkness, extreme cold, and under great pressure? Thus, the theory became widely accepted as scientific fact. Only years later did increasing evidence begin to surface that brought into question the Azoic Hypothesis. In 1860 a marine telegraph cable laid in the Mediterranean at a depth of 1200 fathoms broke. When the cable was recovered, naturalists were astonished to find it crusted in marine life. It was only then that Forbes' Azoic Theory was finally shattered.<sup>37</sup> Unfortunately, Forbes did not live to see this discovery. He succumbed to illness and died at the age of 39 in 1854. Yet, over the course of his short life he had helped change the way that naturalists understood the distribution of life in the oceans and, most importantly, he had inspired a new generation of naturalists to investigate the mysteries of the sea. The stage was set for an ever-expanding scientific investigation of the oceans.

Parallel developments were also taking place on the other side of the Atlantic. However, in the United States the primary the principle promoter of marine research was the State. With maritime commercial interests at stake, the government created two agencies tasked surveying and charting coastal water. The first was the United States

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<sup>37</sup> It should be noted that the publication of Darwin's *On the Origin of Species* in 1859 also helped to stimulate interest in the deep-sea biota. Further evidence refuting the Azoic theory was gathered by the *Lightening* expedition in 1868. Jennifer Hubbard, *A Science on the Scales: The Rise of Canadian Atlantic Fisheries Biology, 1898 -1939*, (Toronto: University of Toronto Press, 2006), 20.

Coast Survey established in 1807; this was followed by the Depot of Charts and Instruments – a branch of the United States Navy – in 1830. By 1840 both agencies had integrated measurements of currents, temperature, salinity, and bottom composition into their regular work of sounding and charting.<sup>38</sup> Much of the work of these organizations dealt with the study of the Gulf Stream, of vital importance for maritime commerce. However, other research efforts took place much further afield, the most important being the scientific research and collection carried out under the auspices of the United States Exploring Expedition (1838 – 1842) under the command of naval lieutenant, and head of the Depot of Charts and Instruments, Charles Wilkes.<sup>39</sup> Biological research was only institutionalized with the creation of the U.S. Fish Commission in 1871.<sup>40</sup> An Act of Congress in 1886 established the Hydrographic Office, a division of the Bureau of Navigation which, alongside the Coast Guard and U.S. Maritime commission, supplied navigational charts and coordinated the collection of oceanographic and hydrographic data.<sup>41</sup> Thus, by the end of the nineteenth century, state-supported branches of government fostered a broad range of marine research programs.<sup>42</sup>

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<sup>38</sup> Susan Schlee, *The Edge of An Unfamiliar World: A History of Oceanography*, (New York: E. P. Dutton & Co., 1973), 23 – 24.

<sup>39</sup> Antony Adler, “From the Pacific to the Patent Office: The U.S. Exploring Expedition and the Origins of America’s First National Museum,” *The Journal of the History of Collections*, Vol.23, No.1, (2011), 49 – 74.

<sup>40</sup> Susan Schlee, *The Edge of An Unfamiliar World*, 67.

<sup>41</sup> Kathleen Broome Williams, “From Civilian Planktonologist to Navy Oceanographer: Mary Sears in World War II,” *The Machine in Neptune’s Garden: Historical Perspectives on Technology and the Marine Environment*, ed. by Helen Rozwadowski and David K. van Keuren, (Sagamore Beach, Mass.: Science History Publications, 2004), 253.

<sup>42</sup> It should be noted that naval patronage for marine science in the United States dates back to the late nineteenth century. With the onset of WWI in the early twentieth century, the Navy began sponsoring research in marine acoustics, a field which required important oceanographic consideration such as temperature and salinity variations. This work

By the second half of the nineteenth century a transnational network of naturalists with a shared interest in the study of marine life was in place. The scientific work of probing the marine environment was also becoming more standardized; the dredge was now a scientific instrument rather than a fishing tool. With this framework in place, naturalists studying the marine environment could hope to expand the range and capability of their investigations at sea.

*Chapter Overview:*

In order to tell the story of how ever-larger spans of the marine-scape became legitimate spaces for scientific fieldwork, I begin in Chapter One by discussing the state of the field sciences in the early nineteenth century. While marine science is not the primary focus of this chapter, the history of the first voyager naturalists provides an important starting point for a discussion of the history of science in the field. This was a period in European history often described as the “Age of Exploration,” when – with important technological barriers to global exploration finally overcome – travel both to and from remote locals was finally possible.<sup>43</sup> Still, a naturalist who wanted to gather information about the natural world would have to risk life and limb in order to gather transportable collections of specimens. If he survived the hazardous voyage by ship or over land, it was still likely that he would succumb to disease or malnutrition once he

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continued throughout the nineteen twenties in the Naval Research Laboratory under the direction of Harvey C. Hayes (1878 – 1968), and became a matter critical to Naval strategy with the onset of WWII. Ronald Rainger, “Science at the Crossroads: The Navy, Bikini Atoll, and American Oceanography in the 1940s,” *Historical Studies in the Physical and Biological Sciences*, Vol. 30, No. 2, (2000), 350 – 355.

<sup>43</sup> John Harrison received the prize for solving the problem of longitude at sea in 1773, a discovery that dramatically facilitated navigation in the open ocean, however, the term “Age of Exploration,” is generally used to describe the period between ca. 1500 and 1800. Gilbert F. LaFrenière, *The Decline of Nature: Environmental History and the Western Worldview*, (Palo Alto, CA: Academica Press, 2008), 201.

arrived at his destination. Were he fortunate enough to survive, it was still highly likely that the collections he assembled in the field would arrive moth-eaten or disarticulated. Even if all went as planned, and the naturalist and his collections arrived home safely, it was still possible that his hard work would be dismissed by established armchair naturalists who considered scientific analysis conducted in the field illegitimate, or sought to capitalize on the work of field collectors while maintaining their own hierarchical place in the scientific ranks of metropolitan centers.

Because fieldwork does not allow the luxury of exclusion provided by the metropolitan laboratory, it is likely to require the assemblage and cooperation of a large number of people who would normally be separated by social differences. And, as this chapter demonstrates, the social division between the “field” collector and the metropolitan naturalist was often stark. The first voyager naturalists can, therefore, best be understood as “invisible technicians” gathering information in the field but effaced from the final scientific product. Yet, as field sciences gained scientific legitimacy this division of status and labor began to shift; as I show in Chapter Two, devoted to the development of French coastal marine stations.

Histories of the marine sciences in the late 19<sup>th</sup> and early 20<sup>th</sup> centuries often ignore developments in France, focusing instead on the oceanographic expeditions carried out by England and the United States. With regard to coastal marine biology and the development of marine biological stations, however, France was at the forefront. Preeminent among the French marine stations were the laboratories of Roscoff and Arago. In order to understand why these stations succeeded we must first and foremost consider questions of place and space. What were the geographical criteria for the

establishment marine stations? What types of scientific spaces were created in these places? Moreover, how did place and space shape the scientific work produced? This chapter examines these questions and seeks to answer a third: why did marine biology succeed in France while expeditionary oceanography did not? To answer this larger question I explore the connection between marine biology and efforts in France during the late nineteenth century to centralize scientific instruction and data collection. I argue that French marine stations were liminal spaces, providing naturalists access to different types of natural environments. They also permitted scientists, students, and workers of different status and background, the opportunity to collaborate. While the French government did not support large-scale oceanographic ventures, marine stations were successful at garnering support because they aided local fisheries and embodied a democratized vision of science: one that connected national glory with broad access to education. An examination of the French marine stations reveals the importance of institutional networks for the diffusion of scientific practice and the promotion of some fields of study over others. Thus, the explosion of marine stations during this period helps to explain the rise of coastal marine zoology in France and the comparative absence of research in physical oceanography. This institutional context, and the scientific culture it fostered would have long-term ramifications for the development of the marine sciences in France where shallow-water research took precedence over state-sponsored deep-sea expeditions.

After examining the hybrid lab-field boundary of the French marine station network, Chapter Three brings our attention back to the metropole, to Paris and Monaco. In a departure from the spatial focus of the preceding chapter, here I employ a

biographical approach to examine the life and work of one of the most influential figures of late nineteenth-century oceanography, Prince Albert I of Monaco. Prince Albert, who once described himself as uniting in one mind “ideas and will,” is a towering figure in the early history of oceanography. Yet, his unique position as both a scientist and head of state poses several historiographical challenges. Because of his elite status, much of the surviving secondary literature is extremely polarized in its portrayal of Albert, though it does provide much useful information about his life and work. Scientists lionized the Prince for his contributions to the emerging science of oceanography and, perhaps most importantly, for his work as a scientific patron. Yet, Albert was also subjected to frequent mockery, as his small principality’s reliance on gambling revenue was an easy target for moralizing condemnation by the popular press. This chapter attempts to navigate these two extremes and evaluate the true extent of Prince Albert’s contribution to the development of marine science. Building on the work of Jacqueline Carpine-Lancre and Eric Mills, I argue that Prince Albert I<sup>st</sup> must be included in any account of the development of the marine sciences primarily because his efforts to meld oceanographic work with political internationalism helped forge transnational cooperative programs in marine science that extended beyond the realm of fisheries. Furthermore, Prince Albert’s institutions, the oceanographic museum at Monaco and the Oceanographic Institute in Paris, helped bolster the French marine science program in the absence of French government support, and melded physical and biological research under a humanist program for marine research. This chapter also revisits a central theme of my dissertation: a technological attention to the importance of ships as mobile laboratories. Prince Albert I<sup>st</sup> constructed a series of yachts specially designed for oceanographic work. These ships,

at a time when most state-sponsored expeditions still employed modified naval vessels, set an important precedent for the design of oceanographic research vessels in the early twentieth century.

The biographical approach is useful because it reveals both the opportunities and restrictions that certain social networks impose on the diffusion of scientific programs and ideas. As Eric Mills has already shown, the patron client relationship between Prince Albert and Julien Thoulet was ultimately too weak to promote a physical oceanography program in France. But, Albert's own social network, defined by his position as a regal head of state was crucial for the transnational promotion of oceanographic work. The dependence of Albert's oceanographic program on his own dynastic lineage proved, however, to be its greatest weakness. Albert sought to offset this difficulty by creating endowed scientific institutions, but the down-scaling of their scientific output in the aftermath of his death (and in the wake of World War I) reveals the inherent flaw in a program dependant upon "ideas," "will," and "means" united in only a single individual.

As the twentieth century went on, oceanography in particular came to be associated with aspirations for cooperative international endeavor. A key feature of late nineteenth-century scientific rhetoric on the topic of oceanography was a focus on its usefulness for the promotion of international cooperation. While some programs for international cooperation were achieved in the period leading up to World War I – notably the International Council for the Exploration of the Seas – large-scale scientific internationalism in marine science only gained considerable headway during the interwar period. Several historians have acknowledged the importance of internationalism in marine science in the post-World War II period, notably Gary Weir and Jacob Darwin

Hamblin.<sup>44</sup> Chapter Four helps push this narrative back in time to show how scientific internationalism during the interwar period established practices and ideology which would later re-emerge during the Cold War.

Historians of oceanography have argued that the need for international cooperation in marine science derives from the geographical scale of the field under study. The world's oceans encompass a territory extending beyond the claims of any single nation. However, achieving internationalism in the marine sciences was a lengthy process. There is a sharp contrast between the State-sponsored, nationalist expeditions of the late-eighteenth and early nineteenth-century voyages of exploration and the collaborative oceanographic ventures of the late twentieth century.

This chapter demonstrates the importance of scientific internationalism for the making of an imagined "Pacific World" in the early twentieth century. In a recently published essay, entitled "Finding the Pacific World," Katrina Gulliver asserts that, "whereas the Atlantic World was born of slavery, the Pacific World was born of science."<sup>45</sup> Her claim suggests that we reexamine the structure of the Pacific World by

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<sup>44</sup> As Jacob Hamblin writes, in the first decades after World War II, "support for [oceanographic] research was based on its usefulness for making war on other nations. At the same time oceanography retained an identity that tied it closely to international cooperation[.]" Jacob Hamblin, *Oceanographers and the Cold War: Disciples of Marine Science*, (Seattle: University of Washington Press, 2005), xviii. See also Gary Weir, *An Ocean in Common: American Naval Officers, Scientists, and the Ocean Environment*, (Texas A & M University Press, 2001).

<sup>45</sup> Katrina Gulliver, "Finding the Pacific World," in *Journal of World History*, (March 2011), 89. There does seem to be a consensus among historians that it was slavery that anchored networks of trade in the Atlantic. For example, James Delbourgo and Nicholas Dew argue that "the Atlantic constitutes a 'logical unit of analysis' because of its specific history of interactions between Amerindians, Africans, and Europeans through varieties of triangular trade – above all the slave trade – that transforms the culture and economy of each continent," James Delbourgo and Nicholas Dew, "Introduction: The Far Side of

studying the history of the Pacific region through the lens of the history of science. I argue that the history of oceanography, both as a science of the ocean, and one that has often relied on international cooperation, is best suited for the task of tracing the ways in which science shaped the “Pacific World.”<sup>46</sup>

The rhetoric of science, in conjunction with the internationalist movement during the interwar period, played a crucial role in shaping how the Pacific was imagined and described by inhabitants of the Pacific region and by scientists who sought to conduct systematic, large-scale, research in the Pacific basin. This vision was embodied by two international exhibitions: the 1939 Golden Gate International Exposition in San Francisco, and the 1962 Seattle World’s Fair.

In the aftermath of World War I, the Pacific Ocean seemed to promise a new terrain for international scientific collaboration - particularly with respect to the marine sciences. The dream of an internationalist program for the marine sciences suffered a major blow with the beginning of World War II. Nevertheless, while the Second World War helped institutionalize military patronage for science in the Pacific, internationalism remained an important component of science carried out on an ocean-wide scale, and internationalist rhetoric an integral component of popular science presentations meant to bolster public support for Cold War era “Big Science.”

With the preceding narrative as background, Chapter Five focuses on the technological innovations that have facilitated scientific work at sea. Expanding upon the

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the Ocean,” *Science and Empire in the Atlantic World*, ed. by James Delbourgo and Nicholas Dew (New York: Routledge, 2008), 8.

<sup>46</sup> As Jacob Hamblin explains, “[t]he lack of national borders at sea, the indiscriminately hostile environmental conditions, and the global scope of observations have long lent oceanography the reputation of being an inherently international endeavor.” Jacob Darwin Hamblin, *Oceanographers and the Cold War*, xix.

model of vessels of exploration as scientific instruments first proposed by Richard Sorrenson, this essay examines the changing nature of the ship as scientific space on expedition vessels during the late nineteenth century. Particular attention is paid to the expedition of *H.M.S. Challenger* (1872–1876) as a turning point in the design of shipboard spaces that established a place for scientists at sea and gave scientific legitimacy to the new science of oceanography. There was a progressive development in research vessel design from “ship as instrument” to “ship as laboratory” and changing spatial practices aboard these vessels were paralleled by changes in shipboard culture. I suggest that the “ship as laboratory” has now in turn been supplanted by a new model, the “ship as invisible technician,” as oceanographic research vessels deploy remote-sensing equipment and gather data that are no longer analyzed on board.

With respect to technological capability, the experience of a nineteenth-century naturalist in the field is very different for the experience of an oceanographer in the present day. In my conclusion, I explore the many ways in which the boundary between field and laboratory has blurred in contemporary marine science. Oceanographers now use fiber optic cables, remotely operated vehicles, and satellites to observe natural phenomena in marine environments in which man could not survive for more than an instant. So what, then, are the points of continuity between the voyager naturalists of the early nineteenth century and the marine fieldworkers of the present?

Here I re-examine the lab/field boundary, as identified by Robert Kohler, and ask whether this historical model can be made applicable to present-day oceanographic field science. I argue that while technological innovations have rendered the boundary between field and lab increasingly porous, oceanographers of the present share with their

predecessors, the fieldworkers of the early nineteenth century, a desire to transform the natural world – the field – into a legitimate space for scientific experimentation and analysis. Over the course of this study we will see the many challenges naturalists encountered as they sought to transform the ocean into a laboratory environment. If, in the present day, the oceans have been transformed into laboratories, it is but confirmation that Kohler’s model can, and should, be applied to interpretations of scientific practice in the marine environment.

## Chapter 1:

### The First Fieldworkers: The Voyager-naturalists of the Muséum d'Histoire Naturelle (1818 – 1900)

#### *Introduction:*

One of Balzac's lesser-known novellas, *Z. Marcas*, published in 1840 but set in the early 1830s, describes the plight of a generation of poor, but well-educated, young French men. In the wake of the French Revolution, when the old guild-system was abolished, recruitment limitations were also removed for schools of medicine and law. This broad access to higher education flooded the job market with doctors and lawyers, and soon many found themselves qualified but unemployed. The only solution for many was to leave France. As the fictional narrator describes his circumstances, and that of his friend, Juste:

[We] could not see any room for us in the two professions our parents wished us to take up. There are a hundred doctors, a hundred lawyers, for one that is wanted. The crowd is choking these two paths which are supposed to lead to fortune[.] [...] His parent wished him to be a doctor. But if he were a doctor, must he not wait twenty years for a practice? [...] Well, he is a doctor; but he left France, he is in Asia. At this moment he is perhaps sinking under fatigue in a desert, or dying of the lashes of a barbarous horde – or perhaps he is some Indian prince's prime minister. [...] I acquired the knowledge needed for a sailor. [...] [I] keep out of France, where men waste, in the struggle to make way, the energy needed for the noblest works. Follow my example, friends; I am going where a man steers his destiny as he please.<sup>47</sup>

As portrayed in Balzac's novella, these young but skilled laborers believed the path to a successful career might only be found abroad. Outside of France, presumably in one of the French colonial territories, there was possibility employment and even distinction.

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<sup>47</sup> Honoré de Balzac, *Z. Marcas*, (1840). E-book, translated by Clara Bell. [Accessed online, 4 November 2014.] <http://www.gutenberg.org/files/1841/1841-h/1841-h.htm>

Honor gained abroad was important because it offered the possibility of return to France. But to voyage abroad was costly and dangerous.

One way to gain distinction abroad (and finance travel) was to make a contribution to the study of natural history. In the early nineteenth century it was still possible to accomplish this feat simply by collecting, preserving, and naming natural history specimens recovered abroad. Thus, finding themselves barred from their chosen professions, many young men turned to the work of natural history in the hope of making a name for themselves. Established naturalists, already holding comfortable positions in metropolitan scientific institutions, were happy to recruit them.

This chapter tells the story of these young men: the voyager-naturalists. For while their work was not specifically constrained to marine science, it is with them that the history of biological fieldwork began; and it is only with their legacy in mind that the discussion of marine biological fieldwork which follows in later chapters can be understood. The voyager-naturalists brought scientific practices of collection and observation into “uncharted” nature. They found themselves forced to acculturate to new social worlds, and survive in inhospitable environments. Confronted by these difficulties, they adapted, reframing the presentation of their work, and innovating new methods for carrying out their observations. Gradually, largely as a result of their efforts, science carried out *in the field* became a legitimated form of scientific practice.

*The Setting:*

On the left bank of the Seine, in the fifth arrondissement, lies the *Jardin des Plantes*. Today many of the older buildings appear dusty and decayed, their galleries sparsely visited, and upon peering into the exhibit cases, a visitor can still see collections

of pickled specimens with ancient hand written labels. During the 19<sup>th</sup> century, however, the *Muséum d'Histoire Naturelle*, as these buildings of the *Jardin des Plantes* are collectively known, was one of the most important scientific institutions in the world. In part, the *Muséum* earned this reputation by assembling a vast collection of objects and specimens from the furthest reaches of the earth. The administrators of the *Muséum* accomplished this feat by sending young men into the field with specific instructions detailing where they were to go and what they were to collect. These travelers carried the title of “voyageur-naturalist” of the *Muséum*, a title they earned by graduating from the *école de voyageurs-naturalistes*, located in the *Jardin* and organized by the *Muséum* administrators. The voyageur-naturalists who were shaped by the *école* participated in a new division of labor in the production of Natural History at the *Muséum*. This chapter explores why their position was created. It will also examine how the *Muséum* managed this work force throughout the 19<sup>th</sup> century. In so doing, I hope to form a portrait of a complex social landscape, in which multiple actors competed and cooperated in new ways to produce scientific knowledge.

The organization of work involved in the production of natural history knowledge in France changed dramatically during the 19<sup>th</sup> century. Disciplines of study became more formally separated and, within the institutional setting of the National Museum of Natural History, there was an increased departmentalization of activity. This shift in the organization of scientific work has been attributed both to changes brought about by the rise of European industrialization and to colonial expansion.<sup>48</sup> However, for a thorough

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<sup>48</sup> For the colonial expansion argument see, for example, the work of Christophe Bonneuil who writes: “European expansion enabled thousands of people who practiced botany to do so overseas in remote settings. These agents of empire [...] had their own

understanding of this transformation, we must examine in detail why the French scientific elite aspired to shape the divisions of scientific labor in new ways, and how they tried to institutionalize these changes during the course of the nineteenth-century. In this paper I show that the French scientific elite, from the early nineteenth-century on, gave broad training but delegated very limited authority to the assistants they engaged to carry out minutely specified collecting activities. This was particularly the case for the field collectors with whom they competed for the honor of first discovery and for ownership over the production of new knowledge. By the late nineteenth-century, industrialization provided a model of the specialized worker - one whose activity could be limited and disciplined following the hierarchical model of the factory system. The French scientific elite adopted this model of the factory worker in order to justify and implement the specialization and organizational subordination of their assistants, and to place limits on the personal authority and honor won by their efforts. This essay will trace this development as it shaped the work of the field collectors of the *Muséum d'Histoire Naturelle* in Paris, the *voyageurs-naturalistes*.

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agenda. Few of them were ready to use the Latin and were easy to bend to the discipline of a division of labour between collectors and armchair professional systematists.” Christophe Bonneuil, “The Manufacture of Species: Kew Gardens, the Empire, and the Standardisation of Taxonomic Practices in Late Nineteenth-Century Botany,” *Instruments, Travel, and Science: Itineraries of Precision from the Seventeenth to the twentieth Century*, ed. by Marie-Noëlle Bourguet, Christian Licoppe and H. Otto Sibum, (New York: Routledge, 2002), 191. See also Christophe Bonneuil, “Le Muséum National d’Histoire Naturelle et l’Expansion Coloniale de la Troisième République (1870 – 1914),” *Revue Française d’Histoire d’Outre-mer*, Vol. 86, No. 322 – 323, (1999), 143 – 169. For the industrialization argument see for example the work of Peter Galison who writes: “For the French ever since Napoleon, the ambition had been to educate an elite in high mathematics that would be (in due time) able to meet the demands of the practical world they would control.” Peter Galison, *Einstein’s Clocks, Poincaré’s Maps: Empires of Time*, (New York: W. W. Norton & Company, 2003), 228.

*The First Voyager-Naturalists:*

Among the ancient manila folders in the archives of the *Muséum D'Histoire Naturelle* in Paris is was one on which is penciled the heading “Dr. Jullien.” Enclosed are the letters and notes of one nineteenth-century “voyager-naturalist.” Dr. Jullien, I learned, had been sent to Indochina in 1873 – the region of South-East Asia that would soon become a colony of the French empire under the French Third Republic. Jullien had volunteered his services to the museum as a travelling collector. “Everywhere I am given an excellent welcome” he assured the *Muséum* professors in a letter sent from Saigon, dated October 29<sup>th</sup> 1873; “I do not doubt that the harvest will be abundant, if God grants me life and doesn’t make me too ill[.]” Shortly after sending that letter, however, he became deathly ill, his intended itinerary to Tonkin (Vietnam) was postponed indefinitely because of trouble with “rebels,” and upon finally returning to France, he was in such an ill state of health that his wife was forced to write to the *Muséum* on his behalf. Finally, at the very back of the folder, I found a fifteen-page hand-written pamphlet titled “Report addressed to *Monsieur* the director of the *Jardin des Plantes* of Paris, on the voyage to Indochina by the doctor J. Jullien during the years 1873 and 1874.” The pamphlet, which describes Jullien’s efforts to gather a collection of natural history specimens, thanks the assembly of professors for the “considerable honor” of having placed their “trust and hopes” with him. That trust alone, Jullien wrote, had been “his consolation during his worst days,” as was “the satisfaction of having given to [his] country one more proof of his devotion.”<sup>49</sup>

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<sup>49</sup> Archive folder AM631 – (voyageur – naturalist correspondence) – *Muséum d'Histoire Naturelle*, Paris, France.

There were hundreds, if not thousands of men who, like Dr. Jullien, set out from European centers to gather scientific information on the peripheries of Empire. Most left little record of their voyages, their sagas largely omitted from histories of science or colonial expansion. However, it is precisely because there were so many men like Dr. Jullien – anonymous explorers who understood expeditionary science as a means of showing patriotic devotion – that we cannot dismiss their role, or that of the scientific institutions with which they were affiliated, from the history of science in the field.

The experience of one of the first voyager-naturalists, a man named Auguste Plée, serves as a case study example for the work of this group. On the first of June 1819, Auguste Plée, having passed written and oral examinations, acquired the official title of “*voyageur-naturaliste*” and received mission orders from the *Muséum*. He was 33 years old. After years of financial struggle, the commission finally offered economic support, and the opportunity to pursue a long-held interest in natural history.<sup>50</sup>

Plée’s introduction to natural history, and to some of the crafts associated with its pursuit came through a family connection. (As with other nineteenth-century occupations, kinship ties are often visible in the organization of the work force in the *Jardin des Plantes*.) His uncle worked as an engraver at the *Jardin des Plantes*. Along with his cousin François, Plée became an apprentice in his uncle’s workshop where he quickly became interested in the study of botany. Yet at the age of twenty he was to find his first employment not at the *Jardin*, but in a commercial printing house. This transition to a

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<sup>50</sup> The life and travels of Auguste Plée have been documented by Françoise Thésée. My account of Plée is adapted from her work. See Françoise Thésée, *Auguste Plée 1786 – 1825 Un Voyageur Naturaliste: Ses Traveaux et Ses Tribulations aux Antilles, au Canada, en Colombie*, (Paris: Editions Caribéennes, 1989) for a much more detailed account of Plée’s mission to America and the Caribbean.

non-scientific job did little to dampen his enthusiasm for natural history, however. During his free time Plée enrolled in instructional courses at the *Muséum d'Histoire Naturelle* and the *École de Médecine*. In the course of his studies, Plée formed a close bond with the botanist Antoine-Laurent de Jussieu, assisting him with his work at the *Muséum*. Under the guidance of this mentor, and in collaboration with his cousin Francois, Plée produced a series of botanical guides, at his own expense, for the use of amateur naturalists in the Paris region. His text *Herborisations artificielles aux environs de Paris*, printed in the workshop of his uncle, begins with a dedication to Jussieu dated July 20<sup>th</sup>, 1811:

Sir, The interest that you take in all those who study science, which you have enriched with so many useful discoveries, has led you to kindly accept the dedication of our work: it was the best means of obligating ourselves to do it well: We will try to merit more and more this honorable mark of your benevolence.<sup>51</sup>

At this time Plée was having financial difficulties. His wife was expecting a second child, the first having died in infancy, and the income he earned through his work at the printing house and from the publication of his family's botanical pamphlets was proving insufficient. In 1812 he published a second text, *Le Jeune Botaniste: Entretien d'un Père Avec Son Fils sur la Physiologie Végétale*, intended as an introductory guide to botany for children. Though to Jussieu he expressed an interest in continuing to develop botanical texts, the publication of his pamphlets did little to alleviate Plée's financial problems. 1814 brought the fall of Napoleon and the return of the monarchy with the reign of Louis XVIII. Plée took on several administrative duties in support of the new regime, including working as secretary to the Secretary General. For his efforts he was

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<sup>51</sup> Auguste Plée and François Plée, *Herborisations artificielles aux environs de Paris*, (Paris: Printed by the authors, 1811), inside cover.

rewarded with the title “Inspector of Games,” in September of 1814. Yet, he found his job unpleasant, writing to his supervisor:

[W]hat was accorded me as a provisional compensation for services that I rendered to my country under difficult circumstances, has become for me a laborious occupation and frequently an object of disgust.<sup>52</sup>

In spite of his letter of complaint, Plée’s post was not terminated by his superiors, but was soon eliminated with the change of regime that followed upon Napoleon’s return from Elba in 1815. Once more Plée found himself unemployed and, on the 30<sup>th</sup> of June 1815, a father once again. Plée reappears in the historical record with the registration of the birth of a fourth child on the 19<sup>th</sup> of February 1818. His occupation is there listed as “former head of a division of the Paris Secretariat,” suggesting that he was still without an official post. Everything began to change for Plée, however, with the opening of the school for voyager-naturalists at the *Muséum d’Histoire Naturelle* that same month.

After successfully completing exams set by the school’s professors, Plée was certified for immediate commission and set out on his first mission assignment in 1819; it was also to be his last. Though he had expressed an interest in traveling to what is now Vietnam, the *Muséum* at first decided that he could better be used in the region near the Black Sea. Upon final consultation with the Ministry of the Interior, however, it was decided that his destination would be the Caribbean.<sup>53</sup> The Ministry of the Interior’s

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<sup>52</sup> Françoise Thésée, *Auguste Plée 1786 – 1825*, 20.

<sup>53</sup> Burkhardt has shown that the Black Sea was one of the destinations favored by the museum because it was thought to be an area likely to have plants that could be acclimatized in France. Though the State destination recommendations came through the Ministry of the Interior, Burkhardt suggests that the Ministry of the Marine played an equally important role in determining destinations. Voyagers were often dependant upon government ships for transport, and thus the interests and cooperation of the Navy was consequential. Richard Burkhardt Jr., “Naturalists’ Practices and Nature’s Empire,” *Pacific Science*, No. 4, Vol. 55, (2001), 332, 334.

mission objectives were different from those of the *Muséum*. The first graduates of the school received, in addition to the instructions given to them by the *Muséum* administration, a note from the Ministry of the Interior outlining their responsibility to the state. This note read: “Sir, you are in charge of a special mission on behalf of the French government, but during your voyage you will take notes on all that strikes your eye and might interest your country.” This general directive was followed by a series of particular questions to be addressed and a request that reports be sent back to Paris whenever possible.<sup>54</sup> Voyagers were thus made responsible for gathering reconnaissance information of potential interest to the state, and as is clear from this notice, in the eyes of the ministry, scientific research was not necessarily given precedence.

A letter addressed to the Professor-administrators of the *Muséum*, dated January 6<sup>th</sup>, 1820, and sent from Rochefort prior to Plée’s departure for the Americas, reveals the extent of the observations Plée feels charged to report, as well as his acute sense of his place in an organizational hierarchy.

I have taken the trouble to note the atmospheric constitution of Rochefort and the neighboring countryside to question the peasants on the nature of the soil, on their produce; to inform myself about the common diseases, to determine if some that are endemic, and what are their effects [...] I am daring, sirs and very honorable masters, to submit these reflections to you. If I had only to speak as Naturalist-voyager, and only to Naturalists infinitely more learned than I, I would guard myself from acting thus, but it is to observer philosophers that I address myself; and persuaded as I am that all that interests humanity is as much in their hearts as the science they teach, I do not worry that I will be blamed by them if my zeal, by elevating me awkwardly above my knowledge, has carried me into some errors of observation.<sup>55</sup>

Though the collections Plée gathered - of plants, minerals, insects, fish, reptiles, mollusks, and human artifacts - did find their way to the *Muséum*, he, like the other two

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<sup>54</sup> Françoise Thésée, *Auguste Plée 1786 – 1825*, 23.

<sup>55</sup> Françoise Thésée, *Auguste Plée 1786 – 1825*, 31.

voyagers who set out from Paris at the *Muséum*'s behest in 1818, and like many who followed in their footsteps, died before returning to France. He received little recognition for his work.<sup>56</sup> These men were not gentleman voyagers like Alexander Von Humboldt or Joseph Banks, wealthy enough to subsidize their travels in pursuit their own scientific interests. The graduates of the school for voyager-naturalists were a new type. They labored in distant parts of the world, their destinations determined by superiors who delegated the most dangerous part of the scientific work to them. Not only did their undertaking risk their lives and the welfare of their dependant families; it also removed them from the metropole. And it was in the institutional setting of the *Muséum* that professor-administrators, in negotiation with the ministries of the State, made decisions governing the fates of voyagers and of the collections they assembled.<sup>57</sup> Plée's plaintive letters from the field requesting additional funding and support for his dependants at home testify to the vulnerability inherent in distance from centers of decision-making.<sup>58</sup>

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<sup>56</sup> Auguste Plée was one of three voyagers selected for the first series of missions commissioned by the Ministry of the Interior. Félix-François Godefroy was sent to the Philippines where he was murdered seven weeks after arriving at the age of twenty-two, while Armand Étienne Maurice Havet succumbed to fever three and a half weeks after landing in Madagascar. Plée survived the longest, though he too died of sickness in Martinique in August 1825 after five years and five months of voyaging in the Americas. See Richard Burkhardt Jr., "Naturalists' Practices and Nature's Empire: Paris and the Platypus, 1815 – 1833," 334.

<sup>57</sup> Burkhardt provides the example of Diard, a voyager sent to the East Indies whose funding was cut off by the *Muséum* in 1826. According to Burkhardt, "this freed funds that were then employed to pay for a research trip to the Alps by the professor of Geology, another professor's research trip to Berlin, some financial assistance to Plée's widow, and the purchase price of two quaggas [...]" Richard Burkhardt Jr., "Naturalists' Practices and Nature's Empire: Paris and the Platypus, 1815 – 1833," 334.

<sup>58</sup> See Plée's letter from Fort-Royal, Martinique, and dated May 11<sup>th</sup>, 1820. Françoise Thésée, *Auguste Plée 1786 – 1825*, 46.

*The Jardin des Plantes as a Training Facility:*

The first three decades of the nineteenth-century have been referred to as the “Golden Age” of French natural history.<sup>59</sup> In the midst of the French Revolution, the Convention passed legislation on June 10<sup>th</sup> 1793 to establish the *Muséum d’Histoire Naturelle* in the *Jardin des Plantes* in Paris, formerly known as the *Jardin du Roi*. As part of the stipulation of this new ruling, the former king’s medicinal, zoological, and botanical gardens were now to serve the public as a teaching facility.<sup>60</sup> The *Muséum* soon became one of the most important scientific institutions of the nineteenth-century world, and the *Jardin* formally undertook the training of field naturalists with the creation, in 1819, of a state-sponsored school.<sup>61</sup> A team of professors interviewed twenty-nine

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<sup>59</sup> E. C. Spary, *Utopia’s Garden: French Natural History from the Old Regime to Revolution*, (Chicago: University of Chicago Press, 2000), 2.

<sup>60</sup> As Camille Limoges has suggested, the Jacobin founding of the *Muséum* had a great impact of the formation of its administrative structure. She writes: “created at a time of Jacobin supremacy, the *Muséum* long maintained a rather curious administrative structure, known as ‘the professor’s republic’ in the parlance of the day. It was in fact run as an autonomous body, managed by an assembly of professors, all formally equal. Soon to be designated ‘professor-administrators,’ each wielded almost absolute power over his own department and its ancillary services, and all shared in electing the *Muséum*’s director.” Camille Limoges, “The Development of the *Muséum d’Histoire Naturelle* of Paris, c. 1800 – 1914,” *The Organization of Science and Technology in France 1808 – 1914*, ed. by Robert Fox and George Weisz, (Cambridge: Cambridge University Press, 1980), 211. Limoges also describes the salaries of the professor-administrators as “the highest in the French educational system [...] the existence of a large support staff [...] created a situation where each professor ruled over his own tiny empire, populated to all intents and purposes by his personal staff of servitors. A professor was thus able to live in very comfortable circumstances, far beyond what his salary alone could sustain.” *Ibid.*, 215.

<sup>61</sup> Richard Burkhardt suggests that we can understand the 1819 founding of the school for naturalist voyagers as a response to opportunities opened by the defeat of Napoleon in 1815. Prior to the fall of Napoleon, the Napoleonic wars had made travel by sea too hazardous to risk sending voyagers on collecting missions. Another motivation, Burkhardt argues, was that with a change in state leadership the *Muséum* faculty needed to establish ties with the new regime. Richard Burkhardt Jr., “Naturalists’ Practices and Nature’s Empire: Paris and the Platypus, 1815 – 1833,” 327.

applicants, chose six for admission to the school, and identified three including Plée for immediate commission.<sup>62</sup>

The school was not so much intended to recruit workers who were otherwise unavailable, as it was to discipline and control a large number of individuals who were already eagerly seeking employment through the *Muséum*. Louis-Antoine de Bougainville's account of his voyage around the world had been published in 1797, the account of Jean-François Comte de La Pérouse was published in 1807, the account of Baudin's voyage to Australia had been published in 1807, and Alexander Von Humboldt's descriptions of Egypt and the Americas appeared between 1807 and 1810.<sup>63</sup> These accounts, glorifying state-sponsored science and exploration, had fired the public imagination, and a new generation of young adventurers was eager to set out on their own voyages of discovery, hopeful that their service would lead to professional positions, public honor, and intellectual recognition. The faculty of the *Muséum* was eager to harness this potential body of workers, but they had not yet determined how best to do so. As far as the *Muséum* professors were concerned, the work produced by voyagers could easily go to waste. To ensure that young naturalists in the field produced data useful to the *Muséum* professors, these workers had to be disciplined, their methods of collection standardized, their own analysis restricted, and the boundaries of their responsibilities firmly delineated. The school for voyager-naturalists was organized to that end.

The *Jardin des Plantes* was a site of negotiation between the French state and the professors of the *Muséum*, the elite of French science. Within the institutional setting of

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<sup>62</sup> Richard Burkhardt Jr., "Naturalists' Practices and Nature's Empire: Paris and the Platypus, 1815 – 1833," 333.

<sup>63</sup> Françoise Thésée, *Auguste Plée 1786 – 1825*, 13.

the *Muséum d'Histoire Naturelle*, the school for voyager-naturalists was the site where the professors of the *Muséum* and the Ministries of the State shared ownership over a workforce. State interest in mapping, resource exploitation, and intelligence gathering had to be negotiated with the *Muséum*'s professors, who sought to increase natural history knowledge while advancing their own scientific reputations. Rights of first discovery and questions of authority in the production of new knowledge had to be negotiated between the professors at the *Muséum* and the voyagers in the field.

The first historical study of the school was Yves Laissus' 1981 article, "Les Voyageurs Naturalistes du Jardin du Roi et du Museum d'Histoire Naturelle: Essai de Portrait –Robot".<sup>64</sup> Since then it has received relatively little attention; the only study in English can be found in an article published in 2001 by Richard W. Burkhardt Jr., who wrote "the story of the school for naturalist voyagers remains largely unexplored in the history of science and even in the more specialized history of French Naturalist voyages."<sup>65</sup> Burkhardt, examining the relationship between the newly formed Natural History Museum and the French State Government, gives the school for naturalist voyagers a central role. He explains: "Ministers of the Marine and the Interior wanted to use the museum's expertise in making colonies like Guiana and Senegal more habitable to French colonists and more profitable to France." While the professors of the *Muséum* accepted state funding, Burkhardt argues that this came at a price: the ministries had a

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<sup>64</sup> Yves Laissus, "Les Voyageurs Naturalistes du Jardin du Roi et du Museum d'Histoire Naturelle: Essai de Portrait –Robot," *Revue d'Histoire des Sciences*, No. 3, Vol. 34, (1981), 259 – 317.

<sup>65</sup> Richard Burkhardt Jr., "Naturalists' Practices and Nature's Empire: Paris and the Platypus, 1815 – 1833," 328.

large say over where voyagers would be sent.<sup>66</sup> Unsurprisingly, this resulted in a number of compromises though normally the decision made by the Ministry of the Interior prevailed.

Burkhardt's study does not aim to give detailed descriptions of the actions and motivations of individual participants, an omission he readily admits, explaining that he has "simply sketched out the major motivations and initiatives that were constitutive of the government's and the museum's efforts. The motives and perspectives of the voyagers or would-be voyagers are subject for another time."<sup>67</sup> In this paper I seek to examine the school at the *Jardin des Plantes* as a site of negotiations while taking into account the interests and motivations of the students and professors.<sup>68</sup>

*The Garden and the State - Collaborators in Field Science:*

The history of the founding of the *Jardin des Plantes* and the development of the *Muséum d'Histoire Naturelle* can be found elsewhere.<sup>69</sup> To sketch the most important

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<sup>66</sup> Richard Burkhardt Jr., "Naturalists' Practices and Nature's Empire," 333.

<sup>67</sup> Richard Burkhardt Jr., "Naturalists' Practices and Nature's Empire," 335.

<sup>68</sup> In their introduction to *Cultures of Natural History*, Nicholas Jardine and Emma Spary describe natural history as "the product of conglomerates of people, natural objects, institutions, collections, finances, all linked by a range of practices of different kinds." Nicholas Jardine, *Cultures of Natural History*, (Cambridge: Cambridge University Press, 1996), 8. Bruno Latour, in his discussion of actor-network theory, warns that the duty of the social scientist "is not to stabilize - whether at the beginning for clarity, for convenience, or to look reasonable - the list of groupings making up the social." Instead, he suggest that the investigator should look to "the controversies about which grouping one pertains to [...]" Bruno Latour, *Reassembling the Social: An Introduction to Actor-Network-Theory*, (Oxford: Oxford University Press, 2005), 29. Following Latour's lead, my aim is to examine the history of the voyager-naturalists in a complex social landscape where men doing sciences advanced and parried claims over the boundaries of appropriate research and authority.

<sup>69</sup> See for instance Rio Howard, "The Founding of the Jardin des Plantes in Paris," *Proceedings of the 2<sup>nd</sup> meeting of the Western Society for French History*, Nov 21 - 23, (1974). Also, W.H.G. Armytage, "The Jardin Du Roi: Seedbed Of Science," *The British*

developments: the gardens were founded as the king's medicinal garden in 1635, and known as the "Jardin Royal des Plantes Médicinales." In 1729 their name was changed to the *Jardin Royal des Plantes* and the gardens emerged as a research institution where naturalists conducted investigations in newly defined sub-disciplines of natural history. In 1793, after the Revolution, the gardens were renamed the *Muséum d'Histoire Naturelle* and their mandate redefined with reference to a public interest. It was during this period that the *Muséum* divided its staff into separate departments, such as zoology, anthropology, paleontology, and comparative anatomy.<sup>70</sup> A multitude of gardeners and laboratory assistants reported to the directors of these departments, who in turn were subordinate to the central director of the *Muséum*. With the Restoration in 1815, the institution was renamed *Muséum d'Histoire Naturelle au Jardin du Roi* by a government that sought to use it to promote activities beneficial to colonies neglected during the Napoleonic wars.<sup>71</sup>

From this time on the *Jardin des Plantes* became the focal point for the sudden increase of voyager-naturalists in nineteenth-century France. As Laissus notes, "the majority of French voyager-naturalists appear in its history, or at least in the inventory of its collections."<sup>72</sup> Voyager-naturalists of the nineteenth-century fell into two categories. The first, most favored by the professors of the *Muséum*, included men who had worked alongside the professors as disciples and assistants. These individuals shared their

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*Medical Journal*, Vol. 2, No. 5207 (22 Oct. 1960). And Camille Limoges, "Development of the Museum d'Histoire Naturelle."

<sup>70</sup> Lewis Pyeson and Susan Sheets-Pyeson, *Servants of Nature: A History of Scientific Institutions, Enterprises, and Sensibilities*, (New York: W.W. Norton & Company, 1999), 154.

<sup>71</sup> Françoise Thésée, *Auguste Plée 1786 – 1825*, 22.

<sup>72</sup> Yves Laissus, "Les Voyageurs Naturalistes du Jardin du Roi et du Museum d'Histoire Naturelle: Essai de Portrait – Robot," 261.

understanding of proper observation and collection techniques. The second category included administrators, military officials, and missionaries, among others - agents of colonial expansion who, with the exception of doctors, had little experience of the practices of natural history collecting. Members of the first category, driven by a desire to establish a name for themselves in the field as naturalists, hoped to secure later permanent positions in the metropole, provided, that is, that they survived their time in the field.<sup>73</sup> Fieldwork was a dangerous occupation, requiring a certain amount of youthful zeal, as it entailed facing risks of disease, hostile natives, wild animals, and the hazards of nineteenth-century transportation.

In several countries, the early the nineteenth-century was a period of increased state interest in the creation multi-disciplinary research institutions. As Dorinda Outram observes: “natural history was increasingly given the backing of major new state-funded and state-controlled institutions staffed by paid full-time expert researchers.”<sup>74</sup> The transition of the Jardin des Plantes from royal medical garden to a public research institution was part of this international trend.<sup>75</sup> The *Jardin* survived the upheavals of the revolutionary period and continued to adapt to changing demands of the state as French colonial power expanded and new commercial interests reshaped the social landscape.

The name *Muséum* may mislead the modern reader. The *Jardin des Plantes*, consisting of twenty acres of enclosed space, included public exhibit galleries, a research library, a zoo, botanical gardens, lecture halls, laboratories, and living quarters for

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<sup>73</sup> Christophe Bonneuil, “Le Muséum National d’Histoire Naturelle et l’Expansion Coloniale de la Troisième République (1870-1914),” 148.

<sup>74</sup> Dorinda Outram, “New Spaces in Natural History,” *Cultures of Natural History*, ed. by Nicholas Jardine, James Secord, and Emma Spary, (Cambridge: Cambridge University Press), 250.

<sup>75</sup> E. C. Spary, *Utopia's Garden*, 191.

naturalists and their families<sup>76</sup> It was a space both public and professional, one which sought to replicate the entire biodiversity of the known world in the heart of one Europe's most important urban centers. With the increasing importance of field collecting, the *Jardin des Plantes* became the space in which the exotic natural world gathered in the field could be ordered. It was the space where the voyages of the field collectors began and where the results of their voyages were supposed to end up.<sup>77</sup>

*The Muséum as Professional and Public Space:*

The public must have viewed the gardens as a park and as a treasure house of wonders. The publicizers of the museum framed the work carried out there as service conducive to the educational and spiritual elevation of the people. If the museum (one of the only scientific institutions to survive the revolution) was to endure the politically turbulent period of the early nineteenth-century, its continued existence had to be defended with reference to the public good.<sup>78</sup> The botanist and popular writer Pierre Boitard appealed to his readers to visit the gardens, writing:

Go then to visit the *Jardin du Roi*, enter into the new gallery of mineralogy that resembles in its dimensions the most vast cathedrals, take a look at the closets that contain fragments of all the mountains, sample from all the lands, minerals torn from the burning entrails of our globe. Examine the marvelous succession of layers that form the solid envelope of our planet and the diverse organized bodies that appear gradually, from the formless trilobite of the salt quarries to the fossilized mammals of the modern alluvial terrains. [...] You will understand finally that this nature, *rarum magna parans*, is not only a vain spectacle for

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<sup>76</sup> Nicholas Jardine, *Cultures of Natural History*, 250.

<sup>77</sup> My concern with the question of "space" in the museum context is derived from a reading of Outram, who remarks: "[L]ittle attention has been paid to the 'spaces' of science which lie outside the built environment, spaces like the public botanical and zoological gardens of the Muséum, or indeed the whole area of 'wild nature' into which its 'field' naturalists ventured to find specimens for examination by the experts in Paris. How did they see 'the wild' or 'the field'? [...] What were the interactions between these very different sorts of spaces?" Dorinda Outram, "New Spaces in Natural History," 253.

<sup>78</sup> E. C. Spary, *Utopia's garden*, 192.

curious people of leisure, but that it is worthy of our most fervent adorations, and you will be convinced that the study of beings elevates the soul, increases intelligence, and renders man more happy because she makes him better.<sup>79</sup>

Though Boitard's text implies a visitor would see one single narrative display collectively assembled in the galleries of the *Muséum*, this was not the case. *Muséum* professionals jockeying for academic recognition, competed with one another. This was even manifested in the scientific information the museum produced and presented to the public. Museum staff who were in disagreement over which classification scheme to use occasionally mounted specimens using their own preferred method without concern for the methods being used by others in the same building. This resulted in galleries organized using mutually incompatible systems of organization.<sup>80</sup>

One of the most important staff divisions in the *Muséum* was that between the *voyageurs-naturalists* who gathered most of the collections, and those entitled *philosophes*, the sedentary theorists.<sup>81</sup> We can interpret the *Muséum's* efforts to host training sessions for aspiring field naturalists as symptomatic of the emerging gulf between these two types. It was at this time that the museum published its first manual for field collectors: "Instructions for voyagers and for the employees in the colonies, on the manner of gathering, conserving, and packaging natural history objects." It was produced under the direction of the botanist André Thouin who had previously drawn up

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<sup>79</sup> Pierre Boitard and Janin, Jules, *Le Jardin des Plantes*, (Paris: J.J. DuRochet et Editeurs, 1842), xlvi.

<sup>80</sup> Nicholas Jardine, *Cultures of Natural History*, 257.

<sup>81</sup> Dorinda Outram, "New Spaces in Natural History," 259. Outram explains: "Field natural history was closely associated with a particular approach to nature, as well as with ideals of heroic, manly endeavour. Increasingly, however, field naturalists who theorized about the order of nature, or who conducted wide-ranging comparative research in taxonomy, physiology, or anatomy, usually within built environments, ceased to be the same people."

instructions for the voyage of La Pérouse.<sup>82</sup> These instructions, translated into English and Portuguese, were reprinted five times, the last edition in 1860.<sup>83</sup> While voyageur-naturalists are not referred to as a professional group (we are informed by the title that the instructions are intended for “voyagers” and “employees in the colonies,”) the text does clearly define the two interests most heavily invested in the accomplishment of this work, the museum and the state. The introduction reads:

His excellence the Minister of the Navy agreed to offer to Messrs. the professor administrators of the garden and the cabinet of the king, to employ the means in his power to augment the collection confided to their care. [The ministry] proposes to give orders to the heads of the colonies and to the commanders of state vessels so that they might procure in the diverse countries where they sojourn the objects which the museum lacks, and she asked Messrs. the professors for instructions that she will send to these officers so that they might be

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<sup>82</sup> Silvia Collini, *Les instructions scientifiques pour les voyageurs: XVIIe-XIXe siècle*, (Paris: l'Harmattan, 2005), 46. There is a long and complex literary history of “instructions for travels.” For background on the early-modern precedent for travel instructions see Justin Stagl, *A History of Curiosity: The Theory of Travel, 1550 – 1800*, (Amsterdam: Harwood Academic Publishers, 1995). For an example of instructions distributed to Spanish colonial officials by the Royal Botanical Gardens in Madrid see: Casimiro Gomez Ortega, *Instruccion Sobre el Modo Mas Seguro y Económico de Transportar Plantas Vivas Por Mar y Terra a los Paises Mas Distantes*,” (Madrid: Por D. Joachin Ibarra Impresor de Cámara de S. M., 1779). On the first page we are informed that Ortega is a correspondent member of the academy of sciences in Paris and the Royal Society in London, which suggests the international reach of this movement to standardize instructions.

<sup>83</sup> A letter dated February 28<sup>th</sup>, 1845 “from the professors, administrators of the Museum of natural history” E. Chevreul, B. Geoffrey Saint-Hilaire, and De Jussieu to the French Philanthropist Alexander Vattermare, notes: “We are now completing the printing of new instructions for harvest and preparation of objects of natural history. As soon as this is completed we will send you a few copies so that you can transmit them to your American correspondents.” These instructions together with additional instructions relative to anthropology and zoology, were translated into English and published in pamphlet form by Vattermare in 1846. The letter from the Museum is quoted in this pamphlet. Alexander Vattermare, *Movement of the International Literary Exchanges, Between France and North America, From January, 1845, to May, 1846, with Instructions for Collecting, Preparing, and Forwarding Objects of Natural History Written by the Professors of the Museum of Natural History at Paris. And Instructions Relative to Anthropology and Zoology, by M. Isidore Geoffroy St. – Hilaire, (Both series translated by an American Lady)*, (Paris: Printed by Paul Dupont, 1846), 22 – 23.

communicated to those that they will charge with assisting them. This instruction must make known:

- 1) The manner of gathering and preparing natural history objects.
- 2) The manner of embalming and making them arrive in France in the best state possible.
- 3) The choice and form of notes that should accompany these objects.
- 4) The identification of objects that are particularly desired.<sup>84</sup>

The text then turns to various subject disciplines, and we are informed that the professors working within these divisions have highlighted the specimens of greatest interest to the *Muséum*. The instructions cover in detail the proper method of gathering and preserving specimens yet make no reference to scientific analysis. Collecting efforts are justified as harboring potential for the discovery and commercial exploitation of new resources. For instance, the section on zoology reads: “if these animals are of the nature to render services to the domestic economy or to agriculture, and if they reproduce, we have the means to raise them, to domesticate them and thus procure new resources. The vicuna, the lama, the kangaroo, the cassowary may one day be very useful.”<sup>85</sup> It is likely that the intended audience for this statement was as much the Ministry of the Navy as it was the naturalists upon whom the *Muséum* wished to impress the importance of the task they were proposing.

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<sup>84</sup> “Instruction pour les voyageurs et pour les employés dans les colonies, sur la manière de recueillir, de conserver et d’envoyer les objets d’histoire naturelle (1818)” in Silvia Collini, *Les Instructions Scientifiques pour les Voyageurs*, 251.

<sup>85</sup> *Ibid.*, 252. The emphasis on the commercial application of exploration was not unique to French voyager instruction. See for example Jefferson’s instructions to Meriwether Lewis: “The object of your mission is to explore the Missouri river, & such principal stream of it, as, by it’s course & communication with the waters of the Pacific Ocean, may offer the most direct & practicable water communication across this continent, for the purposes of commerce.” *The Journals of Lewis and Clark*, ed. by Frank Bergon, (New York: Penguin Books, 1989), xxiv.

The publication of this text also suggests that the professor-administrators of the *Muséum* were confident of the availability of a work force that only needed to be tapped into in order to acquire a stream of collections and useful reports. The only thing needed to extract the maximum return from these travelers was widely distributed proper written instruction. As early as 1800 Professeur Louis Jean-Marie Daubenton had written:

We must applaud the zeal of the naturalists that propose to make lengthy voyages. I would like to contribute to their glory and to the advancement of natural history, by exhorting them to take all the precautions necessary for assuring the success of their research and the utility of their observations. If we represent for ourselves, while reading the majority of voyage accounts, all the pains that they caused, all the dangers they occasioned, if we consider at the same time the little instruction that we can take from these relations, we regret that so much patience and effort, so much constancy and courage produced so little good information in the midst of such a large number of interesting objects [...] [O]nce [voyagers] have been instructed to choose [...] the minerals that are unknown to us, they will make an ample harvest, and they will have the advantage of illustrating their name among the naturalists.<sup>86</sup>

Daubenton clearly distinguished between a mere voyager and a naturalist. Only by identifying an “unknown” mineral could a voyager hope to make a name as a naturalist. The acceptance of an individual’s claim to authority as a “naturalist,” a member of an emerging gentility among those who practiced natural history, hinged on his ability to secure recognition as having produced new knowledge. Would the gathering and transport of hitherto unknown specimens be enough to give a traveler a name as a naturalist? Hope that discovery of unknown specimens could confirm a scientific reputation made for a convergence of interest between field naturalists with this understanding of science and the colonial projects of the State. Unexplored territories

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<sup>86</sup> Louis Jean-Marie Daubenton, “‘Sur les Voyages et les Theories des Naturalistes,’ Quinzieme Séance (2 Ventose) Histoire Nature,” *Séances Des Écoles Normales, Recueillies par des Stenographes, et Revues par les Professeurs*. Nouvelles Edition, Vol. 2, (Paris: A L’imprimerie du Cercle-Social, 1800), 180.

held promise as frontiers of scientific advance. The identification of scientific opportunity not with an unexplored problem but by unexplored territory is illustrated by Plée's letter of complaint about the destination assigned to him:

You will reflect yourselves on the nature of the mission with which I am charged; and, with as much justice as with reason, never would you expect as much as from my colleagues MM. Havet and Godfroy. They will both traverse unknown countries, countries where the lightest work on their part may perhaps be a conquest for science; me, I must drag myself over lands already exhaustively researched [...]<sup>87</sup>

*Training School of the State:*

The question facing the professors of the *Muséum* in the early 1800's was how to best use French travelers to procure material for their collections and information for their analysis, something that was required by the museum in order for it to continue to grow and justify its government funding. The answer lay in partnership with other State institutions with similar interests in information gathering. The project of pursuing natural history, with potential pay-offs in resource discovery and exploitation through well-supervised information gathering by French travelers, was supported by the Ministry of the Interior and the Ministry of the Marine. The school for naturalist voyagers was a joint venture. Professor Administrators of the *Muséum* who set training standards and Ministries that funded and co-determined voyagers' destination planned to manage individual missions from the top down – as they would be managed in the navy or a department of state.

The creation of a school for naturalist voyagers was not a unique effort, but one of several comparable educational projects. The opening of the school for voyager-naturalists in 1818, in partnership with the Ministry of the Interior, would have been seen

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<sup>87</sup> Françoise Thésée, *Auguste Plée 1786 – 1825*, 62.

by many as the opening of yet another state-sponsored trade school.<sup>88</sup> It was, in fact, part of a broader movement to standardize professional and craft disciplines, and to give increased administrative control over their practice to the State. Trade schools were intended to increase economic production and provide increased state control over the availability of labor sources. One announcement of the opening of the school for naturalist-voyagers compared its organization to that of the corps of engineers, stating: “All the research of these voyagers will be directed towards the goal of real usefulness. This institution which promises the happiest results, is a seed, fertile on its own, that will develop to the profit of the philosophical studies: we can consider it as the core of a corporation of naturalists, analogous to the current organization of the corps of engineers.”<sup>89</sup> Baron, Charles Dupin, in a text entitled “Productive and Commercial Strength of France,” mentioned the school for voyager-naturalists together with other trade schools:

The secondary schools that give the instruction to the intermediary classes have acquired many students since 1814, but the instruction provided in these establishments has not ceased to be inefficient and without harmony with the needs of the majority of professions [...] The municipalities establish at their expense, schools for geometry, mechanics and chemistry applied to the arts, and classes in draftsmanship. Already the navy has created the officer training school and forty-five courses in industry; the war [ministry] has created the school for military pyrotechnics, the finance [ministry], the school of forestry, the [ministry

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<sup>88</sup> For a description of Ministerial partnership with the French Academy of Sciences, and a description of the Ministry of the Interior in particular see Maurice Crosland, *Science Under Control: The French Academy of Sciences 1785 – 1914*, (New York: Cambridge University Press, 1992), 319.

<sup>89</sup> Marc-Antoine Jullien, Auguste Jullien, and Hippolyte Carnot, *Revue Encyclopédique, ou Analyse Raisonnée des Productions les Plus Remarquables dans la Littérature, les Sciences et les Arts, par une Réunion de Membres de l'Institut, et d'Autres Hommes de Lettres*, Vol. 2, (Paris: Au Bureau de la Revue Encyclopédique, chez Baudouin Frères, 1819), 178.

of the] interior, the school of music in Toulouse, and the school for voyager naturalists in Paris.<sup>90</sup>

While the *Muséum* was charged with organizing instruction at the school, funding, in the form of an annual payment of 20,000 francs, was provided by the Ministry of the Interior.<sup>91</sup> Additional funding was awarded for individual missions in the form of subsidies from the Ministry of Public Instruction from a fund designated as *service des voyages et des missions scientifiques et littéraires*.<sup>92</sup> After passing entrance exams, successful applicants began their course work. The first entrance examination took place on April 2<sup>nd</sup>, 1821; 32 candidates took the entrance exam, of those, 29 passed.<sup>93</sup> Before final certification, students were tested in all the scientific the disciplines in which they would be expected to collect specimens, fluency in a foreign language, and drafting ability. Each candidate's physical health and temperament were also evaluated. It was then the responsibility of the Ministry of the Interior, under advisement from the museum, to assign a voyaging destination of every graduate. The journal *Nouvelles*

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<sup>90</sup> Le Baron Charles Dupin, *Forces Productives et Commerciales de la France*, Vol. 1, No. 55, (Paris, Bachelier, Libraire, Successeur de Mme V. Courcier, Quai des Augustins, 1827), xxiii.

<sup>91</sup> This payment represented a substantial sum and accounted for 7 to 8% of the total budget of the *Muséum*. Not all of these funds were used to support naturalist voyagers, the *Muséum* in actuality spending only 6000 francs per year on the school. The program thus provided a useful source of revenue as it generated additional funding which administrators utilized as they saw fit. Richard Burkhardt Jr., "Naturalists' Practices and Nature's Empire," 334.

<sup>92</sup> Christophe Bonneuil, "Le Muséum National d'Histoire Naturelle et l'Expansion Coloniale de la Troisième République (1870-1914)," 149.

<sup>93</sup> Silvia Collini, *Les instructions scientifiques pour les voyageurs*, 47. Collini and Vannoni cite a study conducted as part of the doctoral thesis of Lorelay Kury which examined the age of aspiring voyager naturalists the vast majority of whom were under the age of 25. Lorelay Kury, *Civiliser la Nature: Histoire Naturelle et Voyage (France, fin du XVIIIe siècle – début du XIXe siècle)* [doctoral thesis], École des Hautes Études en Sciences Sociales, (1995).

*Annales Des Voyages, de la Geographie et de L'Histoire* reported on the opening of the school in an article simply titled “*École des voyageurs naturalists*”:

Young people who show a taste and an aptitude for traveling, are designated by the ministry, on the recommendation of the professors of the *Jardin du Roi*, to enjoy, for a certain number of years, a pension for which the royal munificence has put together the funds; they must follow all the classes of the museum, and devote themselves to all the studies that can be useful for a voyager. It is among these students that the diverse ministries will then designate the voyagers to be charged with particular missions, to gather information on navigation, commerce, agriculture, and the productions of the countries with which it may be in the interest of the state to open relations.<sup>94</sup>

Tellingly, in this text, published by a journal unaffiliated with the museum, the emphasis of the field collector’s work hinges entirely on the benefit to the state. No mention is made of the gathering of collections, or physical objects. Instead, the responsibility of the voyager is to gather practical information relevant to state interest: navigation, commerce, agriculture, and production.

#### *Voyagers as Spies:*

To label voyager-naturalists “spies” would be a simplification. It is more accurate to say that spying was one facet of the work they were expected to carry out. The ministries who financed and supported their missions were interested in intelligence gathering of various kinds – political and commercial. And the conflation of scientific voyaging and espionage was not at all new. Linnaeus, for example, in the late 18<sup>th</sup> century, when seeking funding, emphasized the practical gains to be expected by sending his students afield. As Koerner explains: “Linnaeus preferred his students to travel the well-worn Cadiz-Ghuangzhou trade route, instead of visiting ‘wild deserts’ (as he even-

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<sup>94</sup> In Jean Baptiste Benoît Eyriès, *Nouvelles Annales Des Voyages, de la Geographie et de L'Histoire*, Vol. 5, (Paris: Librairie de Fide Fils, 1820), 233.

handedly designated Pennsylvania and Yemen). For it was there that such prizes as tea-seeds, herbal medicines, and techniques of porcelain manufacture might be found [...]

The Linnaean ideal voyager, then, was an industrial spy in the busy cities of high civilizations, not a lone wanderer in a pristine natural world.”<sup>95</sup>

The voyagers of the *Muséum*, as we saw with the example of the note given to all graduates by the Ministry of the Interior, were urged to “take notes on all that [...] might interest your country [...].” In wide-spread public rhetoric voyager-naturalists were portrayed as non-threatening enquirers, in the service of all humanity, who were above suspicion of deceit. This rhetoric may in fact have been useful in parrying concern about voyager spying. Take for instance this text by Boitard.

Who ever you are, nations armed for war, let them pass these ambassadors of spring and fall, these pacific representatives of Pomone and of Flore, [...] let them pass, because one does not want any of your frontiers, nor of your shores, nor of your charts, nor of your despotes; only does one want to collect a few fish in your rivers, two or three shells on edge of your seas [...] a bird that sings on the branch of your flowering trees. That is all that they ask, the envoys of the noble garden [...]

In exchange, Boitard continues, the voyagers will bring “our most beautiful flowers, our most handsome trees, the tastiest fruits, the most fertile grains, the most loyal animals, their birds with the best song.” The voyager will not be harmed, Boitard reassures his French readers, because “the ambassadors of the *Muséum* are assured, even among the most ferocious people, of encountering the most tender sympathy.”<sup>96</sup>

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<sup>95</sup> Lisbet Koerner, “Carl Linneaus in His Time and Place,” *Cultures of Natural History*, ed. by Nicholas Jardine, James Secord, and Emma Spary, (Cambridge: Cambridge University Press, 1996), 152.

<sup>96</sup> Pierre Boitard and Jules Janin, *Le Jardin des Plantes*, xlii.

Despite this rhetoric of peaceful exploration and exchange we do have one accusation of espionage against one of the school's early graduates, Victor Fontanier. In 1846 a British magazine fumed with respect to Fontanier's mission to the Middle East:

A French political mission, especially when composed of one individual, is a thing *sui generis*. It is not a mission of peace, nor a mission of friendly alliance, nor one for commercial and other advantages, nor even of French interests, — it is a mission simply of hostility to England and the English, unflinching in its objects, and unscrupulous in its means. Mr. Fontanier's especial mission was as a spy upon the proceedings of the Euphrates Expedition.<sup>97</sup>

While the British were accusing Fontanier of spying, their own expedition was motivated by colonial ambition. The Euphrates Expedition was as an important step in securing the region for British interest prior to the building of the Suez Canal. It was described in 1903 by professor of Assyriology H. V. Hilprecht as owing “its origin mainly to commercial and political considerations, with the ultimate view of securing the Euphrates valley as a highway to India.”<sup>98</sup> In the absence of other specialized, state employed, professional intelligence gatherers and political representatives in the field, voyagers remained the principal informants of over-seas activity.

*Observateurs-Philosophes and Field Naturalists:*

For an early nineteenth-century field-naturalist to achieve a position as professor administrator, he would first have to navigate the difficult and sensitive negotiations of patronage, collections exchange, publication, and institutional membership. He would also have to make the transition from “field collector” to “cabinet naturalist.” This

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<sup>97</sup> “The Political Mission to the East,” *Ainsworth's Magazine, A Miscellany of Romance, General Literature, & Art*, ed. by William Harrison Ainsworth, Vol. 6, (London: John Mortimer, Publisher, 1846), 183.

<sup>98</sup> Hermann Vollrat Hilprecht, *Explorations in Bible Lands During the 19<sup>th</sup> Century*, (Philadelphia: A. J. Holman and Company, 1903), 57.

transition was made all the more difficult because the position of “cabinet naturalist” was jealously guarded. Cabinet naturalists continuously attempted to define and enforce the social boundaries, and allotted tasks, which differentiated these two categories. The position of *Muséum* professor was coveted, not only because this sedentary work was safer and amply more comfortable than that of the field naturalist, but also because the prestige of the position granted a degree of authority in the production of new knowledge that field naturalists, despite their discoveries, did not enjoy.

While financial need and the necessity of supporting families provided one motivation for young voyagers to risk their lives in long-distance journeys that could require years-long absence, there is ample evidence that these individuals were frequently passionate about the work they were doing. In an account of his first meeting with the prominent French Naturalist and *Muséum* professor Georges Cuvier, Isidore Bourdon described his feelings upon being invited to join the school for voyager-naturalists:

The first time that I saw Cuvier, I was very young, and the impression that his person had on me has never been erased from my memory. It was in 1819; I had just published a first memoir of physiology, and I had saved a draft for him. [...] All the while reading my draft, [...] he looked at me, congratulated me, and asked me: ‘Have you’ he said to me ‘studied natural history? Would it be agreeable to you to travel, to be part of a school in which the students, all destined to go to the still little known regions of the globe, will be chosen by examination?’ I answered him that I would like to. [...] He might have said to me: “would you descend with me into the fiery crater of Vesuvius?” I think in truth I would have responded *yes*.<sup>99</sup>

Popular texts helped to shape the image of the voyager-naturalist as a romantic and honorable profession, “an ambassador” even, of an ideal republic or kingdom of Science. A book describing the *Jardin des Plantes*, published in 1842, enthuses: “[*the*

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<sup>99</sup> Isidore Bourdon, *Illustres Médecins et Naturalistes des Temps Modernes*, (Paris: Comptoir des Imprimeurs-Unis, 1844), 94.

*Jardin des Plantes*] has made from these few arpents of forgotten land in one of the suburbs of Paris a vast and powerful kingdom that sends its ambassadors into all the regions of Europe: triumphant and glorious ambassadors [...] that nothing can stop, neither flotillas heavy with cannons, nor armed fortresses, nor wars between peoples, nor the deserts, nor the flooded rivers, nor the valleys, nor the mountains.”<sup>100</sup> It is easy to imagine that the rhetoric of glory, honor, and even martyrdom appealed to young men, all the more so if, like Plée, they were facing financial difficulties. The position of voyager-naturalist at the *Muséum* held the promise of opening a path to social and professional distinction.

Yet, the rhetoric of adventure and glory, so easily dispensed in Paris, could lose its meaning when voyagers came face to face with the realities of work in the field. In a letter written by voyager Claude Gay to Alcide D’Orbigny, like him a graduate of the school for voyager-naturalists, Gay mocks his Paris superiors:

I still remember the marvelous idea I had in Paris when I left to come explore this country [South America], it seemed to me that I would vanquish all, devour all [...] but when upon my arrival I saw the danger that one risked upon leaving the city and, a few months later, all these revolutions that rendered these dangers even more real, it was then that with M. Bertero we laughed at those good and credulous Parisians who hired us to cross this republic in zig-zag [...] really, one must admit that they are good children.<sup>101</sup>

The halo of romance that clung to voyager-naturalists can in part be attributed to the fact that they were quite likely to perish in the course of carrying out their missions. As martyrs to science, voyager-naturalists, like soldiers and missionaries, risked dying in

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<sup>100</sup> Pierre Boitard and Jules Janin, *Le Jardin des Plantes*, xlii.

<sup>101</sup> Letter to Alcide D’Orbigny, February 23<sup>rd</sup> 1830; Bibliothèque Municipale de La Rochelle, Manuscript 654. Pp. 153 – 155. Cited in Olivier Baulny, “L’Oeuvre Américaine d’Alcide Dorbigny,” *Cahiers des Amériques Latines*, No. 5, (1970), 59.

service without ever seeing home again. In fact, their sacrifice and glory was rhetorically identified with that of the heroes of Austerlitz and Waterloo:

It is understood of course that this noble mission, through the forests, the plants, the oceans and the deserts of this world, should have its martyrs. Life was only given to man so that it might be sacrificed, as one gives a final proof of obedience and respect to ones hopes and ones convictions. Such were killed at Austerlitz, at Wagram, at Waterloo, to have their name written in the imperial bulletin, who would not understand that, in order to complete his herbarium, a young scientist of thirty years should go find pestilence and death in the mountains of the Himmalayas.<sup>102</sup> This one might well take on an entire battery of thundering cannons on his own, but would be horrified, if he had to go and remove the young of a tiger and its female from their cave. Thank God that whatever type of glory one seeks, it is always glory! [...] [T]here is no science small as it might be, or restrained, that doesn't have its own immensity and grandeur.<sup>103</sup>

After 1830 the *Muséum* no longer advertised for students. The reason for the school's temporary dissolution remains unclear, yet that the deaths of *all* of the first graduates may have been a contributing factor. The suspension of a formal school in the 1830s did not signal an end to the *Muséum*'s role as a training facility for voyager-naturalists, however. Funding continued to be provided by the Ministry of the Interior until 1833, and during the 1820s Victor Jacquement and Alcide D'Orbigny (who would later become a professor at the museum) received training and mission assignments at the *Muséum*.<sup>104</sup> Perhaps a more important contributing factor in the abandonment of the school was the continuously unstable political climate. The rise of Emperor Napoleon III

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<sup>102</sup> This reference is to Victor Jacquement, trained at the *Muséum* during the mid-1820s, who died in India, though not before having sent home a number of important collections. The same text goes on to give describe Jacquement as an exemplary voyager, "a young man without employment and without fortune, but full of zeal, full of courage, as knowledgeable as an old man, ardent like a young man, intrepid like a soldier, sometimes even a poet [...]" Pierre Boitard and Jules Janin, *Le Jardin des Plantes*, xliii.

<sup>103</sup> Ibid.

<sup>104</sup> Richard Burkhardt Jr., "Naturalists' Practices and Nature's Empire: Paris and the Platypus, 1815 – 1833," 334 – 335.

in 1848 brought renewed tensions with Prussia, culminating in the outbreak of the Franco-Prussian war in 1870. As in the period following the first Napoleonic wars, the end of the Franco-Prussian war inaugurated a boom in industry<sup>105</sup> and a new era in the Muséum's commitment to field research.

*Reviving the School for Voyager – Naturalists:*

Some viewed the victory of Prussia over France as evidence of the failure of French science.<sup>106</sup> Peter Galison describes the atmosphere among French scientific institutions in the wake of the conflict:

“[T]he problem of balancing pure knowledge against useful applications was gripping France as never before [...] France [...] struggled desperately to understand the roots of its catastrophic defeat. The technical infrastructure of the State came into question [...] But more than any piece of technology, critics dissected the institutions of technical learning, which appeared to need reconstruction and fast.”

Even the formerly unrivaled *Muséum* fell under criticism. In 1871, the scientific publicist Victor Meunier scathingly described the *Jardin* as a “tenant farm in the hands of sinecurists.”<sup>107</sup> Reconstruction required rational planning and, as Michael Osborn has argued, during the 1870s the factory system had become the model of organizational rationality. Educational and scientific institutions sought to refashion themselves with reference to its standards. For example, the *Jardin Zoologique d'Acclimatation* on the outskirts of Paris, “exhibited a machine which married economic zoology and the

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<sup>105</sup> A boom in commercial industry also categorized this period. Ray Jonas, for example, notes the expansion of the French textile industry in the wake of the Franco-Prussian war as “wages rose sharply [and] as demand for labor increased.” Ray Jonas, *Industry and Politics in Rural France: Peasants of the Isère 1870 – 1914*, (Ithaca: Cornell University Press, 1994), 112.

<sup>106</sup> Peter Galison, *Einstein's Clocks, Poincaré's Maps*, 51.

<sup>107</sup> Quoted in Camille Limoges, “The Development of the Muséum d'Histoire Naturelle,” 213.

efficient technology of the factory system.”<sup>108</sup> This apparatus, an enormous chicken coop contraption, allowed a single operator to force-feed 400 chickens in one hour, and showcased the mechanical efficiency of agricultural industrial technology. The demonstration also modeled the ideal factory worker, an individual working alone to accomplish a specific regimented task, and exemplified the inclination to showcase practical applications of scientific research.

The factory model also held sway at the *École Polytechnique*, where the primary goal was the education of students. The physicist Henri Poincaré a student at the *École Polytechnique* in 1873, described his classmates as possessing the “factory stamp” of their alma mater. In letter to his mother he wrote: “It is as if we are in an immense machine whose movement we must follow on pain of being passed by [....]”<sup>109</sup> The factory analogy was also applied by the professors of the *Muséum d’Histoire Naturelle* with reference to the divisions of labor they administered. An 1895 article by *Muséum* professor Pierre Paul Dehérain, for instance, argued:

In order to methodically classify objects, what is essentially the task of the collection chairs, a superficial examination is not enough; one must extend the observations to the interior structure, from there services which are not affiliated with any gallery enter into play: the chairs of anatomy, of chemistry; [...] the physiologists and the physicians; all these works are accomplished in the laboratories and their work demonstrates that our establishment is not only an admirable museum, but that it is, in addition, one of the great factories in which the natural sciences are worked out.<sup>110</sup>

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<sup>108</sup> Michael A. Osborn, *Nature the Exotic, and the Science of French Colonialism*, (Bloomington: Indiana University Press, 1994), 113.

<sup>109</sup> Peter Galison, *Einstein’s Clocks, Poincaré’s Maps*, 53.

<sup>110</sup> Pierre Paul Dehérain, “Bulletin du Muséum d’Histoire Naturelle” *La Nature: Revue des Sciences et de Leurs Applications Aux Arts et a l’Industrie, Journal Hebdomadaire Illustré*, ed. by Gaston Tissandier, Vol. 23, (Paris: Libraire de l’Académie de Médecine, 1895), 295.

Why was the factory model so appealing to French scientific institutions? In part, the development was part of a broader international movement. In the United States it came eventually to be known as the Efficiency Movement, and was followed by Taylorism in the early 20<sup>th</sup> century. In Germany, similar developments have since become known as the rationalization movement.<sup>111</sup> But while the international context is important, it is worth asking why the factory model was adopted at the local level, and at the *Muséum d'Histoire Naturelle* in particular. And it is to be noted that that the change didn't come without resistance. Michael Osborn has shown that some *Muséum* professors were reluctant to allow the *Muséum* to showcase practical, applied science. "In keeping with this philosophy," Osborn writes, "the professors rejected the application of Albert Geoffrey Saint-Hilaire [...] the assistant director of the Jardin, to deliver lectures on applied zoology on *Muséum* premises."<sup>112</sup>

But even if the model of the factory, carrying its tinge of commercialism and applied science, was distasteful to some *Muséum* professors who sought to cast their work as pure disinterested science, the model of the factory worker, at least when it came to those they wished to cast as their assistants, retained considerable appeal. In the same article in which Dehérain announced that the *Muséum* was in essence a "great factory", he described the relationship between voyager-naturalists and permanently stationed specialists employed by the *Muséum*:

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<sup>111</sup> Still in their infancy during the late nineteenth-century, these movements fully flourished during the early 20<sup>th</sup> century, particularly in the wake of the First World War. For a discussion of the French "rationalization" movement and its international context see Richard F. Kuisel, *Capitalism and the State in Modern France: Renovation and economic Management in the Twentieth Century*, (Cambridge: Cambridge University Press, 1981), 77. See also Jennifer Karns Alexander, *The Mantra of Efficiency: From the Waterwheel to Social Control*, (Baltimore: Johns Hopkins University Press, 2008).

<sup>112</sup> Michael Osborn, *Nature the Exotic, and the Science of French Colonialism*, 30.

The voyager shows the extent of his knowledge, his zeal, his sagacity by the choice of the objects he brings back; there stops his mission, because he cannot have a deep understanding of all the sciences. So that his bounty might not be lost, his collections must be distributed between the different services of the *Muséum*; there they will be the object of deep study by specialists [...]<sup>113</sup>

Ernest Théodore Hamy, another *Muséum* professor, and instructor of naturalist-voyagers, exhibited the same conviction about the importance of limiting the field naturalists' personal initiatives, and leaving interpretation of the data they gathered to the professors. At the annual meeting of the Anthropology Society in Paris in 1882, Hamy explained:

It matters little to the progress of ethnographic science whether the questions posed the voyagers by our society be grouped in one fashion or in another fashion; that religious manifestations, for example, on which the questionnaire calls the attention, be considered by one as purely affectional or treated by another as mental manifestations. What matters, is that the voyagers, who for the most part will understand nothing of all these subtleties, should be reminded not to omit anything important in the investigation that he will want to undertake for us in barbarous or wild countries. Let us ask him very precise questions; he will bring us back precise responses that we will print in our publications. Free then are our philosophers to interpret at their convenience the facts that we will have carefully recorded.<sup>114</sup>

Why should sedentary *philosophes* be more qualified to interpret data than naturalists in the field? For the professors the answer would always be the same: proper comparative analysis was not possible in the field. Only in the galleries of the museum and its libraries, they argued, was it possible to analyze the unknown with reference to the encyclopedic assembly of the world's known natural history objects. This prejudice against analysis in the field had a long-standing tradition. Earlier in the century, in a

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<sup>113</sup> Pierre Paul Dehérain, "Bulletin du Muséum d'Histoire Naturelle," 295.

<sup>114</sup> Ernest Hamy, *Bulletin de la Société d'Anthropologie de Paris*, 3ème série, Vol. 5, (1882), 456.

review of one of Humboldt's field reports, George Cuvier expressed his attitude towards scientific work carried out in the field in a similar fashion:

Usually there is as much difference between the style and ideas of the field naturalist, and those of the sedentary naturalist, as there is between their talents and qualities. The field naturalist passes through, at a greater or lesser speed, a great number of different areas, and is struck, one after the other, by a great number of interesting objects and living things. [...] But he can only give a few instants of time to each of them, time which he often cannot prolong as long as he would like. He is thus deprived of the possibility of comparing each being with those like it, of rigorously describing its characteristics, and is often deprived even of the books which would tell him who had seen the same thing before him. [...] The sedentary naturalist, it is true, only knows living beings from distant countries through reported information subject to greater or lesser degrees of error, and through samples which have suffered greater or lesser degrees of damage. [...] Yet these drawbacks have also their corresponding compensations. If the sedentary naturalist does not see nature in action, he can yet survey all her products spread before him. He can compare them with each other as often as is necessary to reach reliable conclusions. [...] The traveler can only travel one road; it is only really in one's study that one can roam freely throughout the universe [...] <sup>115</sup>

Cuvier, like Hamy after him, identifies theorizing with freedom - and in particular, freedom to dispose of one's own time. Ideas about where theorizing could, and should take place, were thus infused with longstanding conceptions of the leisured gentleman of science. The field naturalist traveling at the bidding of others did not fit that image. By the late nineteenth-century the factory ideal of labor specialization gave new support to the belief that the work of the voyager-naturalist should begin and end in the field while the products of their work should be appropriated by others for analysis in the laboratory.

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<sup>115</sup> Cited in Nicholas Jardine, *Cultures of natural history*, 259.

*The Colonial Expansion:*

In the 1870s, the *Muséum*, casting itself as a partner in the expansionist colonial project of the State, re-established courses for voyagers.<sup>116</sup> Beginning in 1876, *Muséum* professor Ernest-Théodore Hamy began teaching a course on Anthropology,<sup>117</sup> and by 1893, this time at the initiative of the *Muséum* director, M. A. Milne-Edwards, a new school for the instruction of voyager-naturalists opened. The school was an immediate success; more than one hundred auditors attended, including officers and students from the Colonial School.<sup>118</sup> Milne-Edwards militantly declared in his opening address:

[I]t was up to us to facilitate the task of voyagers and to arm them for the battle they propose to undertake. Curiosity has awakened on the far off countries; explorations are multiplying, they are becoming more and more complete, more and more serious, and an instruction of the type we inaugurate today responds to a new demand.<sup>119</sup>

Future missions, he announced, would be destined to the interior of Africa. For it is that great continent that “attracts the attention of civilized nations, and the explorers lay siege to the citadelle once thought impregnable, the ramparts [...] are falling one after the other.” But why was attention now focused on a region that earlier in the century had attracted little interest? The answer, Milne-Edwards responded, was that “the inhabitants of the old world have their eyes fixed on the virgin regions of the world where nature is rich and where the resources are yet to be exploited. Our earth of Europe,” he continued,

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<sup>116</sup> Bonneuil suggests that the *Muséum* moved away from the experimental sciences at this time, and developed a renewed interest in collecting, as the Sorbonne took over the role of experimental research center. Christophe Bonneuil, “Le Muséum National d’Histoire Naturelle et l’Expansion Coloniale de la Troisième République (1870-1914),” 145.

<sup>117</sup> Ibid., 151.

<sup>118</sup> Ibid.

<sup>119</sup> H. Filhol, *Conseils aux Voyageurs Naturalistes: Publication consécutive aux leçons faites au Muséum d’Histoire Naturelle en 1893*, (Paris: Imprimerie Nationale, 1893), 1.

“seems to be exhausted from having been productive, all the men who think to the future are profoundly convinced that we must undertake industrial and commercial conquests, and that the peoples who will not have taken part in this grand movement of colonial expansion in time will find the routes closed and the positions occupied.”<sup>120</sup>

In an essay on the newly re-inaugurated school for voyagers at the *Muséum* published by the French Association for the Advancement of Science in 1893, *Muséum* anthropologist Fernand Delisle described the colonial project in even clearer terms:

“What we know of our colonies in the Congo, and upper Sénégal, of Indo-China, of Tonkin is very little in contrast to what we should know already. The era of conquest is over, the era of agricultural, industrial, and commercial expansion has arrived.”<sup>121</sup> The same sentiment had been echoed in Milne-Edwards opening address:

The first part of the task is accomplished. The territories have been recognized, we know how to penetrate. Treaties have been passed with the chiefs, the good and pacific memories left with the populations assure us free entry. It is necessary now that we benefit from these new possessions, and for that we must know what they produce, by what race of men they are inhabited, what is their fauna, what is their flora, what are the metals found in their soil, etc... It is only with that condition that we can begin profitable exploitation.<sup>122</sup>

The renewal of the school for voyager-naturalists in the 1890's was thus part of the new wave of colonial expansion and an effort to meet the concern that, without overseas exploitation, France, in a struggle of the fittest among European nations would fall behind. This second phase of European expansion is what Daniel Headrick has termed “the consolidation phase” of technological imperialism, which he sees as being directly

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<sup>120</sup> Opening address of Milne-Edwards quoted in H. Filhol, *Conseils aux Voyageurs*, 2.

<sup>121</sup> Fernand Delisle, “L'Enseignement spécial pour les Voyageurs organisé par le Muséum,” *Association Française pour l'Avancement des Sciences Fusionnée avec l'Association Scientifique de France Compte Rendu de la 22e Session, Second Partie Notes et Extraits*, (Paris: Au Secrétariat de L'Association, 1894), 867.

<sup>122</sup> H. Filhol, “Conseils aux voyageurs,” 4.

associated with new technological advances made during the late nineteenth-century. “In the phase of consolidation,” he explains, “the links that tied the colonies to Europe and promoted their economic exploitation included steamship lines, the Suez canal, the submarine telegraph, and the colonial railroads.”<sup>123</sup> The *Muséum* integrally invested in this second wave of colonial expansion, appealing once more to the interests of the State. And, the school for voyager-naturalists continued to flourish in the late nineteenth-century, only to be dissolved once more with the outbreak of World War One.

*Conclusion:*

Peter Galison has pointed to the late nineteenth-century as a time when new divisions of labor penetrated science.<sup>124</sup> In the case under examination here the late nineteenth-century witnessed the increasingly formal enforced separation of pre-existing labor divisions in natural history. Men working in science were delegated specified tasks in an institutional setting that formally organized a complex division of labor and honor. Thus, in 1895, *Muséum* professor Dehérain cheerfully announced a new regime of communicative efficiency:

The director has asked all the naturalists attached to the *Muséum* to come together once each month in one of the amphitheatres to communicate to the Assembly the results noted in their divers services. – No memoires are requested, nor conference papers; one quickly describes what one has seen, shows objects, projects photographs, turns in a note for the *Bulletin*, then one returns to ones’ row; we can thus listen to some twenty communications in the space of one séance.<sup>125</sup>

The school for voyager-naturalists, intent upon forming a useful worker capable of carrying out standardized directives, appealed to a state concerned with international

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<sup>123</sup> Daniel R. Headrick, *The Tools of Empire: Technology and European Imperialism in the Nineteenth Century* (New York: Oxford University Press, 1981), 12.

<sup>124</sup> Peter Galison, *Einstein’s Clocks, Poincaré’s Maps*, 49.

<sup>125</sup> Pierre Paul Dehérain, “Bulletin du *Muséum* d’Histoire Naturelle,” 294.

commercial and military competition. This effort played its part in shaping the social dimensions of scientific research in the late nineteenth and early twentieth centuries, as distinctions between scientific disciplines and different categories of science workers became organizationally institutionalized, and the Humboldtian ideal of the traveling naturalist waned to be replaced by the reality of the specialist, and the fieldworker with limited claims to authority in the production of new knowledge.

## Chapter 2:

### The Hybrid Shore: The Marine Station Movement and Scientific Uses of the Littoral (1843 – 1910)

*Before the land rose out of the ocean, and became dry land, chaos reigned; and between high and low water mark, where she is partially disrobed and rising, a sort of chaos reigns still ... The sea-shore is a sort of neutral ground, a most advantageous point from which to contemplate the world ... Creeping along the endless beach amid the sun-squall and the foam, it occurs to us that we, too, are the product of sea slime. ... There is naked Nature ... where gulls wheel amid the spray.*

– Henry David Thoreau, *Cape Cod* (1865)<sup>126</sup>

#### *Introduction:*

Writing in 1865, Thoreau described the seashore as a space in which the history of the natural world was revealed, the viewer prompted to look inwards and contemplate humanity's place in the evolutionary progression of life. Thoreau was not alone in these speculations; by end of the nineteenth century the sea and seashore had become new terrains for scientific investigation. In recent years environmental historians and historians of science have also turned their attention to the shore. Moving away from the study of “wild spaces,” they have argued that attention to changing uses of seashore spaces can provide a better historical understanding of the relationship between humanity and the natural environment. The littoral zone, as the shoreline is sometimes called, is a hybrid space that has marked a boundary between man-made environment and wild

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<sup>126</sup> Henry David Thoreau, *Cape Cod*, (Boston: Ticknor and Fields, 1865), 64, 173. Both Helen Rozwadowski and Rebecca Stott have cited Thoreau's *Cape Cod* as evidence of a renewed attention to the sea in the nineteenth century. See Helen Rozwadowski, *Fathoming the Ocean: The Discovery and Exploration of the Deep Sea*, 3; and Rebecca Stott, *Darwin and the Barnacle: The Story of One Tiny Creature and History's Most Spectacular Scientific Breakthrough*, (New York: W. W. Norton & Company, 2003), 22.

nature. Indeed, a generation of scholarship has emphasized for historians of science the hybrid character of the spaces where scientists and nature, in particular, intersect.<sup>127</sup>

Another branch of emerging scholarship, again by both environmental historians and historians of science, has directed renewed attention at the marine environment. As Helen Rozwadowski explains, “the oceans have begun to attract scholarly attention across the disciplines, reflecting the growing concerns about depleted fisheries, ecosystem shifts in the sea, and the role of the world’s oceans in the global climate.”<sup>128</sup> Certainly in our own times, oceans have become hybridized spaces as we extend our reach ever further into the depths, both for scientific research and for the exploitation of natural resources.

But this hybridization of marine space is not new. In the nineteenth century, marine stations were constructed at the boundary between sea and shore - part man-made, controlled, scientifically monitored space, and part natural environment. Marine stations were spaces in which the natural world moved easily in and out of the laboratory, where salt water was pumped into the buildings, or entered passively with the rise and fall of the tide. Here animals collected in the field lived out their lives, were artificially stimulated to reproduce in the controlled space of the laboratory, and were named and classified.<sup>129</sup>

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<sup>127</sup> Richard White, “From Wilderness to Hybrid Landscape,” *A Companion to American Environmental History*, ed. by Douglas Cazaux Sackman, (Malden, MA: Wiley-Blackwell, 2010), 188.

<sup>128</sup> Helen Rozwadowski, “Oceans: Fusing the History of Science and Technology with Environmental History,” *A Companion to American Environmental History*, ed. by Douglas Cazaux Sackman, (Malden, MA: Wiley-Blackwell, 2010), 444.

<sup>129</sup> At least twenty-eight marine organisms carry the name *roscoffensis*, meaning “from Roscoff.” *The Encyclopedia of Life*. [Accessed online 28 April 2014] [www.eol.org](http://www.eol.org). The hybrid space of the shoreline, first identified by Robert Kohler, has been described as the birthplace of the science of ecology. See Robert Kohler, *Landscapes and Labscales: Exploring the Lab-field Border in Biology*, (Chicago: University of Chicago Press, 2002);

The corpus of scholarship on the history of marine stations is vast. Much of the existing work has taken the form of case studies, looking at the development of certain stations, or the rise of marine biology in particular national contexts.<sup>130</sup> With the case study approach, however, it becomes tempting to try to evaluate the “success” of certain stations over others. Particular stations, notably the Zoological Station of Naples, have acquired an almost mythic status in the historiography, historians repeating the adulations of marine scientists in this respect. It is not to be denied that some stations produced greater scientific output than others, or that some had longer institutional lives. But by searching for what set stations apart we risk ignoring what they had in common.

A useful approach has recently been proposed by historian of biology Raf De Bont, who suggests, following scholarship in the history and sociology of science, that the history of marine stations be studied with particular attention to uses and designs of

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and Sharon E. Kingsland, “The Role of Place in the History of Ecology,” *The Ecology of Place: Contributions of Place-Based Research to Ecological Understanding*, ed. by Ian Billick and Mary V. Price, (Chicago: University of Chicago Press, 2010). When and why ecology and marine biology diverged is a topic of historical debate. See Robert P. McIntosh, *The Background of Ecology: Concept and Theory*, (Cambridge: University of Cambridge, 1985), 115; and Eric Mills, *Biological Oceanography: An Early History, 1870 -1960*, (Toronto: University of Toronto, 2012), 4.

<sup>130</sup> In her 1988 study of Naples and the Marine Biological Laboratory at Woods Hole Jane Maienschein showed that naturalists turned to the seashore for the variety of organisms obtainable and for the scientific advantages offered by studying organisms in their natural environment. Crucially, she identified marine stations as repositories of expertise where “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.” Jane Maienschein, “History of American Marine Laboratories: Why Do Research At the Seashore,” *American Zoologist*, Vol. 28, No. 1 (1988), 22. See also, Keith Benson, “Summer Camp, Seaside Station, and Marine Laboratory: Marine Biology and its Institutional Identity,” *Historical Studies in the Physical and Biological Sciences*, Vol. 32, No. 1, Second Laboratory History Conference (2001), 11 – 18.

“space.”<sup>131</sup> In a comparative study of the Naples station and the French station of Wimereux, he argues that the “physical makeup” of marine stations “and their organization have tangible bearing on the knowledge [...] produced there.”<sup>132</sup> In his comparison of the two stations he demonstrates that “place, with its physical and social components [...] plays a role in orienting the scientist towards a particular type of research and to a particular use of the spaces at his disposal.” This is a valuable insight, yet risks de-emphasizing other forces at work far beyond the laboratory. After all, the vast majority of workers visited marine stations for only a few months of the year; we must assume that their understanding of their work was shaped as much elsewhere as it was by their time at any particular station.

Between 1840 and 1900 marine stations were built throughout Europe, North America, and even as far afield as Japan.<sup>133</sup> In France alone, twelve stations were constructed during this period. The marine station movement – for that is the best way to think about it – must be examined in concert with an attention to international developments – international rivalries, the widespread exploitation of marine resources, and a changing transnational culture of science. Ultimately, historians must integrate an attention to local conditions with a consideration of national and international context.

Like ships, marine stations were liminal social spaces. Despite their location within particular national boundaries, marine stations permitted unprecedented international cooperation, bringing together workers of different national, social, cultural,

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<sup>131</sup> De Bont draws in particular from the work of Kohler, Shapin, and Livingstone.

<sup>132</sup> Raf de Bont, “Between the Laboratory and the Deep Blue Sea: Space Issues in the Marine Stations of Naples and Wimereux,” *Social Studies of Science*, Vol. 39, No. 2 (April 2009), 199.

<sup>133</sup> See Homer A. Jack, “Biological Field Stations of the World,” *Chronica Botanica*, Vol. 9, No. 1, (Waltham, Mass.: Chronica Botanica, 1945).

and ethnic backgrounds.<sup>134</sup> Marine stations, like ocean-going vessels, were spaces in which the discipline of marine science acquired legitimacy in the late nineteenth century. And, like ships, the geographic and environmental constraints of the spaces in which marine stations were founded shaped marine science.

Finally, French marine stations in particular deserve closer attention. Histories of the rise of marine science (produced outside of France) often fail to include discussion of developments in that country. Though, by some accounts, modern marine zoology began on the coast of Normandy, where Cuvier spent the years of the *Terror* studying mollusks, France is frequently relegated to passing comment in English language scholarship (to the French *Talisman* and *Travailleur* expeditions in the 1880s or, jumping ahead, to Cousteau's technological innovations in the second half of the twentieth century).<sup>135</sup>

There are many possible explanations for this omission in the historiography, all of which deserve longer treatment than can be provided here. One might be the overshadowing influence of Albert Ist, Prince of Monaco, in a historiography which has traditionally placed greatest emphasis on deep sea expeditions as markers of scientific progress.<sup>136</sup> Another possible explanation is the longtime exclusion of France from

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<sup>134</sup> Helen Rozwadowski has argued, “one valuable contribution of ocean-based scholarship to a history of the oceans is its demonstration that historians must cross political and cultural boundaries to follow human actors across bodies of water.” The same might be said of histories of marine stations in the 19<sup>th</sup> and early 20<sup>th</sup> centuries, not because the historical actors present in these spaces were working in international waters, but because their subject of study, the ocean, was still largely free of territorial claims.

<sup>135</sup> On Cuvier's coastal work see Charles Couston Gillispie, *Science and Polity in France: The End of the Old Regime*, (Princeton: Princeton University Press), 452.

<sup>136</sup> This pattern can be traced back to George Wüst, “The Major Deep-Sea Expeditions and Research Vessels 1873 – 1960.”

international cooperative efforts in marine science.<sup>137</sup> In the transnational history of marine science, Eric Mills has very correctly shown that while physical oceanography was beginning to emerge as a distinct branch of marine science elsewhere in Europe, France did not follow suit. Mills has termed this “the paradox of French marine science.”<sup>138</sup> He argues that the failure of physical oceanography in France may be attributable to “contingency,” “personal eccentricities,” and “narrow nationalism,” but does not claim to provide a definitive explanation for the absence he identifies. Yet, his observation that physical oceanography *did* fail to take off in France leads us to ask other questions about the development of the marine sciences in that country. As historian Edward Eigen has observed, “during France’s Third Republic, the laboratory became the focus of a state-sponsored cult of science, the site of a strategic alliance of research and pedagogy.”<sup>139</sup> Perhaps then, we must look for the roots of French marine science not at sea, but in the laboratory.

While it is true that physical oceanography failed to take hold in France, biological oceanography (or what was then termed marine zoology) was particularly

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<sup>137</sup> On the exclusion of France from the first meetings of the International Council for the Exploration of the Seas (ICES) see Jens Smed, “The Accession of France Into ICES,” *History of Oceanography*, No. 21, (September 2009). On the strained relations between French scientists and the Naples marine station see Jean Louis Fisher, “L’aspect social et politique des relations épistolaires entre quelques savants français et la Station zoologique de Naples de 1878 à 1912,” *Revue d’histoire des sciences*, Tome 33, No. 3, (1980), 225 – 251.

<sup>138</sup> Eric Mills, *The Fluid Envelope of our Planet: How the Study of Ocean Currents Became a Science*, (University of Toronto Press, 2009), 163.

<sup>139</sup> Edward Eigan, “The Place of Distribution: Episodes in the Architecture of Experiment,” *Architecture and the Sciences: Exchanging Metaphors*, ed. by Antoine Picon and Alessandra Ponte, (Princeton: Princeton Architectural Press, 2003), 53.

strong.<sup>140</sup> Despite the claim that narrow nationalism hindered the development of marine science in France many of the stations founded there in the late nineteenth century are still in operation to this day – testimony enough to the lasting achievement of their founders. We should not ignore the French stations in favor of Naples or Woods Hole; collectively, all have played a part in the history of marine science.

Geographically, marine stations were built at the border between land and sea; they enclosed both natural and artificial environments; and they favored an overlap between pure science and practical research, driven by the industrialization of commercial fisheries. A consideration of marine stations *as* hybrid spaces encourages us to reconsider the hybrid nature of the history of oceanography – a branch of science that emerged from the coalescence of various scientific disciplines. The history of oceanography has tended to separate physical oceanography from biological research, assigned instead to the purview of marine biology. One consequence is that France, dismissed as a “failure” because of its comparative lack of ocean going expeditions, disappears from treatments of nineteenth-century international marine science despite its importance as a center for marine zoology.

The international marine station movement was motivated largely by commercial fisheries’ interests; but these spaces were also sites of projects to develop and popularize

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<sup>140</sup> Harry W. Paul, *From Knowledge to Power: The Rise of the Science Empire in France 1860-1939*, (London: Cambridge University Press, 1985), 105. I use the term “zoology” and not “ecology,” a term already coined by Ernst Haeckel in 1866. Initially naturalists working at marine stations were interested in questions of morphology and development and not in the interaction of marine organisms with their biotic and abiotic surroundings. However, as Darwinian evolutionary theory continued to gain ground, the emphasis of coastal marine biology shifted increasingly to questions concerning the interactions of organisms with their surrounding ecosystems. This led, in the 20<sup>th</sup> century, to an increasing disciplinary distinction between “marine biology” and the more system-oriented “biological oceanography.”

science, enhance national prestige and naval power, democratize access to education, and meld scientific with aesthetic sensibility. Recovering this history reunifies the ocean and the shore, the biological sciences and physical oceanography.

*Roscoff and Arago - Setting the Stage:*

Before proceeding further, it is worth setting the stage with a brief description of two French stations which will feature prominently in this discussion: Roscoff and Arago.<sup>141</sup> The first to be built, Roscoff, was founded by Henri Lacaze-Duthiers (1821 – 1901), then professor of zoology at the Sorbonne, in 1872. The Ministry of Public Instruction provided a financial subsidy for the maintenance of the station of 3000 francs per year. Initially as housed in rented accommodations, permanent accommodations were acquired with the purchase of a house in 1876, once again with support from the ministry of public instruction. The station was then gradually improved with purchases and donations of additional scientific equipment, including a boat, the *Dentalium*, a gift of the French Association for the Advancement of Science.

By 1881 the station was formally annexed to the Sorbonne. This inaugurated a new period of growth with the gradual acquirement of neighboring properties, a former primary school, an old military fortification, and a footpath running along the shoreline.

Lacaze-Duthiers reported that each visiting worker now might have “lodging, an

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<sup>141</sup> I have relied heavily on the summaries provided by American oceanographer Charles Kofoid, who visited both stations while compiling a report on the biological stations of Europe in 1910. He relied on personal communication with the station directors as well as Lacaze-Duthiers’ reports in the *Archives de zoologie expérimentales*. For a detailed history of the Roscoff station see Josquin Debaz, “Une histoire de la station de biologie marine de Roscoff (1872 – 1914).” Unfortunately this essay was produced for an edited volume which was never published, however, Dr. Debaz has made it freely available online. See also, Josquin Debaz, *Les stations françaises de biologie marine et leurs périodiques entre 1872 et 1914*, [Doctoral Thesis], École des Hautes Études en Sciences Sociales, Centre Alexandre Koyré, (7 July 2005).

aquarium and a work stall or laboratory[.]”<sup>142</sup> Despite conflict with the local townspeople, by 1891 Lacaze-Duthiers had succeeded in acquiring a large section of the town’s waterfront for the exclusive use of the station.<sup>143</sup>

However, work at Roscoff was limited primarily to the summer season. Brittany is famous for its fierce winter storms, with waves engulfing the northern French coastal towns and causing considerable property damage. Under these conditions marine work is rendered “perilous and collecting at times impossible.”<sup>144</sup> Because of these seasonal limitations Lacaze-Duthiers founded a second marine laboratory in the small fishing town of Banyuls-sur-mer on the shores of the Mediterranean in the Pyrénées-orientales in 1881. Named “Arago” after the mathematician and astronomer François Arago (1786 – 1853) born in the regional capital of Perpignan, the station benefitted, unlike its sister institution, from local backing and financial support – though once established, like Roscoff, it also received financial subvention from the ministry of public instruction. In a report published in 1881, Lacaze-Duthiers wrote: “In my last communication, I was still undecided about the location for the installation, I was spoilt for choices, because two localities argued over possession of the laboratory; since then, it must be said, Banyuls-sur-Mer forced my hand.”<sup>145</sup>

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<sup>142</sup> Lacaze-Duthiers, “Les progrès de la station zoologique de Roscoff et la création du laboratoire Arago à Banyuls-sur-mer,” *Archives de Zoologie Expérimentale et Générale*, Vol. 9, (1881), 556.

<sup>143</sup> This was a point of contention between the Station and the local government administration. See Louis Joubin’s remarks in the visitor log, 14 September 1887. Roscoff Station Archives.

<sup>144</sup> Charles Kofoid, “The Biological Stations of Europe,” *Bulletin of the United States Bureau of Education*, No. 4, (1910), 68.

<sup>145</sup> Henri Lacaze-Duthiers, “Zoologie. – Les laboratoires maritimes de Banyuls-sur-Mer et de Roscoff,” *Comptes Rendus Hebdomadaires des Séances de L’Académie des Sciences*, Tome 93, (Paris: Gauthier-Villars, 1881), 764. The competing locality was the

By 1910 the Arago station also received an annual subvention of 3500 francs from the Ministry of the Marine for fisheries research. In exchange, the station reserved a research room for the exclusive work of a member of the national fisheries service. Research was the primary focus of the work conducted at Arago, unlike Roscoff where instruction was given precedence. Also unlike Roscoff – but in this way resembling Dohrn’s station at Naples – the Arago station was designed to include a public aquarium (which operates to this day).<sup>146</sup> As at Roscoff, the station occupied a large section of the waterfront and each visiting scientist was given a private research room. By 1910, the laboratory could accommodate a maximum of twenty investigators at a time, the average number working at the station each year being about thirty. Though the Arago station remained open all year, Kofoid notes that in winter even on the Mediterranean “the cold ‘mistral’ from the mountains sometimes brings chill and discomfort [...] effectively preventing work at sea.”<sup>147</sup> Another problem often remarked upon at Roscoff, was the lack of light in winter. Prior to the installation of electric lighting, winter fog limited the

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neighboring town of Port-Vendres. The competition seems to have been over revenue generated by the station from the influx of visitors, from salaries, and rent fees. Lacaze-Duthiers estimated that in the first twelve years of operation, the Banyuls stations had brought 60,000 francs in revenue to the community through rent fees and an additional 43,800 francs had been dispensed in salary to local sailors. Henri Lacaze-Duthiers, “Les Laboratoires de Roscoff et de Banyuls,” *Revue Scientifique*, Quatrième Série, Tome 3, (Paris: Bureau des Revues, 1895), 230.

<sup>146</sup> Lacaze-Duthiers notes, however, that the Banyuls aquarium was often operated at a loss since most visitors arrived during the summer months when the scientific work had moved to Roscoff. The cost of keeping the aquarium running year-round was expensive. Henri Lacaze-Duthiers, “Les Laboratoires de Roscoff et de Banyuls,” 230. Lacaze-Duthiers imagined, however, that the aquarium would excite the interest of local fisherman, effectively recruiting them to aid in the work of the station. Lacaze-Duthiers, “Les progrès de la station zoologique de Roscoff et la création du laboratoire Arago à Banyuls-sur-mer,” 590. Roscoff opened a public aquarium only in 1952 (it has been closed since 2004 with no prospective re-opening date).

<sup>147</sup> Kofoid, “The Biological Stations of Europe,” 72.

daylight hours during which laboratory work could be done.<sup>148</sup> Arago, under the bright Mediterranean sun, provided access to a very different natural environment. Situated at the far western edge of the *golfe du lion*, the waters off the coast of Banyuls drop off rapidly into a series of underwater canyons (one is named after Lacaze-Duthiers) that stretch, finger-like, into the continental shelf, some reaching depths of 2000 meters.<sup>149</sup> On the continental plate, however, depths remain comparatively shallow, and Kofoid describes the region as “the principal fishing ground on the south coast of France.”<sup>150</sup> If Roscoff provided easy access to a tidal estuary, Arago provided access to the open sea.<sup>151</sup>

Deep-water work was facilitated by the acquisition in 1893 of a 22-ton steamship, the *Roland*, made possible by a gift of 50,000 francs provided by Prince Roland Bonaparte.<sup>152</sup> The station also acquired diving gear – later used by Louis Boutan for

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<sup>148</sup> I was unable to determine exactly when electricity was installed though an undated entry in the visitor log for the year 1888 by a professor from the University of Charkoff notes that electric lighting had been installed recently “permitting work at night,” and offering the promise of electrical experimental work on marine organisms, “a field of study still under-cultivated which may produce excellent fruit.” Roscoff visitor log, 1888. Roscoff Station Archives.

<sup>149</sup> The canyon was named by G. Pruvot, a later director of the Arago station and former student of Lacaze-Duthiers. See G. Pruvot, “Contribution à la topographie et à la faune du golfe du lion,” *Annales de l’Université de Grenoble*, Vol. 7, No. 4 (1895).

<sup>150</sup> Kofoid, “The Biological Stations of Europe,” 67.

<sup>151</sup> The website of the station states that the Arago “laboratory is to become a site of reference in the area of observation and experimentation in deep-water habitats[.]” “Discovering the Depths of the Lacaze-Duthiers Canyon.” [Accessed online 28 April 2014]

[http://www.upmc.fr/en/university/marine\\_stations/oceanology\\_observatory\\_of\\_banyuls\\_sur\\_mer/discovering\\_the\\_depths\\_of\\_the\\_lacaze\\_duthiers\\_canyon.html](http://www.upmc.fr/en/university/marine_stations/oceanology_observatory_of_banyuls_sur_mer/discovering_the_depths_of_the_lacaze_duthiers_canyon.html).

<sup>152</sup> A great-nephew of Napoleon I, Roland (1858 – 1924) entertained a broad range of scientific interests, which included geography, ethnography, and the scientific applications of photography. The *Roland* was constructed nearby at Seyne-sur-Mer. Henri Lacaze-Duthiers, “Les Laboratoires de Roscoff et de Banyuls”, 228.

experiments in underwater photography.<sup>153</sup> Because of the station's remote location, much of the equipment, both for the laboratories and the *Roland*, had to be built on site. To this end, a workshop was constructed and a full-time mechanic hired.<sup>154</sup> Gradual improvements made in the following years included the addition of a dark room for photographic work and a saltwater reservoir. Between 1893 and 1894 Lacaze-Duthiers estimated total expenses accrued amounted to over 85,000 francs, obtained through private donation. It is thus no surprise that Lacaze-Duthiers imagined himself an "itinerant monk" always in search of financial donations.<sup>155</sup>

Nevertheless, when the American naturalist Charles Kofoid travelled through Europe in 1908, charged by the American government to produce a report on European biological stations, he was particularly impressed by what he found in France.<sup>156</sup> In the preface to the section of his report dealing with French marine stations he writes:

With over 500 miles of coastline bordering [...] the great tidal funnel of the English Channel, an equal extent fronting upon the Atlantic, and a Riviera upon the Mediterranean [...], France offered a field for the development of and differentiation of marine biological work unequalled among European states. She has also large maritime interests and fisheries, both local and on the distant shores of Newfoundland and Senegal, of great and growing extent. The scientific work of the French fisheries bureau has not been developed on an independent footing, but has been attached to or associated with existing biological stations and

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<sup>153</sup> Lacaze-Duthiers, "Les progrès de la station zoologique de Roscoff et la création du laboratoire Arago à Banyuls-sur-mer," 589.

<sup>154</sup> The French naturalist Louis Boutan, who famously conducted experiments in underwater photography at the Arago station, later wrote that the remote setting of the station was advantageous; the station became entirely self-sufficient. Louis Boutan, *La photographie sous-marine et les progrès de la photographie*, (Paris: Librairie C. Reinwald, 1900), 124.

<sup>155</sup> Henri Lacaze-Duthiers, "Les Laboratoires de Roscoff et de Banyuls," 228.

<sup>156</sup> See Deborah Day and Eric Mills, "Charles Atwood Kofoid and the Biological Stations of Europe," *Places, People, Tools: Oceanography in the Mediterranean and Beyond. Proceedings of the Eight International Congress for the History of Oceanography*, (Naples: Stazione Zoologica Anton Dohrn, 2013).

members of the biological faculties of the universities. Add to these factors the highly centralized national system of education, with its practically coequal subdivisions, and finally and principally, the large share which men of scientific interests and training have had in shaping and developing educational policies and practice, and we have the potent influences which have led to the establishment of no less than twenty-six marine or freshwater biological stations in France.<sup>157</sup>

In Kofoid's view, the success of France's marine stations could be attributed to availability of institutional support, state support (motivated by commercial interest), and, most importantly, favorable geography. To weigh Kofoid's claim we must consider the importance of place and space at different scales. First, at the national scale: what set France apart from England and the United States? Why was the establishment of marine stations in France unrivalled worldwide? At the regional scale: why were the first marine stations built in Northwestern France? And at the local scale: what were the geographical considerations that determined where stations were built?

*The Sea Travels Inland: Re-discovering the Marine Environment:*

*At ebb-tide [the Ocean] manifests, and, in some sort, presents to you, the rich life he nourishes. You must follow, step by step, the retiring waves[.][...] If you look closely you will perceive that the sand is not, as you at first thought it, dead, but here and there moved by numerous lingerers that the ebb-tide has left behind. [...] [I]mmense and unexplored spaces are left bare, and we can survey that mysterious bottom of the sea, on which we have so often speculated and dreamed.*

– Jules Michelet, *La Mer* (1861)<sup>158</sup>

The late nineteenth century has been described as a time when Europeans and North Americans gained a new appreciation for the sea. As Helen Rozwadowski writes, “the blue water became a destination rather than a byway or barrier.”<sup>159</sup> The shore became a place to visit for health and leisure; yachting and fishing became favourite

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<sup>157</sup> Charles Kofoid, *The Biological Stations of Europe*, 35.

<sup>158</sup> Jules Michelet, *La Mer*, (Paris: Librairie de l. Hachette et Co., 1861), 384.

<sup>159</sup> Helen Rozwadowski, *Fathoming the Oceans*, 6.

pastimes of the rich, and maritime fiction came into its own, embodied in the works of Robert Lewis Stevenson, Herman Melville, and Jules Verne. But if people were turning from the landlocked interior towards the sea, the world of the sea was also moving inland.

The railroads, which brought visitors to the coast, also allowed the transport inland of living or freshly caught marine organisms. The revolution in transport had two important effects: it boosted the commercial value of the marine fishing industry by opening new markets and driving demand for increased production; and it facilitated the work of inland naturalists who, previously hindered by geographic distance, could now study, and experiment with, freshly caught marine organisms. Naturalists could now receive specimens sent from the coast by rail without leaving the laboratories of their landlocked cities. Rapid transportation even offered the possibility of transporting living marine organisms. As one American visitor to Germany enthused in 1908:

Transportation of live fish for market purposes is now an established fact in Germany. [...] [O]n the Prussian state railways, the fish are being hauled over considerable distances. I am advised that shipments are being made to Berlin from Lyon, in France, and from as far south as Rumania. [...] So far only fresh water fish are being transported, but I understand that it is the intention to take up the transportation alive of salt-water fish.<sup>160</sup>

By the end of the nineteenth century, as a direct result of the transportation revolution, European and North American fishing industries reached an unprecedented scale.<sup>161</sup> As one American writer reported in 1907.

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<sup>160</sup> Unknown author, "Transportation of Live Fish," *New York Tribune*, (12 July 1908).

<sup>161</sup> Transportation was only one obstacle. Consumer demand also needed to be generated through marketing. See Ingo Heidbrink, "Creating a Demand: The Marketing Activities of the German Fishing Industry, c. 1880 – 1990," *The North Atlantic Fisheries: Supply, Marketing, and Consumption, 1560 – 1990*, ed. by David Starkey and James Candow, (Hull, UK: North Atlantic Fisheries History Association, 2006), 137 - 138.

Now the whole system of selling fish has completely changed [...]. Markets for the sale of fish have been opened in all parts of the country, and such a stimulus has been given to fishing as is little appreciated by many who might be supposed to understand something of what is going on around them. [...] The cost of carrying fish a hundred miles inland is now of trifling importance[.][...] The means thus afforded of disposing of any quality of fish, while yet only a few hours out of the water, and in a condition which not many years ago would in inland towns have been thought simply impossible, stirred up the fishermen to work with corresponding energy.<sup>162</sup>

Unlike the British, Canadian, and American fisheries of the 19<sup>th</sup> century, which have all received considerable scholarly attention in recent years, the history of the French fishery remains largely understudied.<sup>163</sup> The examination of but a few contemporary statistics, however, demonstrates the industrial scale of the saltwater fishery in late nineteenth-century France.

The most important fisheries were for North Atlantic herring and cod.<sup>164</sup> The bulk of this catch was landed in the ports of La Manche, in Brittany, followed by the ports of the Atlantic seaboard. In descending order of economic importance, other large-scale fisheries harvested sardines, herring, mackerel, mussels, anchovies, crustaceans, and oysters.<sup>165</sup> Fishing on an industrial scale rapidly depleted stocks. New England

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<sup>162</sup> E. Huntington Fallows, "Fisheries," *The New Werner Twentieth Century Edition of the Encyclopaedia Britannica* (Akron, OH: The Werner Company, 1907), 212.

<sup>163</sup> French historians have begun to fill this lacuna, however. See for example Xavier Dubois, *La révolution sardinière: pêcheurs et conserveurs en Bretagne Sud au XIX<sup>e</sup> siècle* (Rennes: Presses universitaires de Rennes, 2004) and Marc Pavé, *La pêche côtière en France (1715-1850): approche sociale et environnementale* (Paris: L'Harmattan, 2013).

<sup>164</sup> In 1879 the herring fishery brought in a total catch of 29,592,292 kilograms, while the cod fishery off the coast of Iceland and on the Grand Banks, produced a total catch of 33,786,913 kilograms. *Annuaire Statistique de la France* (Paris: Imprimerie Nationale, 1882), 366.

<sup>165</sup> *Annuaire Statistique de la France*, (Paris: Imprimerie Nationale, 1882), 366. An 1882 U.S. Consul report on the sea fisheries of France and Algiers described the French fishing fleet as consisting of 22, 891 boats and employing a total of 209, 241 people. By point of comparison, an 1884 estimate of the total population of France was 38,130,000.

fishermen working off the coast of Nova Scotia saw cod landings decrease by more than 50% between 1852 and 1859. They placed the blame on large French fishing vessels that frequented the Grand Banks, each armed with long lines deploying thousands of baited hooks.<sup>166</sup> Even more disastrous was the arrival of the steam trawl in the 1880s.<sup>167</sup> As the French scientist Julien Thoulet observed when he travelled to the Grand Banks on a French naval vessel in 1890, “Since the fishery is carried out in the most harmful way possible [...] this source of wealth will soon be exhausted forever.”<sup>168</sup>

France was at the forefront of the revolution in industrialized fishing, and it was there that the first modern steam trawlers were developed. Early experiments outfitting fishing vessels with steam engines were carried out in the late 1830s near the fishing port of Arcachon on the Atlantic seaboard. By 1876 a French company, whose name suggests

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“Probable Population of the World at the End of 1884,” *The Record Almanac 1885*, (Philadelphia: Philadelphia Record, 1885). The total value of the fishery for that year was estimated to be \$17, 941, 878 (adjusted for inflation this would be \$420,427,697.07 in 2012) *Commercial Relations of the United States with Foreign Countries During the Years 1882 and 1883. Annual Reports from the Consuls of the United States on the Commerce, Manufactures, Industries, etc., of Their Several Districts for the Above Year*. Vol. 1, (Washington D.C.: Government Printing Office, 1884), 405. By comparison, the total value of the freshwater *and* saltwater fisheries of the Dominion of Canada in 1883 was \$16, 958, 192. John H. Bissell, “The Canadian and American Fisheries of the Great Lakes”, *Biennial Report of the State Board of Fish Commissioners*, Vol. 8, (Lansing: Darius D. Thorp, State Printer and Binder, 1888), 72.

<sup>166</sup> Jeffery Bolster, *The Mortal Sea: Fishing the Atlantic in the Age of Sail*, (Harvard University Press, 2012), 10.

<sup>167</sup> Bottom trawl nets had been in use in the waters off the British Isles as far back as the 14<sup>th</sup> century. Ruth Thurstan, Julie Hawkins, Callum Roberts, “Origins of the bottom trawling controversy in the British Isles: 19<sup>th</sup> century witness testimonies reveal evidence of early fishery declines,” *Fish and Fisheries*, Vol. 15, Issue 3, (2013), 2.

<sup>168</sup> Julien Thoulet, *A Voyage to Newfoundland*, trans. and ed. by Scott Jamieson, (Montreal: McGill University Press, 2005), 50.

the scale of late nineteenth-century fishing aspirations, “Société de Pêche de l’Ocean,” was operating two commercial steam trawlers in the North Sea.<sup>169</sup>

In Europe, as on the east coast of North America, fishermen increasingly voiced concerns over the overexploitation of the saltwater fisheries. Particularly contentious was the use of trawls and driftnets, seen by many as overly exploitative.<sup>170</sup> In England petitions to the government resulted in the appointment of a series of royal commissions tasked with assessing the sustainability of British fisheries.<sup>171</sup> Nevertheless, the first commission report of 1866 dismissed the testimony of fishermen:

[F]ishermen, as a class, are exceedingly unobservant of anything about fish which is not absolutely forced upon them by their daily avocations; and they are, consequently, not only prone to adopt every belief, however ill-founded, which seems to tell in their own favor, but they are disposed to depreciate the present in comparison with the past. Nor, in certain localities, do they lack the additional temptation to make the worst of the present, offered by the hope that strong statements may lead the state to interfere in their favor, with dangerous competitors.<sup>172</sup>

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<sup>169</sup> Though the company seems to have been based in France, a Scotsman named W. S. Johnston was the founder. These steam trawlers were built by J. Elder and Company in Scotland. Henry Wood, “Fisheries of the United Kingdom,” *Sea Fisheries: Their Investigation in the United Kingdom*, ed. by Michael Graham, (London: Edward Arnold Ltd., 1956), 16. For more on Elder’s Fairfield shipbuilding company see W. J. Macquorn Rankine, *A Memoir of John Elder Engineer and Shipbuilder*, (Edinburgh: William Blackwood and Sons, 1871).

<sup>170</sup> A later commentator, writing in 1902, compared steam trawling in the North Atlantic fisheries to the decimation of the American buffalo, writing: “when the modern steam trawler, knowing the season when fish crowd into very limited haunts, gets at these grounds with his persistence and effective gear, it is not a too prejudiced view to take when we say that an exterminating hunt has begun.” W. S. Green, “The Sea Fisheries of Ireland,” *Ireland: Industrial and Agricultural*, (Dublin: Browne and Nolan, Limited, 1902), 374.

<sup>171</sup> Thomas Henry Huxley was appointed to three of these commissions.

<sup>172</sup> James Caird, Thomas Henry Huxley, and George Shaw Lefevre, “Sea Fisheries. Report of the Commissioners appointed to inquire into the Sea Fisheries of the United Kingdom,” *Annals of British Legislation: Being a Digest of the Parliamentary Blue Books*, ed. Leone Levi, Vol. 3, (London: Smith, Elder and Co., 1866), 189.

Despite all signs to the contrary, many scientists believed that the oceans were not being exploited to full potential. The celebrated British naturalist, Thomas Henry Huxley, in his address at the opening of the International Fisheries Exposition in London in 1883, lamented that British fisheries had yet to undergo the industrial transformation that had revolutionized commercial agriculture:

Within the last quarter of a century, [...] agriculture has been completely revolutionized, partly by scientific investigations into the conditions under which domestic animals and cultivated plants thrive; and partly by the application of mechanical contrivances, [...]. The same causes have produced such changes as have taken place in fishery, but progress has been much slower. [...] [M]y astonishment was great when I discovered that the practical fishermen, as a rule, knew nothing whatever about fish, except the way to catch them. In answer to questions relating to the habits, the food, and the mode of propagation of fishes—points, be it observed, of fundamental importance in any attempt to regulate fishing rationally—I usually met with vague and often absurd guesses in the place of positive knowledge. [...] [A]s to the application of machinery and of steam to fishery operations, it may be said that, in this country, a commencement has been made, but hardly more.<sup>173</sup>

Though scientific attention was increasingly turning to the sea by the mid-nineteenth century, marine science remained in its infancy.<sup>174</sup> State support for the development of marine science continued to be motivated primarily by military concerns; the depths needed to be sounded and accurately charted so that submarine telegraph cables might be laid. These state-driven projects had little investment in questions of marine biology or, for that matter, in management of fisheries. When Britain launched the

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<sup>173</sup> Thomas Henry Huxley, “Inaugural Address, Fisheries Exposition, London (1883),” *The Fisheries Exhibition Literature (1885), Scientific Memoirs V*. [Accessed online 29 April 2014] <http://aleph0.clarku.edu/huxley/SM5/fish.html>

<sup>174</sup> Marine conservation biologist and writer Callum Roberts has attributed the Commission’s inability to recognize the destruction of British fisheries as due to the fact that “in the absence of systematic fishery statistics [...] they were unable to see any clear trend in abundance.” Callum Roberts, *The Unnatural History of the Sea*, (Washington D.C.: Island Press, 2007), 142. As Jennifer Hubbard notes: “Fisheries biology was essentially a branch of science born out of the growing recognition that human activities were altering the environment.” Jennifer Hubbard, *A Science on the Scales*, 149.

famous *Challenger* expedition in 1872 some naturalists felt that the unprecedented allocation of state funds could have been better used to solve more practical scientific problems closer to home. Frank Buckland (1826 – 1880), the naturalist and fisheries inspector later wrote: “the natural conditions of the bottom of this great North Sea is in a scientific sense less well known than the deserts of Sahara. Yet this ‘Great Fish Farm’ of Her Majesty’s subjects is practically more important than the revelations made at vast expense to the country of the abyssal depths of far distant oceans.”<sup>175</sup> Buckland had created the first fisheries museum in the United Kingdom in 1865 – “The Museum of Economic Fish Culture” – in his own words, “intended as an Educational means of informing the public, not only as to the Natural History of Fish, but also as to their commercial uses, and as to the development of the fisheries of this country.”<sup>176</sup>

Despite the lack of widely available scientific information concerning the oceans, it was clear to both established and aspiring naturalists that the marine environment presented a fruitful field for scientific discovery, which also offered the possibility of resolving practical questions regarding fisheries management. Despite the infancy of marine science, the rapidity of stock depletion was evident to many. As W. Jeffrey

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<sup>175</sup> Frank Buckland, *The Natural History of British Fishes; Their Structure, Economic Uses, and Capture by Net and Rod*. (London: The Gresham Press, 1881), vii. Geoffrey Burgess writes of Buckland, he “remains the only one consistently calling for research into fishery problems, publicizing the activities of the industry, drawing attention to the national importance of fish in the diet, and acting as a focus for those in the industry and elsewhere who were interested and concerned about its proper commercial development.” Geoffrey Burgess, “Frank Buckland and the Buckland Foundation,” *British Marine Science and Meteorology: The History of their Development and Application to Marine Fishing Problems, Buckland Occasional Papers: No 2*, (1996) 20.

<sup>176</sup> Quoted in Geoffrey Burgess, *The Eccentric Ark: The Curious World of Frank Buckland*, (New York: The Horizon Press, 1967), 125. Burgess notes, however, that though the museum became a celebrated entertainment venue, visited by Queen Victoria and other members of the royal family, the information presented was of little scientific value

Bolster writes, “fisheries science [...] barely existed. [...] [Y]et the 1850s and 1860s were noteworthy not only in New England and Atlantic Canada, but in Great Britain and Norway as well, for fishermen’s insistence that governments do *something* to preserve the fish on which their livelihoods depended.”<sup>177</sup> Another scientist in attendance at the fisheries exposition in 1883, E. Ray Lankester (1847 – 1929), held a different view from that proffered by Huxley. In a paper summarizing the scientific results of the meetings he argued that it was “a mistake to suppose that the whole ocean is practically one vast storehouse”:<sup>178</sup>

[I]f we are to have effective legislation at the present day in regard to our sea fisheries – we must, before proceeding any further, have *more knowledge*. Those [...] who earnestly desire additional restrictive Fishery Laws should do their utmost to enable zoologists to carry on researches which will provide that accurate knowledge of fishes and shell-fish, their food-reproduction and conditions of life – which must be obtained before legislation can reasonably be proposed.<sup>179</sup>

Lankester and his supporters recognized that commercial fisheries were overexploited. They advocated the construction of seaside laboratories for fisheries research. Citing existing seaside laboratories in France, Holland, Italy, and the United States, Lankester argued that “by offering free accommodation in such a laboratory to competent investigators you may obtain a large amount of valuable results at a minimum of expenditure. [...] [T]hus the working power and the general interest of the scientific world in these institutions and their work would be enormously increased.” This effort eventually led to the creation of the Marine Biological Association and later to the construction of many of the British marine stations including Plymouth, Lowestoft, and

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<sup>177</sup> Jeffrey Bolster, *The Mortal Sea: Fishing the Atlantic in the Age of Sail*, 122.

<sup>178</sup> E. Ray Lankester, *The Scientific Results of the Exhibition*, (London: William Clowes and Sons, Ltd., 1883), 11.

<sup>179</sup> *Ibid.*, 14.

Millport.<sup>180</sup> In his 1883 Exposition address, Lankester described his vision of the ideal layout for a marine station:

Such a laboratory would stand near the shore, possess its own jetty and small harbour, with steam-launch for dredging and trawling, and other boats. Adjacent to it would be marine ponds for experiments in the culture of oysters, mussels, and whelks, and of various fish. [...] The basement [...] would consist of large well-paved rooms fitted with tanks, and an apparatus for the circulation of sea-water. Here animals would be kept for observation, and the produce of a day's dredging or trawling would here be sifted and sorted. On the ground-floor and first-floor would be spacious rooms, with large windows [...], and fitted with tables suited to the requirements of the microscopist. Small aquariums and pumping apparatus would also be provided [...]. Accommodation for ten workers, in addition to the director and his assistant, would thus be provided. [...] [A] complete zoological and piscicultural library would be established, and the means for writing and making drawings would be provided. The naturalists permanently and temporarily working here would in the course of a few years provide us with much-needed knowledge.<sup>181</sup>

However, Lankester believed that if the term “station” was applied too hastily to any zoological seashore endeavor it might damage the reputation of the relatively young field of marine zoology. After all, seaside collecting had, by the late 19<sup>th</sup> century, become a favorite pastime of the middle class. In an article in *Nature* published in 1880 Lankester wrote: “that any enthusiastic young person who may unfold his umbrella on the sea-shore and contemplate under its shadow the starfish washed to his feet – should say that he has ‘opened a zoological station’ may be strictly true so far as the etymology of the words ‘zoological’ and ‘station’ respectively is concerned; but it is at the same time a

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<sup>180</sup> David W. Sims and Alan J. Southward, “Dwindling fish numbers already of concern in 1883,” *Nature*, Vol. 439, No. 9 (February 2006), 660. It has been suggested that Lankester provided the basic layout design for the Plymouth station, the largest of the British stations. A. J. Southward, “The Marine Biological Association and Fishery Research, 1884 – 1924: Scientific and Political Conflicts that Changed the Course of Marine Science in the United Kingdom,” *British Marine Science and Meteorology: The History of their Development and Application to Marine Fishing Problems, Buckland Occasional Papers: No 2*, (1996), 67.

<sup>181</sup> E. Ray Lankester, *The Scientific Results of the Exhibition*, 21 – 22.

misleading announcement, and likely to do more harm than good to the cause of zoological stations.”<sup>182</sup> In Lankester’s opinion, marine stations were crucial for the advancement of marine science but, if they were to succeed, their purpose needed to be defined and standards of operation needed to be set.

*Exhibiting the Oceans – French Marine Science on Display:*

Many believed that a solution to declining fish stocks might be found through the artificial manipulation of fish populations.<sup>183</sup> And, as with the development of fisheries technology at sea, France was at the forefront of aquaculture research.<sup>184</sup> This was also the heyday of the exposition and technological fair. It is not surprising then, that we find a strong connection between aquaculture, marine science, and public expositions at the end of the 19th century. Furthermore, in popular discourse a frequent correlation was made between the state of national fisheries and national power. A satirical passage from *Punch* belies contemporary British concerns over France’s maritime military aspirations: “the ocean a French lake and England at the bottom of it.”<sup>185</sup>

In France, one of the most important fisheries expositions of the period was held in Arcachon in 1866. It was organized in part by the local scientific society, founded in

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<sup>182</sup> E. Ray Lankester, “An American Sea-Side Laboratory,” *Nature*, (March 25, 1880), 498.

<sup>183</sup> In France, the sardine fishery was particularly important to the economy in Brittany and, during the early twentieth century, was subject to periodic collapse. Tim D. Smith, *Scaling Fisheries: The Science of Measuring the Effects of Fishing, 1855 – 1955*, (Cambridge: Cambridge University Press, 1994), 14. See also, “French Sardine Crisis – Brittany Fishermen Making Small Catches – The Probable Causes,” *The Montreal Gazette*, (Feb. 22, 1908), 13.

<sup>184</sup> Olivier Levasseur has called Napoleon III’s Third Empire the “golden age” of French aquaculture. Olivier Levasseur “La culture des mers en France au XIXe siècle,” *Observation des écosystèmes marin et terrestre de la Côte d’Opale: du naturalisme à l’écologie*, ed. by François G. Schmitt, (Paris: Union des océanographes de France, 2011), 97.

<sup>185</sup> “Punch’s Sentiments,” *Punch Magazine*, 7 (1844), 213.

1863, which created a biological station in 1867 and, after the completion of the exposition, a marine museum-aquarium.<sup>186</sup> In preparation for the exposition, the organizers published a lengthy questionnaire in the *Bulletin of the Imperial Society of Zoological Acclimatization*. This questionnaire was divided into three main sections: Natural History, Technology, and Aquaculture and Social Economics. Each section was headed by a thematic phrase or quote: “dominate the fish of the sea,”<sup>187</sup> “Is aquiculture [sic] to the fishery what agriculture is to hunting?” and finally, “If agriculture furnishes us with soldiers, the fishery furnishes us with sailors.”<sup>188</sup>

A British author provided his impressions of the exposition, taking the opportunity to voice concerns about what he saw as the weakened state of the British navy in the face of expanding French naval power. He suggested that the fisheries, and even aquaculture, were key elements of the French military strategy.

Aquiculture [sic] in every form is wrought so that it shall tend to ‘the glory and strength of France.’ Even the expositions at Arcachon and Boulogne are [...] visible tokens of the *rôle* which the Emperor would have populations [...] adopt. [...] the French Government is rapidly extending an industry which produces very large [...] revenues. This therefore, is not only strength and glory; it is internal wealth wherewith to support them[.]<sup>189</sup>

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<sup>186</sup> See R. Weill, “La station biologique d’Arcachon 1867-1968.” [Accessed online 29 April 2014] [http://www.sauvonslemuseeaquarium.org/wordpress/wp-content/uploads/2009/10/museeaquarium03-1\\_weill.pdf](http://www.sauvonslemuseeaquarium.org/wordpress/wp-content/uploads/2009/10/museeaquarium03-1_weill.pdf).

<sup>187</sup> From the book of *Genesis*, chap. 1, verse 28.

<sup>188</sup> “Exposition internationale de pêche et d’aquiculture à Arcachon, en juillet 1886. Formulaire de questions.” *Bulletin de la Société Impériale Zoologique d’Acclimatation*, (Paris: Victor Masson et Fils, 1866), 182 – 188.

<sup>189</sup> “The Exposition of Arcachon and its Object,” *Fraser’s Magazine: Fishing Excerpts*, Vol. 4, (1861-1868), 299.

And indeed, the Emperor's attention was turned to Arcachon, and he was presented with an exposition report.<sup>190</sup> But, by 1867 he had little time to implement its recommendations as he fell from power in 1871 with the end of the Franco-Prussian war.

When the naturalist Edmond Perrier (1844 – 1921), president of the Muséum of Natural History, addressed the assembled members of the *Congrès International d'Aquiculture et de Pêche*, he concluded his speech by noting that while the Stockholm International Conference on the Exploration of the Sea, in June 1899, had shown that men of science could “overcome the limits of their nationalism for the greater good of humanity,” such idealism was dangerous:

Out of this is born that notion of perpetual peace and of universal patriotism, dangerous utopia, for war is the law of the world and competition the spirit of social progress. [...] Alcohol suppresses the taste for action, and our sailors drink too much. [...] [W]e may fear catastrophe.

Perrier called upon “fishermen” to exercise their “vivifying action” on the navy and on the country, for which he received thunderous applause.<sup>191</sup> The fate of France rested on her control of the marine environment; and it was by supporting fishermen, the fishery, and the science of aquaculture that France might assert her dominion.

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<sup>190</sup> P. Lacoïn, “Rapport à L'Empereur sur l'exposition internationale de Pêche et d'Aquiculture d'Arcachon,” (Paris: Typographie E. Panckoucke, 1867). Expositions were an important means for promoting marine science in France, a trend that continued into the early 20<sup>th</sup> century. The colonial exposition in Paris in 1900 exhibited the work of the Oceanographic Institute of Indochina. The 1906 colonial exposition of Marseille featured a “Palace of the sea”, and the international and maritime exposition of Bordeaux in 1907 included displays featuring the work of French marine zoologists, of Albert the 1<sup>st</sup>, Prince of Monaco, and charts produced by the Hydrographic Service and the Oceanographic Society of the Gulf of Gascogne. See Jules Girard “L'océanographie à l'Exposition maritime de Bordeaux”, *La Géographie: Bulletin de la Société de Géographie*, Vol. 16, (1907), 111 – 113.

<sup>191</sup> M. J. Pérard and M. Maire, *Congrès International d'Aquiculture et de Pêche Tenue à Paris du 14 au 19 Septembre 1900. Procès – Verbaux Sommaires*, (Paris: Imprimerie Nationale, 1900), 13.

*Beginnings – The First Stations:*

*It is not necessary to undertake distant voyages, always over much too quickly, and generally too filled with the collection of the riches which present themselves for one to devote oneself, [...] to minute, specialized investigations which much be undertaken over a longer period of time. A sojourn on certain points of our coast is more favorable to this type of research. More master of one's time, one can then chose the localities which are convenient, stay as long as one wishes, without failing to neglect any of the circumstances proper for the facilitation of the work, or the precautions guaranteeing exactitude.*

– Jean Victor Audouin and Henri Milne – Edwards, *Résumé des recherches sur les animaux sans vertèbres, faites aux îles Chausey*, (1828).<sup>192</sup>

Writing in 1896, the authors of a biography of Fridtjof Nansen, the famed Norwegian explorer and a former student at the Naples marine station, noted: “every educated man now knows, in a general way at all events, what a Zoological Station is.”<sup>193</sup> This statement would certainly not have been valid in the mid-nineteenth century and suggests the extent to which biological stations had become ubiquitous by the eve of the twentieth century. The first marine biological station built in Europe was established at Ostende, Belgium, in 1843 by the naturalist, and professor of zoology at the university of Louvain, Pierre-Joseph van Beneden using private funds. Though Belgian by birth, Beneden had been a student of Cuvier at the Museum of Natural History in Paris.<sup>194</sup> Little

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<sup>192</sup> Jean Victor Audouin and Henri Milne – Edwards, “Résumé des recherches sur les animaux sans vertèbres, faites aux îles Chausey”, *Annales des Sciences Naturelles*, XV, (1828), 7.

<sup>193</sup> Waldemar Christopher Brøgger and Nordahl Rolfsen, *Fridtjof Nansen, 1861 – 1893*, translated by William Archer, (London: Longmans, Green, and Co., 1896), 102.

<sup>194</sup> Cuvier, an expert in mollusks, passed on his inclination for seaside fieldwork collecting to many of his students, most famously to Henri Milne-Edwards and Jean Victor Audouin. Henri Milne-Edwards, famous among other things for being the use an underwater breathing apparatus for scientific fieldwork, was the mentor of Henri Lacaze-Duthiers. Edward A. Eigen, *Between Stations and Habitations: The Architecture of French Science at the Shore, 1830 – 1900*, Doctoral Dissertation, MIT Department of Architecture, (2000), 26 – 27. See also Jean Théodoridès, “Les débuts de la biologie

record remains of this first pioneering enterprise, however. Beneden's son Édouard later recalled that many prominent international scientists, including a young Henri Lacaze-Duthiers, visited the station.<sup>195</sup>

The first marine station built in France was established by Victor Coste (1807 – 1873) in the town of Concarneau on the south coast of Brittany in 1859. Coste, an embryologist, described his station as an “observatory of the ocean” where all arrangements had been made according to the requirements of “advanced studies.”<sup>196</sup> Coste enjoyed the patronage of Napoleon III, having previously been charged with writing a government report on the state of fisheries and aquiculture on the coasts of France and Italy.<sup>197</sup> Evidently, this official assignment led Coste to direct his own research towards aquiculture as well – his most notable experiments being attempts to extend oyster aquiculture in the bay of Saint-Brieuc in northwest Brittany. In an 1859 report to the Emperor, Coste enthused that by using artificial means the Saint-Brieuc oyster industry promised to become “inexhaustible.” He argued that the entire bay might

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marine en France: Jean-Victor Audouin et Henri-Milne Edwards, 1826 – 1829,” *Actes du 1er Congrès International de l’Océanographie (Monaco, 1966)*, Vol. 2, (1968), 417 – 437.

<sup>195</sup> Édouard van Beneden, “Compte rendu sommaire des recherches entreprises à la Station biologique d’Ostende pendant les mois d’été 1883,” *Bulletins de l’Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique*, Vol. 7, (Bruxelles, 1883), 458.

<sup>196</sup> Victor Coste, “De l’observation et de l’expérience en physiologie,” *Journal de l’anatomie et de la physiologie normales et Pathologiques de l’homme et des animaux*, Vol. 6 (1869), 659.

<sup>197</sup> Victor Coste, *Voyage d’exploration sur les côtes de France et d’Italie*, (Paris: Imprimerie Impériale, 1855).

become “a veritable granary of abundance” once “converted in its entirety to a vast field of production.”<sup>198</sup>

In a notice written in 1861, Coste described his latest additions to the station infrastructure:

I am building, [...] at Concarneau, a marine enclosure laboratory of 1500 meters of circumference, which will serve as a model for fishermen disposed to enter into the path of progress. They will witness by what means science creates, in constrained spaces, the conditions of the open ocean; how the numerous herds thus enclosed live and prosper.<sup>199</sup>

Coste described the outdoor enclosures as “a small sea in miniature” where the salt water was “renewed” twice daily, entering via a sluice gate “imitating flux and reflux” of the tides. In this fashion, Coste explained, “the captive species [...] find there all the conditions of the open sea. They live, they grow, reproduce freely, and when they present some interesting particularity, we take the subjects into the aquariums, in order to place closer to the eye of the observer the physiological phenomenon or the acts which are important to follow in their diverse phases.” As is clear from Coste’s description, the Concarneau station’s mandate was limited in scope, in the service of the fishery and, it was hoped, to further the practical science of aquaculture.

A self-proclaimed cutting-edge research institution, the station soon became a tourist attraction. As a British hunting guide informed readers:

[T]he little seaport of Concarneau [...] possesses a Marine Observatory, in the waters of which a great variety of sea-fish not only seem ‘to live at home at ease,’ but to disport themselves like creatures unconscious of captivity and in the enjoyment of perfect health. [...] Every hunter is, or ought to be, something of a

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<sup>198</sup> Victor Coste, “Rapport a sa majesté l’empereur sur les huîtres artificielles créées dans la baie de Saint-Brieuc,” *Voyage d’exploration sur les côtes de France et d’Italie*, (Paris: Imprimerie Impériale, 1855), 173.

<sup>199</sup> Victor Coste, “Pisciculture – L’établissement de Concarneau,” *Magasin Pittoresque*, Vol. 37, (1869), 300.

naturalist; and here, at Concarneau, the faculty of his observation will be directed to a new study – to the nature and habits of animals, not such, perhaps, as he has so long loved to pursue, but to denizens of the deep, the finny tribe, vertebrate and non-vertebrate, whose ways have hitherto been inscrutable and beyond the power of man’s ken.<sup>200</sup>

In reality, the station had become much more an aquarium than a research laboratory, far short of Coste’s lofty vision. An anonymously published critique appeared in the same journal in which Coste had announced the construction of the basins only a few years earlier. The author lamented that none of the basins were ever used for aquaculture, employed instead as holding tanks for wild-caught “crabs, lobsters, and langoustines” sold for private gain at the local fish market by the grounds keeper. The rooms, intended as laboratories, served instead for sardine canning.<sup>201</sup> Henri Lacaze-Duthiers recalled that Concarneau “offered only a single room for the work of researchers,” and that only the basins were of importance, holding “fish, oysters, and lobsters.”<sup>202</sup>

Following Coste’s station at Concarneau, two more French stations were founded, one at Arcachon in 1867, and another at Sébastopol in 1871, both privately operated. Dohrn’s celebrated Naples station was founded in 1872, largely with Prussian backing. In a Belgian report published in 1897 Dohrn’s station was acknowledged as a “palace installed in the largest and most luxurious fashion.” However, the author was also quick to point out that the Roscoff station, also founded in 1872, was the “first true university

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<sup>200</sup> William Lewis Davies, *Wolf-Hunting and Wild Sport in Lower Brittany*, (London: Chapman and Hall, 1875), 164 – 165.

<sup>201</sup> Victor Coste, “Pisciculture – l’établissement de Concarneau,” 300.

<sup>202</sup> Henri Lacaze-Duthiers, “Les Laboratoires Maritimes de Roscoff et de Banyuls en 1891,” *Archives de Zoologie Expérimentale et Générale*, Série 2, Tome 9, (1891), 256.

station, that is to say dedicated to the practical research of students, and not solely to the studies of professors.”<sup>203</sup> In this respect, Roscoff was very different from Naples.

*The Founder – Henri Lacaze-Duthiers:*

Henri Lacaze-Duthiers was the single most influential figure in the construction of marine stations in France. Born into an aristocratic family in southwestern France in 1821, the young “baron” Lacaze-Duthiers moved to Paris to study medicine, but soon discovered a passion for zoophytes. By 1854, he had taken a position as professor of zoology at the university of Lille, and in this post received government sponsorship for a voyage to the Mediterranean to study corals along the coast of Algeria.<sup>204</sup> The resulting “Monographie du Corail,” widely acclaimed both in France and abroad, secured his reputation as a specialist in coastal marine biology.<sup>205</sup> He capitalized on his success by relocating to Paris, where he became Maître de Conférences at the École Normale Supérieure in 1864, professor of zoology at the Muséum in 1865, professor at the Sorbonne in 1868, and member of the Academy of Sciences in 1871. However, the accomplishment for which he is best remembered is his establishment of a marine biological station at Roscoff in 1872 and another at Banyuls-sur-Mer in 1881. Both

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<sup>203</sup> René Sand, “Les Laboratoires Maritimes de Zoologie,” *Revue de l’Université de Bruxelles*, Tome III, (1897-1898), 10. The Algerian “coral fishery” was a valuable commercial export industry of the French colony.

<sup>204</sup> For a more lengthy description of this period of Lacaze-Duthiers’s life, and his voyages to the Atlantic and Mediterranean coasts see Henri Lacaze-Duthiers, *Notice sur les travaux scientifiques de M. F. – J. – Henri de Lacaze-Duthiers présentée à l’appui de sa candidature à l’académie des sciences*, (Paris: Institut de France, 1862).

<sup>205</sup> Henri de Parville, “Henri de Lacaze-Duthiers,” *La Nature*, N°1471, (3 August 1901). When Charles Darwin learned from Quatrefages that Lacaze-Duthiers would vote in support of his election as a corresponding member of the French Academy 1872, he wrote that he was delighted, having “long honored his name.” Quoted in Charles Darwin, *The Life and Letters of Charles Darwin Including an Autobiographical Chapter*, ed. by Francis Darwin, Vol. 3, (London: John Murray, 1887), 155.

stations provided accommodations and research laboratories for visiting naturalists, and were equipped with small aquariums open to the public.<sup>206</sup>

Initially, Lacaze-Duthiers's vision of the future of French marine biology extended much further than the tidal flats of Roscoff. He writes that his initial intention for going to Roscoff with his students was to begin "a survey of the zoological riches of the coasts of France and to direct the young zealous and adept in zoology [...] in the publication of work similar to that the English had made some time since for the oceans that bathe the coasts of Great Britain."<sup>207</sup> By mid-century British naturalists possessed the greatest technological expertise in collecting marine specimens at depth (a scientific advance which paralleled British advances in submarine telegraphy deployment and recovery).<sup>208</sup> In a letter to Huxley, dated the 14<sup>th</sup> of March 1861, Lacaze-Duthiers writes: "could you tell me by what procedure one obtains foraminifera at great depth. – I've been told that a particular sounding procedure is employed by the English."<sup>209</sup> It is easy to imagine that Lacaze-Duthiers, looking to the coastal surveys already completed by the British, believed that French marine science had fallen behind. Roscoff would be the

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<sup>206</sup> Louis Joubin, "Le Laboratoire Zoologique de Roscoff," *La Nature*, No. 648, (31 October 1885).

<sup>207</sup> Henri Lacaze-Duthiers, "A propos de la station des choetoptères et des myxicoles sur les plages de Roscoff et de Saint-Pol-De-Léon, cotes de Bretagne (finistère), *Archives de Zoologie Expérimentale et Générale: Notes et Revue*, Vol. 1, (1872), xvii. As early as 1839 the British Association for the Advancement of Science had formed a "dredging committee" at the instigation of Edward Forbes. This committee oversaw a coordinated effort to investigate marine life in the seas surrounding Great Britain and produced standardized blank forms on which naturalists could note the time and place dredging was undertaken, and the organisms recovered. Philip Rehbock, *The Early Dredgers: "Naturalizing" in British Seas, 1830 -1850*, *Journal of the History of Biology*, Vol. 12, No. 2, (autumn, 1979), 328.

<sup>208</sup> The first major report of the dredging committee was produced in 1850. See Rehbock, "The Early Dredgers," 341.

<sup>209</sup> Lacaze-Duthiers to Huxley, 14 March 1861, Imperial College of London archives.

starting point for a survey of comparable scale, serving as a base line for the comparison of biological diversity elsewhere along the French coast:

The station of Roscoff that I had come to know during two previous voyages (1868 and 1869) seemed to me so fertile in all things, that I wanted to take it as a type, discern the local fauna, extend to other important localities on our coast this study and in a comparative study over several years produce a zoological history of our littoral, a project in which each of us had brought their distinct and respective part of original observations and work.<sup>210</sup>

The Ministry of Public Education provided an annual subsidy of 3000 francs, nevertheless, funding often fell short, and Lacaze-Duthiers was often forced to take the expenses of the station upon himself. But, as Harry Paul has written, “fortunately, Henri Lacaze-Duthiers, an old bachelor content with the sexual activity of marine life, could afford her.”<sup>211</sup>

But, if Lacaze-Duthiers saw his work as part of a nationalist scientific re-awakening, he also viewed science as a pursuit worthy in and of itself, a collective endeavor that elevated the human spirit.<sup>212</sup> *The Times* of London published a short article summarizing the work at the Roscoff marine station on March 3<sup>rd</sup> 1881.<sup>213</sup> The author reported that the station had made “remarkable progress” and that, what had at first been “merely a primitive aquarium under a shed at the side of a garden” had become a “well-equipped station.” The region as a whole was becoming more accessible; and, by 1883, an overnight train connected Roscoff with Paris.

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<sup>210</sup> Ibid.

<sup>211</sup> Harry Paul, *From Knowledge to Power*, 108.

<sup>212</sup> Harry Paul describes Lacaze-Duthiers’ support for the popularization of science as adhering to “one of the basic republican dogmas.” Ibid., 111.

<sup>213</sup> Unknown author, “Progress of a French Zoological Station,” *The Times*, London (3 March 1881).

Writing in 1891, Lacaze-Duthiers felt he could declare Roscoff and Banyuls “complete,” noting that gradual improvement would always be necessary, but that the “means of research” for both stations “were largely assured.”<sup>214</sup> These “sister stations” were designed to complement one another. Students and professors travelled seasonally between the two stations, spending part of the summer at Roscoff and, in the winter, visiting Banyuls. Lacaze-Duthiers explained that, “there was a great advantage to having united under the same direction two laboratories offering a perfect unity of organization, under climates so different as those of the north and south of France and situated on seas as different as the Atlantic and Mediterranean.” This “exceptional organization” he continued, “permits young naturalists to easily complete their education with the same means and in completely different surroundings.”

Lacaze-Duthiers believed that all naturalists needed direct, hands-on experience with his subject of study. The work was a collective effort to be sure, but to be carried out with equality, liberty, and brotherhood. As Lacaze-Duthiers explained in a presentation delivered before the purpose of both stations was “to make naturalists.”<sup>215</sup> As far as he was concerned, the Naples station would never accomplish this aim because it removed students from the collection process. As an example, he described how a foreign naturalist, having previously worked at Naples, had asked him for permission to finish some embryological research at Banyuls. “You will find these animals when you look at the base of the laboratory [...] in the same conditions in which you collected them at Naples,” Lacaze-Duthiers reportedly informed him, to which the young naturalist replied,

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<sup>214</sup> Henri Lacaze-Duthiers, “Les Laboratoires Maritimes de Roscoff et de Banyuls en 1891,” 254.

<sup>215</sup> Henri Lacaze-Duthiers, “Le Monde de La Mer et ses laboratoires,” *Revue Scientifique*, Vol. 42, No. 6, Series 3, (11 August 1888), 37.

“I have never seen them in situ, they were brought to me, and I do not know their habitat.”<sup>216</sup> Lacaze-Duthiers believed that it was the experience of entering the field that made the zoologist. As he explained in one of his reports: “undoubtedly the young naturalist going to Roscoff will find all the means necessary for his work, but he will be forced to go out on the tidal flats, and this is above all what I desire, to look himself for animals and thus form his education;” adding, “our marine stations must serve to form zoologists.”<sup>217</sup>

In reality, Lacaze-Duthiers’s dismissal of the Naples station likely had much more to do with the fact that it received financial backing from Prussia; and that the founder, Anton Dohrn, proudly self-identified as Prussian. Lacaze-Duthiers’s distaste for all things Prussian undoubtedly stemmed back to the Franco-Prussian war, a sentiment shared by many of his compatriots. Unfortunately, this animosity helped contribute to the increasing insularity of France, at a time when Prussia was making rapid progress in quantitative research. This had long lasting effects on the development of marine science in France. While physical oceanography became increasingly the dominant branch of marine science in the rest of Europe, in France marine zoology continued to hold center stage.<sup>218</sup>

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<sup>216</sup> Ibid.

<sup>217</sup> Henri Lacaze-Duthiers, “Les progrès de la station zoologique de Roscoff et la création du laboratoire Arago à Banyuls-sur-mer,” 564.

<sup>218</sup> Mills has termed this “the paradox of French marine science: the virtual invisibility of France at a time when dynamic oceanography was making inroads into the way that physical oceanography was being practiced in Scandinavia, Germany, and the United States.” Eric Mills, *The Fluid Envelope of our Planet*, 163.

*Why Brittany? Marine Stations and the Moving French Frontier:*

For a Parisian travelling to the northwest coast of France in the late nineteenth century, the province of Brittany would have seemed foreign. Unlike the rest of France, which was primarily agricultural, Brittany's economy was dependent on the ocean and, in particular, on a few commercial fish species. Historian of France Eugen Weber has argued that, around 1870, France was "neither morally nor materially integrated; what unity it had was less cultural than administrative." Only at the very end of the nineteenth century through the shared experience provided by "roads, railroads, schools, markets, military service, and the circulation of money, goods, and printed matter," did French culture begin to become truly national.<sup>219</sup>

Even in the late nineteenth century many Bretons did not speak French, but Breton or Gallo. Even within Brittany, linguistic differences catalyzed distrust and hostility. As Webber explains:

Real hostility existed between Lower and Upper Brittany, a division based on the celtic speech of the west and the French dialect of the east. Bretons and Gallos disliked and despised each other, insulted each other and each other's women folk, and stood together only in their dislike of the French – notably the Normans, who returned the aversion with interest.<sup>220</sup>

French-speaking travelers sometimes compared the Bretons to "savages," envisioning the improvements to be brought to the region through moral as well as technological progress.<sup>221</sup> As the rector of the Academy of Rennes, advised in a report on the Breton departments in 1880: "Frenchify Brittany as promptly as possible [...];

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<sup>219</sup> Eugen Weber, *Peasants into Frenchmen: The Modernization of Rural France 1870 - 1914*, (Palo Alto: Stanford University Press, 1976), 486.

<sup>220</sup> Eugen Weber, *Peasants into Frenchmen*, 46.

<sup>221</sup> Eugen Weber, *Peasants into Frenchmen*, 4 – 5.

integrate western Brittany with the rest of France.”<sup>222</sup> Yet it was in this “foreign country,” more than in any other region of France that “French” marine biology was born.

In 1869 Lacaze-Duthiers, by then a professor at the Sorbonne, delivered a report on his fieldwork in Brittany to the French Academy of Science. The *Manchester Guardian* published a summary the report, highlighting the opportunities offered by the terrain at Roscoff:

The port of Roscoff, situated at the northern extremity of a tongue of land extending into the British Channel, between Morlaix and the Bay of Pouldu is surrounded by a number of shoals, which lie quite dry at low water, enabling the zoologist to explore their cavities. Here, moreover, the Gulf stream keeps up a mild temperature [...] To the north there is a long granitic bar, running from east to west, which protects the coast from the violence of the waves. Owing to all these causes, the marine fauna is particularly numerous in this locality. When the waters retire, they leave uncovered an extensive meadow of green algae and seaweeds thickly peopled with a variety of animals, such as ascidae, bryozaria, echinodermata, sponges, especially of the calcareous kind, &c.<sup>223</sup>

British naturalists were quick to note the potential opportunities offered by this new terrain, but a short distance across the Channel. A British researcher visiting the station in 1872 noted: “Roscoff seems to one peculiarly well adapted for a Invertebrate Zoological Station. Its retirement in contrast with other fashionable water places is a boon.” While the small rural community of Roscoff lacked the amenities of urban life, the geographical features of the terrain were rewarding enough. Describing the same features identified by Lacaze-Duthiers, the same visitor remarked that Roscoff presented “advantages to the zoologist rarely collected into such a convenient focus.”<sup>224</sup>

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<sup>222</sup> Quoted in Eugen Weber, *Peasants into Frenchmen*, 100.

<sup>223</sup> Unknown author, “Encrinites,” *The Manchester Guardian*, (December 24, 1869).

<sup>224</sup> James Murie, Visitor Book, 23 September 1875. Roscoff Station Archive.

As facilities at the station were improved, the scope of the scientific work expanded. When the German zoologist Carl Vogt visited in 1875, he remarked upon the improvements to the facilities since his visit the previous year. Notably, construction had begun on a building destined to house aquariums tanks. Thus, Vogt, predicted, “all preparations were being made so that invertebrate animals might be followed in their life processes, habits, and reproduction.” To these improvements he hoped a “steam embarkation,” to permit deep water dredging, would be added, the ultimate aim being to create “a veritable zoological chart of a country as rich as that of Roscoff.” Such a chart would register the distribution of marine organisms, the zones of depth, at which they were to be found, and seasons in which they appeared and disappeared. Vogt noted, however, that the project would require more resources than Roscoff possessed at the time.<sup>225</sup>

A record of the early years of the Roscoff station is provided by Henri Lacaze-Duthiers in the first issue of the scientific journal of which he was the founder, the *Archives de zoologie expérimentale et générale*. The first issue had been slated to appear in July 1870 but was delayed for two years because of the outbreak of the Franco-Prussian war. Lacaze-Duthiers, like many other French naturalists at the time, believed that the reinvigoration of French science was the necessary requirement for rebuilding the power and prestige of the nation in the wake of crushing defeat. In his introduction to the newly founded journal he writes: “the awakening of the intellectual movement in France

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<sup>225</sup> Carl Vogt, Visitor Book, 25 September 1875. Roscoff Station Archive.

is to our eyes inevitable. Its rationale is in our defeat. It must be without limit like our disasters and our misfortune.”<sup>226</sup>

Later, in an article entitled “Station du Pentacrinus Europaeus Sur Les Cotes de France,” Lacaze-Duthiers provides a description of the favorable situation of Roscoff:

The port of Roscoff, situated at the extreme north end of a large tongue of land which extends into the Channel, between the rivers of Morlaix, of Saint-Pol-de Léon to the east and the Bay of Pouldu to the west, is surrounded by reefs without number which are exposed at low tide and permit zoologists the most varied harvests; furthermore, the Gulf-Stream, coming along these coasts, brings into these regions a temperature which is eminently proper for the development of animals. Finally, to the north, a long granite band, like the rest of the rocks, going east-west, the Ile de Bass, forms a barrier against the waves of the high sea and protects the canal which she lets pass between her and Roscoff. As a result of these conditions, the fauna is particularly rich at this point of the littoral.<sup>227</sup>

*Marine Stations in Competition – The Naples Station:*

The development of the Roscoff station coincided with the creation of the marine station at Naples, undertaken by the Prussian scientist Felix Anton Dohrn (1840 – 1909), and founded, like Roscoff, in 1872. Dohrn was tireless in his efforts to promote his station at Naples, and advocate for the establishment of a global network of marine stations.<sup>228</sup> Dohrn was born to a wealthy family in the East Prussian city of Stettin (now in Szczecin) in 1840. After a short military career he entered the University of Jena in 1862 where, studying with Ernst Haeckel, he was introduced to Darwinism. Under

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<sup>226</sup> Henri Lacaze-Duthiers, “Avertissement,” *Archives de zoologie expérimentale et générale*, Tome 1, (Paris: Librairie Germer Bailliere, 1872).

<sup>227</sup> Henri Lacaze-Duthiers, “Station du Pentacrinus Europaeus Sur Les Cotes de France,”

xi.

<sup>228</sup> Jane M. Oppenheimer, “introduction”, *Von Baer – Dohrn Correspondence*, (Philadelphia: The American Philosophical Society, 1993), 4.

Haeckel's tutelage, Dohrn became increasingly interested in the study of the marine environment, a project which he soon took up with characteristic energy.<sup>229</sup>

The founders of both the Roscoff and Naples stations carefully considered the constraints and advantages of potential locations. Naples was not Dohrn's first choice of location. He initially hoped to establish a station on the straits of Messina, between Sicily and the Italian peninsula, favoring this region primarily because of local oceanographic conditions: upwelling facilitated the collection of marine organisms.<sup>230</sup> In a letter to Darwin, Dohrn laid out his plans:

Having stayed now several times on the seashore for zoological studies, I have found how difficult it is to study Embryology without an Aquarium. This want has suggested to me the idea of founding not only Aquariums, but Zoological Stations or Laboratories on different points of our European coast. Such a Station should consist of a little house of perhaps four rooms, an Aquarium connected with the sea and the house, - the Aquarium of perhaps 60 feet in Cubus, where one might have streaming water, - a boat for dredging work, dredges, nets, ropes, - in short, all that is necessary for a marine zoologist. [...] All this might be had at a not too high price at Messina, where I thought of founding the first Station. [...] I hope to get so much money during this winter and the next summer, that I might build next winter in Messina the little house and arrange it so as to have it ready in winter 1871.<sup>231</sup>

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<sup>229</sup> As Lankester later recalled: "He was what appeared to me, with my English upbringing, singularly introspective, and he puzzled, even occasionally alarmed, me by his self-conscious and systematic cultivation of his will-power." E. Ray Lankester, "Anton Dohrn," *Nature*, (7 October 1909), 430.

<sup>230</sup> An Italian journal article, written in 2012, describes the straits of Messina as an area "well-known for upwelling phenomena, due to tidal currents, that characterize the hydrodynamic regime and are responsible for the strandings of uncommon mesopelagic and deep-sea fauna." Pietro Battaglia, Giovanni Ammendolia, Teresa Romeo, Franco Andaloro, "Finding of *Eretmophorus kleinenbergi* (Moridae) in the central Mediterranean Sea 93 years after its previous record, with a first description of sagittae and fresh coloration," *Marine Biodiversity Records*, Vol. 5 (2012), 1. See also Mazzarelli G. "Gli animali abissali e le correnti sottomarine dello Stretto di Messina," *Rivista Mensile di Pesca e Idrobiologia* 11, (1909), 177–218.

<sup>231</sup> "Dohrn to Darwin, (30 Dec. 1869)," *Charles Darwin 1809 – 1882, Anton Dohrn 1840 – 1909: Correspondence*, ed. by Christiane Groeben, (Naples: Naples Zoological Station, 1982), 26.

Ultimately, though, Naples proved a better location for financial reasons. A booming tourism industry guaranteed a source of revenue for the station through the sale of entry tickets for an attached public aquarium.<sup>232</sup> Naples had also long been a favored destination for German intellectuals following in the path of Goethe.<sup>233</sup> But, working in Naples instead of Messina also meant working with different organisms, and in different conditions. The bay of Naples was heavily polluted, necessitating filtration of the water pumped into the aquariums. The British scientist, Ray Lankester, noted that while all visitors to Naples studied a “very interesting and abundant worm,” the *Sipunculus nudus*, he had not been able to obtain any eggs of the pelagic octopus *Argonauta*, which, he indicated, was “to be had in quantity at Messina.”<sup>234</sup>

Nevertheless, the Naples station thrived, attracting scientists and fostering international scientific alliances. Though the German anatomist Karl Gegenbaur, in a letter to Haeckel in 1875 referred disparagingly to “the German ‘stationists’” and stated that he had not heard “much to commend about This Station” dismissing Anton Dohrn’s book he dismissed simply as “nonsense.”<sup>235</sup> Dohrn’s tireless energy and prolific

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<sup>232</sup> Jane Maienschein, “History of American Marine Laboratories: Why Do Research At the Seashore?,” 18.

<sup>233</sup> Raf De Bont, “Between the Laboratory and the Deep Blue Sea,” 209. See also Christiane Groeben, “Tourists in Science: 19<sup>th</sup> Century Research Trips to the Mediterranean,” *Proceedings of the California Academy of Sciences – Fourth Series*, Vol. 59, Supplement I, No. 9, (September 2008), 139 – 154.

<sup>234</sup> Ray E. Lankester, “Summary of Zoological Observations made at Naples in the winter of 1871 – 72,” *The Annals and Magazine of Natural History*, Series 4, Vol.11, No. 62, (1873), 81 – 97.

<sup>235</sup> Gegenbaur to Haeckel, 17 May 1875. Quoted in Mario A. Di Gregorio, *From Here to Eternity: Ernst Haeckel and Scientific Faith*, (Göttingen: Vandenhoeck & Ruprecht, 2005), 333.

publications promoting the station secured the support of prominent naturalists throughout Europe.

In his report on the biological stations of Europe, Kofoid lauded the Naples Station as preeminent above all others:

Foremost among the biological stations of the world in the extent and completeness of its material equipment and in the wealth of opportunities it offers, inspiring in its history and unparalleled in its growth, unsurpassed in its contributions to biological science, profound in its influence upon the course of development of modern biology, and powerful in its stimulus to the establishment of biological stations elsewhere, stands the zoological station of Naples, the peer and leader of them all.<sup>236</sup>

He even explained the lack of marine stations in Italy in comparison to the many in France, as attributable to the Naples' Station's overwhelming success.<sup>237</sup> Certainly those naturalists who came to work at Naples were not disappointed by what they found. For instance, the Norwegian explorer Fridtjof Nansen, who visited the Naples station in 1886, described it as a "central organ for zoology," and "international scientific exchange where the various peoples meet and join hands, where research is carried on with assiduity, and where the burning scientific questions of the day are sifted and discussed in a fashion which helps in no small degree to render a stay [...] inspiring and profitable."<sup>238</sup>

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<sup>236</sup> Charles Kofoid, *Biological Stations of Europe*, 8.

<sup>237</sup> "That [marine stations] have not multiplied here as in France is doubtless in part due to the preeminent excellence of the great station at Naples (1872) whose ample facilities provide opportunities for a large number of investigators, and in which Italy has always had a large representation." *Ibid.*, 7.

<sup>238</sup> Nansen recorded his impressions of the Naples station in an article published in 1887 in the Norwegian journal *Naturen*. I have relied on excerpts provided in the English language translation of Nansen's biography. Waldemar Christopher Brøgger and Nordahl Rolfsen, *Fridtjof Nansen, 1861 – 1893*, trans. by William Archer, (London: Longmans, Green, and Co., 1896), 109.

Unlike Roscoff and Banyuls, where resources were directed primarily toward instruction, Dohrn promoted Naples solely as a research station. Much of the work followed the experimental science of the German Embryologist Wilhelm Roux (1850 – 1925). The work of experimental embryology was heavily dependent on the use of sea urchins. Developing embryos were subjected to centrifugation, exposure to chemicals, and electric and magnetic fields, in order to observe the effects on development.<sup>239</sup> The purpose of these experiments was to determine whether development was driven by external stimuli or internal mechanisms.<sup>240</sup> As Jennifer Hubbard notes, the Naples station and the Marine Biological Laboratory in Woods Hole “were essentially biological laboratories in marine settings, not marine biological laboratories.”<sup>241</sup> In other words, much of the work carried out at these stations was aimed at understanding biological processes rather than at tackling questions related specifically to the marine environment.

It might surprise that Dohrn and Lacaze-Duthiers, whose scientific projects seemed to run in parallel, and whose geographical terrains did not overlap, should have found cause for disagreement. Yet, each cast the other as a competitor. Lacaze-Duthiers

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<sup>239</sup> Jennifer Hubbard, *Science on the Scales*, 35.

<sup>240</sup> Paul Farber, *Finding Order in Nature: The Naturalist Tradition from Linnaeus to E. O. Wilson*, (Baltimore: Johns Hopkins University Press, 2000), 81. Urchins are particularly useful model organisms for experimental work as they can be artificially stimulated to spawn, by shaking, electric shock, or injection with potassium chloride. A single urchin produces tens of thousands of eggs. Furthermore, sea urchin cells, like those of all echinoderms, undergo radial holoblastic cleavage, which facilitates comparative study. Because sea urchins made ideal model systems for embryological work they are still employed by marine biologists to this day.

<sup>241</sup> Paul Farber, *Finding Order in Nature*, 81.

referred to Dohrn as “that Prussian scientist in Naples” while Dohrn referred to Lacaze-Duthiers as his “particular rival.”<sup>242</sup>

Both had their problems with the local population, Dohrn writing at one point: “The difficulties in this country are something quite unheard of for all of us northern people. The indolence, dishonesty, hatred even against a good and disinterested enterprise, are quite regular qualities with this people, and it wants one’s last resources of nervous energy to overcome the physical hindrance and the moral disgust, it fills one with.”<sup>243</sup> Dohrn (like other continental naturalists, such as Prince Albert I) turned to the British for custom-order material and technological expertise. All the equipment for the laboratories had to be imported, including pumps, pipes, and sheet glass – much of it coming from England.<sup>244</sup>

Lacaze-Duthiers may have been fiercely competitive with the Naples station, yet he (like Dohrn) was supportive of international marine work elsewhere. The Egyptian oceanographer and historian Selim A. Morcos has shown that the Alexandrian naturalist Osman Ghaleb (1845 – 1920), who studied with Lacaze-Duthiers at Roscoff, maintained a lengthy correspondence with him after his return to Egypt. Lacaze-Duthiers wrote of his pupil, “[Galeb] spent one month at Roscoff to familiarize himself with the methods of

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<sup>242</sup> See Dohrn to Von Baer, (8 February 1873), *Correspondence: Karl Ernst von Baer – Anton Dohrn*, ed. by Christiane Groeben (Philadelphia: The American Philosophical Society, 1993), 46. Liselotte Dieckman translates the passage from Dohrn’s letter to his sister as “my special competitor.” Theodor Heuss, *Anton Dohrn: A Life for Science*, trans. by Liselotte Dieckman, (Berlin: Springer-Verlag, 1991), 239. See also Dohrn’s critique of French “national prejudice.” Anton Dohrn, “The Zoological Station at Naples,” *Nature*, Vol. 43, (19 March 1891), 466.

<sup>243</sup> Dohrn to Darwin, 15 Feb. 1872, *Dohrn Darwin Correspondence*, 39.

<sup>244</sup> Theodor Heuss, *Anton Dohrn: A Life for Science*, 151.

fishing and the research applied in the station, with a view of the studies he is planning to carry out in the Red Sea.”<sup>245</sup>

*The “Scientific City” – A Hybrid Social Space:*

At the conference of the French Association for the Advancement of Science in 1888, Lacaze-Duthiers delivered a speech entitled: “The World of the Sea and its Laboratories.”<sup>246</sup> Playing the part of a gracious host, he described the physical properties of various marine animals, telling his audience, “come to Banyuls, and, if the sea remains beautiful and the wind is favorable, you will see rows of Venus girdles arriving from the open ocean to wash up at the feet of the Arago laboratory.”<sup>247</sup> Lacaze-Duthiers’s obituary in *La Nature* (1901) noted that many readers would remember their friendly reception at the Banyuls station during an organized “voyage scientifique” in 1899.<sup>248</sup> Hospitality, with the promise of a pleasurable working holiday, was a notable aspect of the culture of Lacaze-Duthiers’ stations.

It must also be noted that Lacaze-Duthiers’s dedication to using the stations for both research and instruction, emulated a long established French scientific institutional model. The preeminent scientific research institution in France, the Paris Museum of Natural History in the *Jardin des Plantes*, had offered training courses zoological

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<sup>245</sup> Henri Lacaze-Duthiers, *Rapport sur l’École pratique des hautes études 1877 – 1878, 1878 – 1879*, (Paris: Imprimerie nationale, 1879), 90. Quoted in Selim A. Morcos, “Marine Sciences in Egypt,” *Places, People, Tools: Oceanography in the Mediterranean and Beyond*, Proceedings of the Eight International Congress for the History of Oceanography, ed. by Christiane Groeben, (Naples: Giannini Editore, 2013), 19. Morcos notes, however, that Egypt had historically been a site of competing colonial interests between Britain and France.

<sup>246</sup> Henri Lacaze-Duthiers, “Le Monde de La Mer et ses Laboratoires,” 162.

<sup>247</sup> Henri de Lacaze-Duthiers, “Le Monde de La Mer et ses Laboratoires,” 166.

<sup>248</sup> Henri de Parville, “Henri de Lacaze-Duthiers,” 159.

fieldwork as early as 1815.<sup>249</sup> The stations served as a field school where visiting students could learn the practical skills required to pass their university exams. French students who visited the station were either preparing to be *licencié*, or had passed their exams and were working on thesis projects. The Roscoff and Banyuls model, combining research with scientific instruction, set a precedent for other French marine stations, one later emulated by Lacaze-Duthiers's students: Alfred Giard at Wimereux in 1874, and Edmond Perrier at Tatihou in 1887.<sup>250</sup>

Lacaze-Duthiers proudly claimed that his stations permitted students and naturalists with limited means access to specimens and tools that would otherwise have been prohibitively expensive. He publically criticized Dohrn's station as excessively costly to users, though he never questioned the quality of the scientific work accomplished there. "In Naples also they send out animals that are perfectly conserved, prepared through secret procedures, but which are very expensive; I have received some where the price was excessive. The living animals at Banyuls and Roscoff are all just as useful and certainly less costly, as one doesn't pay for them and each of my colleagues can prepare them for his collections as he sees fit."<sup>251</sup> In this respect as well, the editors of a British scientific journal compared Roscoff favorably to the British Plymouth station when cost of attendance was considered:

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<sup>249</sup> See Richard Burkhardt Jr., "Naturalists' Practices and Nature's Empire."

<sup>250</sup> Raf de Bont, "Between the Laboratory and the Deep Blue Sea," 215. See also Michel Glémarec, *Qu'est-ce que la biologie marine? De la biologie marine à l'océanographie biologique*, (Paris: Vuibert, 2010), 72 – 75. Tatihou received approximately 25% of its funding from the Ministry of Fisheries. Tim Smith, *Scaling Fisheries: The Science of Measuring the Effects of Fishing, 1855 – 1955*, 26.

<sup>251</sup> Henri Lacaze-Duthiers, "Le monde de la mer," 39. Note L-D's use of the term "secret," which is in marked contrast to way he describes Roscoff and Banyuls.

[W]hen we consider the amount of purely biological investigation that is carried on at these laboratories, and the numbers of zoologists that come to them, a calm examination of the facts will show a very large balance on the side of the French. The Roscoff laboratory is thronged every summer, not merely with students, but with investigators from all parts of the world, including England, while the same may be said of the corresponding laboratory at Banyuls[.][...] To work for a month at Plymouth the student must pay £5 for his table, he will be charged extra for all above a small allowance for material and reagents, he will have to take lodgings in the town, and [...] will doubtless make some suitable present to the attendants. At Roscoff during the same period, the student is charged nothing for the use of the table, he is permitted as much of the various reagents, even of absolute alcohol, as any reasonable man can want, he can have a bedroom at the laboratory, and, when he leaves, he will only be expected to leave behind him ten francs for the attendant and fifteen francs for the servant that looks after his bedroom.<sup>252</sup>

The much-affirmed value of scientific liberty meant more than freedom from financial constraint, however. It also meant freedom of study. Lacaze-Duthiers hoped his stations would produce “zoologists” but little in the organization of the station forced any particular specialty on visiting students. This freedom was appreciated; as one student who visited Roscoff remarked in the visitor log:

Almost a stranger to the study of the natural sciences upon my arrival at Roscoff, I leave having acquired already a sufficiently precise knowledge of this science, from the dissections, from the lectures and meetings, and above all from the constant contact with real living nature[.][...] I have enjoyed the complete liberty, which, permitting us to chose for ourselves the subject of our studies, to work at our own pace, to undertake research on the tidal flats, dissection and study of theory, renders the work more varied, more personal, more appealing.<sup>253</sup>

Entries in the Roscoff Station visitor book repeatedly praise the sense of community fostered by the station. Describing recent expansions, one visiting naturalist enthused, “the establishment in its entirety is no longer a house; I voluntarily call it a

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<sup>252</sup> “The Toilers of the Sea,” *Natural Science*, No. 33, Vol. 5, (Nov. 1894), 324.

<sup>253</sup> Roscoff visitor log entry, 3 September 1888. Roscoff Station Archives. This letter is by René Worms, then a student at the école normale supérieure. This is in all likelihood René Worms (1869 – 1926) who went on to become not a zoologist but a prominent lawyer.

small town; it is a scientific city that has developed on our coast of Brittany, just like those large American cities which one sees in but a few years replace a simple hamlet.”<sup>254</sup>

Another visitor described “the most agreeable camaraderie.” At Roscoff he had found himself “in a real scientific circle, a little world full of work and enthusiasm.”<sup>255</sup>

But, if the naturalists found in each other a source of community, their work often put them in direct conflict with local populations. At Roscoff, townspeople opposed to the expansion of the laboratory as it meant the enclosure of a formerly public pathway running along the waterfront. The path had separated the station from the water and, after 1881, from its large saltwater enclosure, or “vivier.” Conflict also erupted over access to the tidal flats themselves. For naturalists, this was a place for gathering scientific specimens, and for the people of Roscoff a place for gathering food and fertilizer for their fields. As Lacaze-Duthiers complained in one of his reports, “during the low tides, the Breton peasants [...] go in hordes out onto the exposed beaches armed with large bars that they use to overturn the large stones so as to get at the fish hiding underneath. Yet, every stone overturned [...] is a stone lost for the zoologist, because the population of animals fixed the underside invariably dies. How many stones have I put back in place in order to avoid these destructions!”<sup>256</sup>

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<sup>254</sup> Roscoff visitor log entry, 24 August 1888. Roscoff Station Archives. Unidentifiable signature.

<sup>255</sup> Roscoff visitor log entry, 17 July 1888. Roscoff Station Archives. Entry may have been written by the Scottish biologist Sir D’Arcy Wentworth Thompson; but signature is difficult to decipher.

<sup>256</sup> Lacaze-Duthiers, “Les progrès de la station zoologique de Roscoff et la création du laboratoire Arago à Banyuls-sur-mer,” 553. Lacaze-Duthiers also saw as particularly destructing the traditional collection of seaweed, or “goémon,” used for centuries in Brittany as an agricultural fertilizer.

It was partly because of the need to protect a section of the tidal flats from the depredations by the locals that Lacaze-Duthiers arranged for the construction of what he called the “park.” This enclosure, surrounded by a one-meter high wall of piled stone, measured thirty by twenty-five meters. Here, one could find “the same animals that were found nearby,” and inside the naturalists placed specially selected, and carefully arranged, flat stones such as to create “numerous shelters.” In this enclosure the natural marine ecosystem of the tidal flats could be studied in what was really an un-natural enclosed space.<sup>257</sup> Not only would the park protect the area of study from unwanted intrusion, it also restricted the space of intensive study. The artificial improvements to marine habitat meant that researchers found interesting specimens more easily and more quickly. Moreover, experiments demonstrated that animals not native to the local tidal flats, captured further afield, could be kept alive within the enclosure.<sup>258</sup> Thus, sea urchins captured during excursions could be held in the enclosure even during the winter season when field collecting became more difficult; an added convenience was that they were then easily accessible when the station received specimen requests by mail order. Lacaze-Duthiers even bragged that the animals found inside the enclosure were healthier than those found on the tidal flats, the arrangement of the stones facilitating the flow of water in and out with the tide.<sup>259</sup>

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<sup>257</sup> In modern ecological science this would be termed a “mesocosm,” a term coined in the late twentieth century. Eugene P. Odum, “The Mesocosm,” *BioScience*, Vol. 34, No. 9, (October 1984), 558 – 562.

<sup>258</sup> Lacaze-Duthiers reported that mussels were introduced successfully and hoped for the introduction of oysters.

<sup>259</sup> Lacaze-Duthiers, “Les progrès de la station zoologique de Roscoff et la création du laboratoire Arago à Banyuls-sur-mer,” 554. A comparison can here be made to the domestication of Normandy scallops in the 1970s, as described by Michel Callon, it being in the interest of the scientists *and* the marine animals to adopt the new artificial

In the same report, Lacaze-Duthiers announced the near completion of two “much more important” construction projects: the aquarium room, and the large outdoor saltwater “vivier.”<sup>260</sup> On top of the aquarium building a stairway led up to a tower serving as a “belvedere from whence could be determined the direction of the dredgings and excursions, and where they might be followed by telescope.”<sup>261</sup> The *vivier* served a dual function, as a reservoir to feed the aquarium tanks when the tide went out, and an enclosure for larger marine animals. Before the construction of the *vivier*, men were hired to manually pump salt water into the aquarium tanks at high tide; sometimes between one and three in the morning.<sup>262</sup> Here too, “experiments” might be carried out “on the large animals,” the *vivier* serving as a “vast storehouse” for the “various products” brought in by fishermen or recovered in the course of dredging.<sup>263</sup> Lacaze-Duthiers even hoped it might eventually be possible to design a machine by which the kinetic action of the tide could power the aeration of the aquarium tanks.

Under these conditions, however, the animals studied were no longer living in a natural state. As one author, writing in 1913, remarked:

[Roscoff’s] tanks, [...] allow one to see living all the species of the coastal waters, to seize them in their states of evolution, not in the state of poor inert things, discolored, as one sees in the [shop] windows, but trimmed by iridescence more

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habitat arrangement. Michel Callon, “Some Elements of a Sociology of Translation: Domestication of the Scallops and the Fishermen of St. Briec Bay,” *The Science Studies Reader*, ed. by Mario Biagioli, (New York: Routledge, 1999), 67 – 83.

<sup>260</sup> Ibid. L-D explains that they are complementary to one another but that by necessity construction of the *vivier* needed to be completed first. He notes that these improvements were necessitated, among other reasons, in order to keep up with developments at “establishments of the same order” abroad. Ibid., 555.

<sup>261</sup> Ibid.

<sup>262</sup> Ibid., 557.

<sup>263</sup> Ibid. Lacaze-Duthiers noted that in Roscoff local fisherman had already built enclosures to hold lobster and langoustines, proof that the *vivier* design could work. “The experiment has been done,” he wrote. Ibid., 558.

ephemeral, more fleeting than even the dust of a butterfly's wing[.] However, they are still like beasts in a cage, and what's more, soon become tame; even the most defiant soon become accustomed to coming at the call of the guardian to get the quotidian prey that they no longer need to track. In their prisons of crystal, of cement, there are never any perturbations.<sup>264</sup>

The completion of the aquarium tanks also brought with an unforeseen annoyance: curious visitors eager to the wondrous creatures returned from the depths. Soon greater restrictions were imposed on the times when the aquarium tanks were open to the public and, as years went by, the hours of visitation became shorter as the station was reserved for scientific research. However, not all who worked at the station were scientists.

Between 1910 and 1912 the French painter and Breton native, Maturin Méheut, lived and worked at the Roscoff station. During his stay Méheut created a series of watercolor paintings of marine creatures as well as of the fishermen and townspeople. These works were exhibited in Paris and later published in two volumes entitled *Study of the Sea: Fauna and Flore of the Channel and the Ocean*.<sup>265</sup> A British observer remarked that Méheut had benefited from working in “an atmosphere of science” where he could observe living creatures; the work produced never “stooping to anything savouring of caricature.”<sup>266</sup>

At first Méheut's visit to the station seems but a peculiar event in the history of the laboratory. How does art and science meld in a space like a marine biological laboratory? In his introduction to Méheut's publication, then station director Yves Delage

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<sup>264</sup> Gustave Babin, “Le peintre de la vie sous-marine M. Mathurin Méheut,” *L'Illustration*, (20 December 1913), 506.

<sup>265</sup> Mathurin Méheut, *Étude de la mer: faune et flore de la manche et de l'ocean*, (Paris: Librairie Centrale des Beaux-arts, 1913).

<sup>266</sup> A Lady Correspondent, “Feminism and Fashion in Paris. A Quaint Exhibition.” *The Observer*, (7 December 1913).

reflected that the work was the realization of a dream “to which everyone has at sometime abandoned themselves, to be guided to the depths of the sea by a siren in feminine form to visit the formidable granite jewel boxes where she has amassed all the jewels created by old Neptune in the slow elaboration of living forms, in the depths of the oceans, since the origin of the centuries.”<sup>267</sup> Art and science mixed at the marine station because both pursuits were products of aesthetically inspired meditation.

As architectural historian Edward Eigan has noted, even as Roscoff and Banyuls “became more developed, spaces were set aside for contemplation.”<sup>268</sup> In Roscoff, this function was served by the central garden, a feature shared by the Museum of Natural History’s marine laboratory Saint-Vaast-la-Hougue.<sup>269</sup> Lacaze-Duthiers, explained in one of his reports that the purpose of the “sheltered” garden was to “offer to the inhabitants of the laboratory a retired place for promenade during moments of rest.”<sup>270</sup> At the Arago station at Banyuls-sur-mer, the view was a source of inspiration, and in the middle of the

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<sup>267</sup> Yves Delage, “Preface,” in Maturin Méheut, *Étude de la Mer: Faune et Flore de la Manche et de L’Océan*, iv. After the death of Lacaze-Duthiers in 1901, the directorship of the stations passed to Yves Delage (1854 – 1920). Under Delage the station abandoned the policy of providing free access. Instead adopting the table renting policy of the Naples station. One of these tables was held by Prince Albert I of Monaco but there is no evidence that he ever visited Roscoff, though His name does appear as one of the Station’s benefactors on a marble inscription in the aquarium room. Under Delage the scientific work of the station became more fisheries orientated. However, Josquin Debaz argues that Delage’s reorientation of the Station’s research program towards fisheries problems was an ultimately failed attempt to gain additional financial backing from the regional government administration. Josquin Debaz, *Une histoire de la station de biologie marine de Roscoff, (1872 – 1914)*, 16.

<sup>268</sup> Edward Eigan, “Architecture of French Science at the Shore, 1830 – 1900,” 235.

<sup>269</sup> Edmond Perrier, “Le laboratoire maritime de Muséum d’Histoire Naturelle de Tatihou,” *La Nature*, No. 794, (18 August 1888). The central garden also recalls the design of the *Jardin des Plantes* in Paris, another example of marine stations replicating in miniature an existing institutional design.

<sup>270</sup> Lacaze-Duthiers, “Les progrès de la station zoologique de Roscoff et la création du laboratoire Arago à Banyuls-sur-mer,” 559.

central room a reproduction of the statue of the Venus de Milo was erected, in the words of the French naturalist Louis Boutan, to “remind visitors that the aim, the ideal of the natural sciences, is the search for beauty in all it’s splendor.”<sup>271</sup> Lacaze-Duthiers described the station as a place of “tranquility” where the view was “superb,” and the air “pure.”<sup>272</sup> Boutan, describing the Arago facilities, compared the individually assigned rooms of visiting researchers with monastery cells, praising their simplicity.<sup>273</sup>

*Hybrid Knowledge – The Assistants:*

Lacaze-Duthiers once wrote that he “always learned something from chatting with fishermen. They have singular ideas, but based on positive facts, on exact observations. [...] It is up to us to interpret what [a fisherman] has told us.”<sup>274</sup> It should come as no surprise then that Lacaze-Duthiers selected laborers and assistants with an eye for the knowledge and skills they could bring to the scientific work of the station. We know, for instance, of Joseph Jézéquel, the son of a Breton fisherman, born in Roscoff in 1855 the second of ten children. He attended school until the age of nine before being apprenticed as a cobbler. However, he spent his free time exploring the tidal flats, happily assisting naturalists visiting the marine station to collect marine animals. Eventually joining the navy where he served for five years, Jézéquel returned to Roscoff at the age of twenty-five, and was engaged as a laboratory assistant by Lacaze-Duthiers. Working for fifteen years for the minor salary of seventy-nine francs per month, Jézéquel devised methods for keeping marine organisms alive in captivity. He also developed a technique

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<sup>271</sup> Louis Boutan, *La photographie sous-marine et les progrès de la photographie*, (Paris: Librairie C. Reinwald, 1900), 117.

<sup>272</sup> Lacaze-Duthiers, “Les progrès de la station zoologique de Roscoff et la création du laboratoire Arago à Banyuls-sur-mer,” 580.

<sup>273</sup> Louis Boutan, *La photographie sous-marine et les progrès de la photographie*, 119.

<sup>274</sup> Henri Lacaze-Duthiers, “Le Monde de La Mer,” 19.

for removing the spines of sea urchins and making their shells transparent, thereby facilitating the observation of internal morphology. By the time Lacaze-Duthiers died in 1885, Jézéquel had become an invaluable asset and continued to hold his position at the station under the directorship of Lacaze-Duthiers's successor, Yves Delage.<sup>275</sup> There were many other employees without formal education capable of bringing local knowledge to the work of the station whose names have been lost. However, one in particular stands out: Charles Marty.

Abutting the Roscoff station is one of the town cemeteries. In it are buried local men and women, many with headstones memorializing their exploits at sea, such as the epitaph on the tomb of a sea captain who circled the world seven times, "facing down the seas and the winds." One grave marker stands out in marked contrast to the others. Built not of cement, but of weatherworn stone, giving it the appearance of an exposed section of reef, it marks the grave of Charles Marty (1850 – 1906), the "keeper" of the station. Its inscription, informing that the monument was raised by subscription "in which took part numerous French and foreign *savants*," also states: "if circumstances had made of Marty not a seaman but a student, he would count today among the naturalists who have given most honor to science and to their country."

The name Marty, is as inseparable from the history of the Roscoff station as that of its founding director. As Kofoid noted in his *Biological Stations of Europe*, Marty was integral in building the reputation of the station: "the director was fortunate in securing

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<sup>275</sup> Maurice Montabré, "Les Découvertes d'un Garçon de Laboratoire," *Je Sais Tout*, (15 Feb. 1922). The naturalist, and frequent visitor to the station, Louis Joubin later recalled in a speech commemorating Yves Delage, that Marty and Delage could often be seen together searching the tidal flats for marine organisms "in all seasons, and in all weather." Louis Joubin, "Discours de M. Louis Joubin," *Travaux de la Station Biologique de Roscoff*, fascicule 5 (Paris: Les Presses Universitaires de France, 1926), 8.

early in the history of the station the services of Ch. Marty, a naturalist fisherman, whose skill as collector, wide knowledge of local fauna, and genial character, endeared him to a generation of investigators.”<sup>276</sup> Though Marty’s name appears regularly in the station visitor book where it became de rigueur to record appreciation for his help, his collaboration is rarely acknowledged in the station’s scientific publication. A record of Marty’s life survives in his obituary, written by then-director Yves Delages. We learn that Marty was born in Nantes in 1851, the son of a gardener. He had become a sailor in the navy, serving on the *Narval*, the vessel that Henri Lacaze-Duthiers embarked upon during his mission to the coast of North Africa in 1878. Perhaps Lacaze-Duthiers recognized Marty’s talent for scientific work, but in any case he made a special request to the vessel commander that Marty be officially assigned to aid him in his research. At the conclusion of the expedition Lacaze-Duthiers arranged for Marty to return with him to Roscoff. As Delage recounts, it was there that Marty “became for Lacaze-Duthiers and soon for all the workers an indispensable auxiliary.” He was called upon to manage and facilitate all aspects of the work carried out at the station - everything from captaining the station vessels and serving as station mechanic, to collecting specimens for visiting scientists and purchasing materials. In the words of Delage, Marty “became a collaborator of the workers at the station, because he knew the habitat and behavior of all the animals on the tidal flats as well as any specialist.” He was, Delage concluded, “the soul of the station.”<sup>277</sup>

It is difficult to assess the extent of Marty’s participation in the scientific work of the station; certainly he was indispensable in the collection of specimens. Less clear,

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<sup>276</sup> Kofoid, *The Biological Stations of Europe*, 95.

<sup>277</sup> From a hand-written note by Delage. Roscoff Station Archives.

however, is the extent to which he may have participated in scientific analysis; we do not know if he was literate. Unlike most of the naturalist who worked at the station, he left no clearly identifiable written record. Yet, as the only other permanent resident of the station aside from the director, Marty's unrivaled local knowledge made him indispensable for naturalists visiting Roscoff for only short periods of time. One thing is clear; his expertise was undisputed and was even cited in support of scientific claims. The British zoologist, Sidney Harmer, for instance, noted in a paper "on the embryology of the ectoprocta" that he could "depend on the accuracy of the statement made to [him] by M. Charles Marty, of the Zoological Laboratory at Roscoff, that [his] own specimens belong[ed] to the species described by Joliet from the same locality."<sup>278</sup>

Collecting marine organism required a specific set of skills attainable only through extended experience in the field. Marty thus possessed experiential knowledge that visiting naturalists lacked. Lacaze-Duthiers, noting that Marty had been indispensable for "intelligently discovering and gathering" the embryos of a particular species of tunicate, observed that these embryos were "delicate and transparent," the size of the head of a pin, and only recognizable because they were normally "stuck to a few grains of sand."<sup>279</sup>

#### *Conclusion – Oceanography as a Hybrid Discipline:*

Writing in 1993, Mott Greene offered a critique of the tendency (still present in oceanography textbooks) to bracket distinct periods in the history of oceanography by

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<sup>278</sup> Sidney F. Harmer, "On the Embryology of the Ectoprocta," *Studies from the Morphological Laboratory in the University of Cambridge*, ed. by Adam Sedgwick, Vol. 5, (London: C. J. Clay and Sons, Cambridge University Press, 1892).

<sup>279</sup> Henri Lacaze-Duthiers, "Zoologie – Note accompagnant la presentation du 3e volume des "Archives de Zoologie expérimentale" *Comptes Rendus des Séances de L'Académie des Sciences*, (26 April 1875), 1058.

reference to famous voyages of exploration. Describing the rise of oceanography as a branch of geography, he writes:

[W]hen we ask what kind of science is oceanography, we must confess that it isn't a science but a collection of sciences[.][...] This heterogeneous character is well known to historians of oceanography, but it has manifold implications for attempts to write 'the history of oceanography.'<sup>280</sup>

Certainly historians of oceanography now acknowledge the disciplinary overlap between physical, chemical, and biological research in the marine sciences. They have also moved away from an over reliance on historical periodization and are giving more attention to role of fisheries in the development of marine sciences (though fisheries still receives more attention from environmental historians). What I advocate is further attention to “hybridity” in the history of the marine sciences, in all its manifestations. We have acknowledged disciplinary hybridity, but we can do more to reveal how marine sciences were shaped by hybrid geographical, social, and knowledge environments.

Let us return briefly to the paradox raised by Mills: the perceived failure of French oceanography. The central character of Mills' account of physical oceanography in France is Julien Thoulet. I want to conclude with Thoulet – and not Lacaze-Duthiers – because he has been called “the father of French oceanography.”<sup>281</sup> It is important for this reason to consider how Thoulet viewed the emerging field of marine science.

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<sup>280</sup> Mott Greene, “Oceanography's Double Life,” *Earth Sciences History*, Vol. 12, No. 1, (1993), 50.

<sup>281</sup> The title “patriarch of French oceanography” makes one of its earliest appearances in Thoulet's 1936 obituary. Camille Vallaux, “Nécrologie – Julien-Olivier Thoulet (1843 – 1936),” *Annales de Géographie*, Vol. 45, Issue 254, (1936), 217. It should be noted, however, that term “father of oceanography” has been historically mutable. It is often applied to the American Matthew Fontaine Maury and Thoulet himself placed the title on Louis – Ferdinand Marsigli. See Julien Thoulet, “Un des fondateurs de l'océanographie – Marsigli,” *Revue Scientifique*, No 26, Vol. 8, (25 December 1897), 805.

Thoulet saw physical oceanography (which he called simply oceanography), and marine biology (which he referred to as zoology), as complementary disciplines for he believed both to be of practical importance to the fishery.<sup>282</sup> His views on the foundational importance of physical oceanography for marine biology, are apparent in his book *The Ocean: Its Laws and Its Problems*:

The vast water mass of the ocean, [...] is the terrain of study of oceanography and the laws discovered find immediate application in zoology [...] we will not understand [the distribution of marine life] until naturalists who study marine animals [...] have adequately enlightened themselves through oceanography. The point of this is not to establish a preeminence between the two sciences: oceanography and zoology, but there is for one, oceanography, anteriority, because of its application to the other, zoology.<sup>283</sup>

In the same text, Thoulet extends this order of application to the fishery, suggesting that the thermometer can become a veritable fishing implement. In his chapter on temperature distribution he writes:

After preliminary studies have been completed by oceanographers, then by zoologists, [...] the fisherman will cease to waste his time [...], and will begin by making thermometric soundings. [...] [T]he thermometer will show him the zones to exploit, the rich veins of this sort of mine.<sup>284</sup>

In *The Fluid Envelope of our Planet*, Mills pushes us to consider the factors that contribute to the rise and fall of scientific disciplines. In noting the absence of physical oceanography as we have come to understand it (in France) it is important to consider the full shape of French marine science in the late nineteenth century. In France, physical oceanography lacked the sponsorship of a strong navy. In contrast, marine biology profited from institutional ties between the navy and the fishery and enjoyed the

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<sup>282</sup> In 1911 he was appointed to the *Conseil Supérieur des Pêches Maritimes*, organized by the ministry of the marine.

<sup>283</sup> Julien Thoulet, *L'Océan: ses lois et ses problèmes*, (Paris: Librairie Hachette, 1904), 60 – 62.

<sup>284</sup> Julien Thoulet, *L'Océan: ses lois et ses problèmes*, 217.

sponsorship of powerful centralized scientific institutions. Marine stations replicated a pre-existing institutional model, tied to a French tradition that placed great value on accessible higher education. All of these factors bolstered public and institutional support favoring marine biology over physical oceanography. And it is certainly telling that Thoulet, the “father” of French oceanography, placed such value on marine zoology.

We must pay attention to the “hybrid” terrains where marine science arose: the exposition, the museum, and the marine station. I have tried to demonstrate how an interpretive approach examining multiple branches of scientific research (which we collectively categorize today as marine science), with particular attention to the use of space, can enhance our understanding of what Greene termed the “heterogeneous character” of oceanography. We would do well to remember that oceanography, born from the amalgamation of multiple scientific disciplines and situated in dynamic environments, is a hybrid science.

## Chapter 3:

### Prince of Science: Albert I<sup>st</sup> of Monaco (1848 – 1922)

#### *Introduction:*

The Spanish novelist Vicente Blasco Ibáñez described Prince Albert I<sup>st</sup> of Monaco as the “supreme pontiff of oceanographic science.”<sup>285</sup> The American scientist and president of the American Museum of Natural History, Henry Fairchild Osborn, upon learning of Albert’s death in 1922, remarked that he had been “altogether [...] the foremost patron of science of his day,”<sup>286</sup> while a journalist for the *Brooklyn Daily Eagle* declared: “Oceanography was so new a science, that the Prince might almost be said to have discovered it for himself.”<sup>287</sup> There is some truth to these statements. It is impossible to dissociate Prince Albert I<sup>st</sup> of Monaco from the early history of oceanography. As Eric Mills has written, Prince Albert was “the best-known exponent of oceanography in Europe during the late nineteenth and early twentieth centuries[.]”<sup>288</sup> Albert, Mills argues, carried out “the most technically varied deep-water oceanography of the late nineteenth and early twentieth centuries. [...] If any person in post-Challenger oceanography surpassed Alexander Agassiz in ingenuity and ambition, it was certainly Albert I[.]”<sup>289</sup>

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<sup>285</sup> Vicente Blasco Ibáñez, *Mare Nostrum*, Trans. by Charlotte Brewster Jordan, (New York: A. L. Burt Company, 1919), 179.

<sup>286</sup> “The Prince of Monaco,” *The Brooklyn Daily Eagle*, (27 June 1922), 6.

<sup>287</sup> *Ibid.*

<sup>288</sup> Eric Mills, *The Fluid Envelope of Our Planet: How the Study of Ocean Currents Became a Science*, 163.

<sup>289</sup> Eric Mills, “Problems of Deep-Sea Biology: An Historical Approach,” *Deep-Sea Biology*, ed. by Gilbert T. Rowe, (Cambridge: Harvard University Press, 2005), 48 – 49. Mills also cautions that most secondary sources accounts of Prince Albert have been laudatory, and that “it is easy to be distracted by these penegyrics or by the sheer volume of the scientific contributions made by his co-workers.” Rather, Mills suggests, Prince

Despite this acclaim, Prince Albert's place in the history of oceanography is frequently relegated to passing comment in historical surveys of marine science.<sup>290</sup> That is not to say that little has been written about his life and work. The preeminent historian of Prince Albert is Jacqueline Carpine-Lancre, longtime conservator and archivist of the Oceanographic Museum in Monaco. Madame Carpine-Lancre has published numerous articles on Albert, however, her work, for the most part published in French, and hence Albert himself, have not received the attention they deserve from the predominantly English-speaking scholars of marine science. A notable exception is Eric Mills, who devotes a chapter to Prince Albert and the history of oceanography in France in his study of the rise of physical oceanography.<sup>291</sup> Mills also published a detailed summary of Prince Albert's oceanographic work in 1983.<sup>292</sup> In 1999 Mills wrote: "It is time to look again at Albert Ier, and at the ways his life illustrates how science, society and morality were interrelated in the decades before the Great War."<sup>293</sup> Following Mills, this chapter seeks to rectify an omission in the English-written historiography of marine science, both by engaging with scholarship only available in French, and by seeking to address the

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Albert "should be evaluated in the light of European science, history, and politics during his time, using the vast material in Monaco rather than the seductive secondary sources." Ibid., 49.

<sup>290</sup> See, for example, Margaret Deacon, *Scientists and the Sea 1650 – 1900: A Study of Marine Science*, 382; Robert Kunzig, *Mapping the Deep: the Extraordinary Story of Ocean Science*, (New York: Norton, 2000), 276; and the slightly more detailed treatment of Prince Albert in Susan Schlee, *The Edge of an Unfamiliar World: A History of Oceanography*, 132 – 137. Helen Rozwadowski does not discuss Prince Albert in her *Fathoming the Ocean: The Discovery and Exploration of the Deep Sea*, though she does discuss Albert's relations with the organizers of ICES in Helen Rozwadowski, *The Sea Knows No Boundaries: A Century of Marine Science Under ICES*, (Seattle: University of Washington Press, 2002), 57 – 59, 72 – 73.

<sup>291</sup> Eric Mills, *The Fluid Envelope of Our Planet*, 162 – 191.

<sup>292</sup> Eric Mills, "Problems of Deep-Sea Biology."

<sup>293</sup> Eric Mills, "Editorial – Rediscovering the Prince of Monaco," *History of Oceanography*, No. 11, (September 1999).

question implied by Mills' appeal: how should we interpret the scientific work of a oceanographer who was also a prince? And, how does Prince Albert's scientific work fit into a broader history of the rise of oceanography in the late nineteenth century?

Over the course of his lifetime, Prince Albert undertook twenty-eight oceanographic cruises aboard his yachts – specially modified for scientific work – and often-employing oceanographic instruments of his own design. In total he completed 3698 observation stations. He corresponded with all the leading naturalists engaged in marine work in Europe and in the United States, and founded an oceanographic research institute in Paris as well as an oceanographic museum and laboratory in Monaco. His interest in oceanography extended far beyond what he was able to accomplish during the course of his own expeditions. He was also an important patron of oceanographic science – supporting marine stations, funding instrument development, and facilitating international scientific cooperation and technological exchange. In short, it can be argued that Prince Albert contributed, *both* as a scientist and as a patron, more than any other individual to the early development of the discipline of oceanography.

Yet, his status as a political leader sets him apart from the many naturalists who were engaged in marine work by the late nineteenth century. Prince Albert's privileged position (the reigning sovereign of the tiny principality of Monaco) cannot be ignored in an assessment of his scientific career. He could not abandon his position as a head of state, and his political and dynastic roles were not separated from his scientific work. His position as a political leader was not necessarily a disadvantage, however. Albert's political influence facilitated his success as a scientist and his status as a scientist elevated his position as a head of state. Prince Albert sought to embody the ideal of the

enlightened monarch, a proponent of peace and social justice, and he insisted that the promotion of science was key to achieving this goal. “Science” illuminated the path to good governance. As he later wrote, “I cultivated science because she spreads light and light engenders justice, the guide without which a people marches towards anarchy and decadence.”<sup>294</sup>

While other important figures in the early history of oceanography – naturalists in France, England, and the United States – had to negotiate State support for their scientific projects, Prince Albert in a very real sense *was* the State. But, as the ruler of a small principality surrounded by French territory, Albert had to operate within an overarching French political sphere of influence. This is not to say that Prince Albert was a puppet ruler. For instance, he did not hesitate to voice his support for the beleaguered French officer Alfred Dreyfus, much to the rancor of some of the members of the French social elite.<sup>295</sup> Though Albert tactfully couched his criticism with an affirmation that he considered France as his second “patrie,” the French Count, Boni de Castellane, published an open letter scolding the Prince for “interfering in an affair in which [he was] in no way concerned.”<sup>296</sup>

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<sup>294</sup> Prince Albert, *La carrière d'un navigateur*, [2<sup>nd</sup> edition], (Monaco: Imprimerie de Monaco, 1905), 30.

<sup>295</sup> In a letter to the French politician and supporter of Dreyfus, Joseph Reinach (1856 – 1921), Albert wrote: “I loudly declare what I think of the Dreyfus affair; all the world may hear it because it is the free opinion of an honest man. I employ my influence in order to deflect a grave danger to the country which I love as a second *patrie*; who would dare reproach me for it?” Prince Albert to Joseph Reinach, Monaco, 7 March 1898, quoted in Jacqueline Carpine-Lancre, *Albert Ier Prince de Monaco: des oeuvres de science, de lumière et de paix*, (Monaco: Palais de S. A. S. Le Prince, 1998), 30.

<sup>296</sup> “Count Castellane Scores Prince Albert of Monaco,” *San Francisco Chronicle*, (5 July 1899).

Nevertheless, largely as a result of Monaco's geographical enclosure within French territory, the history of Albert's oceanographic work is inseparable from the history of the marine sciences in France. As has been discussed in the previous chapter, in the late nineteenth century France possessed an impressive network of biological marine stations on both its Atlantic and Mediterranean coasts. Yet, unlike Britain, the United States, and the member countries of the International Council for the Exploration of the Seas (ICES), France failed to launch a sustained program for deep-sea exploration.<sup>297</sup> Writing in 1892, the editors of the French journal *Annales de Géographie* lamented that, while with regard to hydrography France compared favorably to other nations, it was "sadly evident [...] that France has done little with regard to oceanographic studies, and furthermore that nothing is organized to do so; it would be childish to try to hid it."<sup>298</sup>

Despite these setbacks, interest in oceanography continued to grow in France, paralleling increasing awareness abroad. As Eric Mills explains, the British voyages of

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<sup>297</sup> Jacqueline Carpine-Lancre notes that one important exception was the research vessel *Roland*, deployed by the Arago station on the south coast of France which undertook research cruises as far as the Balearic Islands. Jacqueline Carpine-Lancre, "Les Expéditions Océanographiques Françaises du XIXe Siècle," *Actes du XIIe Congrès International d'Histoires des Sciences, Paris, 1968*, (Paris: Librairie Scientifique et Technique Albert Blanchard, 1971), 61.

<sup>298</sup> "Océanographie. Généralités," *Annales de Géographie*, Vol. 1, Issue 2, (1892), 202. While the term "hydrography" has gradually become synonymous with "physical oceanography," in the nineteenth century it was used primarily with reference to charting and sounding. "Oceanography," which in its early evolution was frequently termed "physical hydrography," dealt with the study of the water column: tides, currents, water chemistry, and marine meteorology. In reality, the French had long been interested in tidal measurements, in so far as they applied to navigation. See Michael Reidy, *Tides of History: Ocean Science and Her Majesty's Navy*, (Chicago: University of Chicago Press, 2008), 179 – 180.

the *Lightening*, *Porcupine*, and *Challenger*, had a “reverberatory effect.”<sup>299</sup> Furthermore, commercial interest in the ocean was rapidly expanding. French industrialists like Augustin Pouyer-Quertier (1820 – 1891), founder of the *Compagnie française du télégraphe de Paris à New-York*, promoted deep-sea sounding in the Atlantic in hopes of developing a French submarine telegraphic network to rival that of Britain. Meanwhile, interest in oceanography was gaining momentum in French scientific circles. The Paris-based Société de Géographie formed a commission in 1874 charged with developing a program for oceanographic observations that could be carried out by naval and civilian vessels, while in 1899 a *Société d’Océanographie du Golfe de Gascogne* formed in Bordeaux.<sup>300</sup>

The French government finally lent their support to a series of deep-water expeditions beginning in 1880. The four State-sponsored expeditions of the *Talisman* and *Travailleur* (1880 – 1883) were largely the result of the persistent lobbying of amateur naturalist and retired naval officer Léopold Marquis de Folin (1817 – 1896).<sup>301</sup> But, considered at a national level, the *Talisman* and *Travailleur* expeditions can be read as the French government’s response to the British *Challenger* expedition. The *Challenger* completed its round the world expedition in 1876 and its widely celebrated achievement spurred similar oceanographic expeditions throughout Europe.<sup>302</sup> However, the *Talisman* and *Travailleur* expeditions, while moderately successful in gathering a number of new

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<sup>299</sup> Eric Mills, *Deep-Sea Biology*, 47.

<sup>300</sup> Jacqueline Carpine-Lancre, “Les Expéditions Océanographiques Françaises du XIXe Siècle,” 62.

<sup>301</sup> Louis Barriety, “Océanographie du golfe de gascogne: un précurseur: le marquis Léopold de Folin,” *Comptes rendus du 94e congrès national des sociétés savants*, Vol. 1, (Paris: Bibliothèque Nationale, 1969), 131 – 140. See also de Folin’s obituary in *Journal de conchyliologie*, Vol. 46, (1898), 44 – 45.

<sup>302</sup> Helen Rozwadowski, *Fathoming the Ocean*, 173.

benthic species, fell far short of the global scale of the *Challenger* expedition. The French expeditions dredged only in the Mediterranean and North Atlantic, primarily in the Bay of Biscay. The *Talisman* and *Travailleur* expeditions culminated in a special exhibit of the collected materials at the Museum of Natural History in Paris in 1884. Extremely popular with museum visitors, the exhibit and was designed by its organizers – in particular by naturalist Alphonse Milne-Edwards – to encourage public interest in oceanography, thereby further stimulating State funding for oceanographic work.

Ultimately, these initial efforts to establish a sustained State-sponsored program for the scientific exploration of the oceans failed. The absence of a deep-water exploration program – particularly when compared to the Coast and Geodetic Survey and Fish Commission programs in the United States – revealed a notable lacuna in France’s scientific agenda. It was this gap in the French scientific program that Prince Albert moved to fill.

*Early Years – The Beginning of Albert’s Life at Sea:*

When Charles III died in 1889, the throne of Monaco passed to his son, Albert-Honoré-Charles Grimaldi (1848 – 1922), better known as Prince Albert Ist. Born in Paris in 1848, Albert spent much of his youth outside Monaco, attending school in Paris and Orleans before beginning a two-year term of naval service at the age of 17 in 1865, first in the Imperial French Navy and the following year in the Royal Spanish Navy. Prince Albert began his maritime career at a time when important scientific discoveries were being made about the oceans. An event of considerable importance occurred in 1860 when a submerged telegraph cable laid at a depth of 2800 meters between Sardinia and Algeria broke. To the surprise of naturalists, when the cable was recovered it was

encrusted with marine life. The celebrated French naturalist Alphonse-Milne-Edwards observed these organisms and published a report the following year, permanently putting to rest Edwards Forbes' Azoic hypothesis – the theory that life could not survive at great depth – and opening a new terrain, the deep-sea, for zoological investigations.<sup>303</sup>

However, while scientific discoveries were shifting the focus of natural history, political and military events were shaping the course of Prince Albert's future as a head of State. Prince Albert came of age during a period of great political change in Europe when the Grimaldi family needed to exercise extreme caution in their diplomatic relations with France. The townships of Menton and Roquebrune, previously ruled by the Princes of Monaco, had already been ceded to the Kingdom of Sardinia in 1848, reducing the principality to the single commune of Monaco. After 1860, France controlled all the territory surrounding the principality of Monaco, having annexed the formerly Sardinian county of Nice during the Italian Wars of Independence. Thus, Prince Albert's engagement to Mary Victoria Douglas-Hamilton, third cousin of Napoleon III, was an important political maneuver. The couple wed in 1869 and shortly thereafter produced a son, Louis Honoré Charles Antoine Grimaldi, heir to the throne. The marriage was unhappy, and within a year of the boy's birth, Mary Hamilton left her husband and moved to Germany, taking her son with her. The marriage was formally annulled in 1880.<sup>304</sup> The separation alienated Albert from Louis, who was raised in Germany by his

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<sup>303</sup> Alphonse Milne-Edwards, "Observations sur l'existence de divers mollusques et zoophytes a de très grandes profondeurs dans la mer Méditerranée," *Annales des Sciences Naturelle, zoologie*, Vol. 4, No. 15, (1861), 149 – 157.

<sup>304</sup> Jacqueline Carpine-Lancre, *Albert I Prince of Monaco (1848 - 1922)*, (Monaco: Editions EGC, 1998), 3.

mother and her new husband, Prince Tasziló Festetics de Tolna, a Hungarian nobleman, and this alienation was to prove fateful for the continuity of Albert's scientific projects.

Albert's father, Charles III, had succeeded in securing the financial stability of the tiny principality by developing Monte Carlo as a gambling center.<sup>305</sup> When Albert inherited the throne from his father he set out to modernize the principality using the revenue generated by the casino. Under his rule, Monaco became a more democratic state. As Carpine-Lancre explains, "absolute monarchy was replaced by a regime which enabled *Monégasques* to associate themselves with the government of their country by means of elected National and Town Councils. The Civil, Penal Procedure and Civil Procedure Codes were revised and the legal system overhauled."<sup>306</sup> These reforms were instituted in part as a response to public pressure and, possibly, external threat. In March of 1910 Albert, perhaps in a maneuver to preserve the monarchy, declared the election of a Parliament through universal suffrage, effectively ending the absolute rule of the Grimaldi family.<sup>307</sup>

Many physical improvements to the city were made under Albert's reign, greatly improving the living conditions of his subjects. The harbor was modernized, tunnels built to connect different parts of the city, a new hospital built and furnished with modern

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<sup>305</sup> As a source of revenue, the casino was intended solely for the use of foreigners. *Monégasques* have since the reign of Charles III been forbidden by law from gambling in the Casino.

<sup>306</sup> Jacqueline Carpine-Lancre, *Albert I Prince of Monaco (1848 - 1922)*, 6.

<sup>307</sup> "More Reform in Monaco; Prince Albert Surrenders Control of the Government Finances," *The New York Times*, (16 October 1910). See also a very interesting interview with Prince Albert II, published by the *New York Times* in 1922, in which he suggests that his granting of the constitution secured Monaco's independence from an impending German takeover. Gualtiero Campino, "The Paradox of Monaco. How Late Prince Had Fairly to Force Constitution on His Reluctant People," *The New York Times*, (2 July 1922).

equipment, a tramway system constructed, and citywide electrical and sanitation infrastructure installed. Albert also reformed Monaco's education system, building new schools, creating an art and professional institute, and constructing a public library. Albert was an influential promoter of the arts; under his reign Monaco became a center for music performances, the casino concert hall serving as a venue for opera. A Palace of Fine Arts opened in 1893, hosting annual exhibitions of painting and sculpture.

During his own lifetime, however, Prince Albert was criticized endlessly in the foreign press for generating revenue from the casinos of Monte Carlo. As the author of an article in an American newspaper remarked in 1913 upon the occasion of Albert's first visit to the United States, "were Albert I of Monaco of less exalted rank he would probably be held at Ellis Island and excluded as an undesirable alien, seeing that he is one of the chief owners of the greatest gambling establishment in the world, from which unsavory source he derives the major portion if not the entirety of his income." The author conceded that "one thing to be said in favor of Prince Albert of Monaco is that he turns part of the money thus dishonorably earned to good account. For he has spent very large sums in his oceanographic researches, and for the past twenty years or more has by means of his deep sea explorations contributed perhaps more than any other one man to the science of oceanography." Yet, the same journalist could not resist adding,

[O]f course he does not actually do the exploring work himself, but employs a staff of scientists for the purpose, and the results which they have achieved at his expense are to be found in the great Oceanographic Museum, alone of its kind in Europe, which is to-day one of the principal attractions of Monte Carlo, and in the great work on oceanography, in a dozen folio volumes, that bears his name, and which is to be found in the leading libraries of Europe.<sup>308</sup>

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<sup>308</sup> F., Cunliffe-Owen, "Prince of Monaco the First Reigning Sovereign of Europe to Visit the United States," *The Sun*, (10 August 1913).

Monte Carlo was essential for the economic survival of Monaco, but it also called into question the moral prestige of the principality and its prince. Thus, the scientific world opened an avenue to international honor and recognition from which the Prince was otherwise excluded.

Albert spent much of the year away from Monaco, either at his palace outside Paris or aboard his yacht. In Paris he led a princely social life, participating in the Salon culture of the *Belle Epoque* and frequently attending scientific lectures. But it was above all in Paris, rather than at sea, that Albert became passionately attracted to oceanography. By his own account, it was one event in particular that drew his attention to the study of the oceans: the 1884 exhibit of the *Talisman* and *Travailleur* exhibits at the Museum of Natural History. As he later recalled,

It was in 1884 that my relations with important scientific personalities following the study of certain maritime questions, directed my thoughts towards the study of thalassography which, first signaled by Alphonse Milne-Edwards, had steadily gained scientific interest with each new expedition. Little by little the desire to contribute to this work took over until the day that it became my obsession. As in many cases when a passion becomes dominant, there came a moment at which I became convinced that I could do better in this field of study than all my predecessors, and I put myself to work despite a complete lack of encouragement from my immediate entourage.<sup>309</sup>

His “immediate entourage” aside, however, Prince Albert did find encouragement for his scientific pursuits in Parisian scientific circles, as well as from some of his social

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<sup>309</sup> Jacqueline Carpine-Lancre, *Albert I<sup>er</sup>, Prince de Monaco. Des oeuvres de science, de lumière et de paix. 150<sup>e</sup> Anniversaire de sa Naissance*, (Monaco, Palais de SAS le Prince, 1998), 24 – 25. Albert’s initial contact with the *Muséum* probably dates closer to the 1870s; an ardent hunter, he employed the same taxidermist. For the publication of the scientific reports associated with his expeditions, Albert came to rely on the expertise of the professors at the *Muséum*. Of the sixty-four scientific campaign reports published between 1889 and 1922, twenty-one have a Museum professor or preparatory as author or co-author. Jacqueline Carpine-Lancre, “Honoré la science: Le Prince Albert I<sup>er</sup> de Monaco, le Muséum de Paris et Lamarck,” *Bulletin du Musée Anthropologique et Préhistorique de Monaco*, No. 51, (2011), 156.

peers. Countess Greffulhe, a prominent Parisian *Dame*, wrote to him in a letter dated 8 September 1905: “there is everything to create in this beautiful science of the sea and you must find in France the person worthy of receiving your ideas and putting them in practice.”<sup>310</sup> Albert soon forged a close relationship with the Museum of Natural History, and became close friends with Alphonse Milne-Edwards.<sup>311</sup> As Albert later asserted, in a speech given at the Museum in 1913: “It is there that illustrious *maîtres* [teachers] inculcated me in the principles which I would obey during [my] oceanographic campaigns.”<sup>312</sup> One important mentor was George Pouchet (1833 -1894), professor of comparative anatomy at the Museum.<sup>313</sup> Pouchet, who himself had gone on an expedition to Lapland in 1881 with the purpose of capturing whales for the Museum’s skeleton collections, was particularly influential in introducing Prince Albert to the study of marine zoology.<sup>314</sup> Thus it was in Paris that Prince Albert discovered his passion for marine science, and first made the scientific contacts that allowed him to put his plans into action.

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<sup>310</sup> Quoted in text of speech delivered by Thomas Fouilleron and Jacqueline Carpine-Lancre on the occasion of the centenary of the Oceanographic Institute, 21 June 2011. Private communication, Jacqueline Carpine-Lancre.

<sup>311</sup> He paid tribute to Milne-Edwards in speech at the inauguration of the Oceanographic Museum in Monaco, referring to Milne-Edwards as his *maître*, or mentor. Prince Albert, “Discours de S.A.S. le Prince de Monaco,” *Discours prononcés à l’occasion des fêtes d’inauguration du Musée océanographique de Monaco, 29 mars 1910*, (Paris: Imprimerie Draegar, 1910), 7.

<sup>312</sup> Prince Albert, “Discours à l’Assemblée générale de la Société des amis du Muséum d’histoire naturelle,” *Journal de Monaco*, Vol. 56, No. 2881, (1913), 2.

<sup>313</sup> He later became a director of the Concarneau marine station.

<sup>314</sup> Jacqueline Carpine-Lancre, “Le Prince Albert Ier de Monaco et la Science,” *Archives de l’Institut de Paléontologie Humaine, Mémoire 39: Histoire et actualité de l’oeuvre scientifique de S. A. S. le Prince Albert Ier de Monaco*, (Paris: Fondation de l’Institut de Paléontologie Humaine, 2008), 14. On Pouchet’s mission to Lapland, see Georges Pouchet, “La mission de Laponie,” *La Nature*, Vol. 10, No. 444, (3 December 1881), 40 – 41. Albert’s published report “Sur le gulf-stream,” published in 1886, is dedicated to Pouchet.

Though Albert devoted his own research efforts primarily to the study of oceanography, he possessed a remarkable breadth of interests. Partly resulting from the discovery of prehistoric cave dwellings near Monaco, Albert became interested in the study of paleontology. In 1902 he created a museum of prehistoric anthropology in Monaco and, in 1910, an Institute of Paleontology in Paris. Though oceanography and paleontology were clearly different fields of study, Albert viewed both as working towards a shared goal: human progress. “Progress,” in Albert’s vision, meant both the moral and cognitive evolution of humanity, with science as a guiding principle. The study of oceanography revealed the origins of biological life, while paleontology revealed the evolutionary progression of humans. In his inauguration speech at the opening of the Institute of Paleontology – which he described as a “temple” – Albert explained:

In bringing together the history of the oceans and [the history] of Life, I am but respecting a law of modern science which prepares in the progressive fusion of its elements a magnificent domain for coordination of human work in our enlarged brain.<sup>315</sup>

Marine science was attractive to Prince Albert because the geographical scale of research necessitated international collaboration and thus encouraged international political and military accord. Albert wrote, for instance, that he intended that the Oceanographic Institute possess an “international character because oceanographic science is immense.”<sup>316</sup> However, the decision to organize international programs for oceanographic research required broad political support, and not all politicians shared Albert’s grand vision.

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<sup>315</sup> Prince Albert, “Discours à l’inauguration de l’Institut de paléontologie humaine,” *Journal de Monaco*, Vol. 63, No. 3283, (1920). Quoted in Jacqueline Carpine-Lancre, “Le Prince Albert Ier de Monaco et la Science,” 15.

<sup>316</sup> *Ibid.*, 20.

*France and ICES; A Role for Prince Albert:*

Marine zoology became a topic of growing interest in the late nineteenth century due to increased concern over the long-term sustainability of marine fisheries. And marine fisheries research required international political negotiation since national fisheries extended into the extra-territorial high seas. Political friction in the North Sea caused by competing trawl fisheries led, in 1882, to the signing of the North Sea Convention by Britain, Belgium, Denmark, France, Germany, and the Netherlands. The signatories relinquished national jurisdiction over the shared fishing grounds, setting in place the groundwork for a program of international collaboration, centered on fisheries management.<sup>317</sup> The International Council for the Exploration of the Seas held its first inaugural meeting on July 22, 1902 in Copenhagen. The countries represented were Denmark, Finland, Germany, the Netherlands, Norway, Sweden, Russia and the United Kingdom. The Scandinavian countries, notably Norway and Sweden, with their important North Sea fisheries, were the strongest supporters of the new program for international cooperation. In the 19<sup>th</sup> century the Scandinavian fisheries underwent wild fluctuations resulting in periodic famine and economic hardship. The fishery collapse in Scandinavia, as in the rest of Europe, encouraged government support for fisheries related research. As Eric Mills explains, “many of the strands in the development of the marine sciences in Scandinavia are plausibly related to fisheries crises during the nineteenth century.”<sup>318</sup> The Scandinavian-led marine science program, with its focus on better understanding the environmental conditions governing fish stock fluctuations, was concerned primarily with

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<sup>317</sup> Norway and Sweden also signed the Convention but did not ratify it. Helen Rozwadowski, *The Sea Knows No Boundaries*, 13.

<sup>318</sup> Eric Mills, *The Fluid Envelope of Our Planet*, 84.

fluctuations in oceanic properties (salinity, chemistry, currents, and meteorology) rather than with the more traditional marine science concerns of classification, physiology, and the morphology of marine organisms. Among the most influential of the scientific participants in the newly founded organization were Martin Knudsen (1871 – 1949) in Denmark, Fridtjof Nansen (1861 – 1930) in Norway, and Otto Petterson (1848 – 1941) in Sweden.<sup>319</sup> Physical oceanography was beginning to emerge as a separate branch of marine science, distinct from marine biology for its reliance on quantitative modeling. However, the new movement was not without its detractors. For instance, French fisheries biologist Adolphe Cligny, director of the Director of the *Station Aquicole de Boulogne-sur-Mer*, criticized promoters of the new science of physical oceanography for offering false promises with respect to practical fisheries applications:

One can beat back and forth across the entire ocean exploring its physical conditions without encountering a single herring, without having a single occasion to observe its habits and migrations; but one cannot follow the herring throughout a season without learning something about its habits and how to go about fishing it. Thus, the preferable method that applies to the pursuit of fish, the analysis of their movements and ambient circumstances, is classic biology, and the introduction of the thermometer is not a novelty. Despite her modest position in the international program, it is from her [marine biology] that will come practical results.<sup>320</sup>

The French marine biologist and future director of the Roscoff biological station Charles Pérez, in his review of the International Exposition of Oceanography held in Marseille in 1906, voiced a similar critique of what he perceived as the prevailing elevation of physical oceanography over marine biology:

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<sup>319</sup> Jens Smed, “Physical Oceanography in Scandinavia,” *Earth-Science Reviews: International Magazine for Geo-Scientists*, Vol. 3, 1967.

<sup>320</sup> Adolphe Cligny, “L’océanographie et les pêches maritimes,” *La Revue du Mois*, Vol. 2, (July – December 1906), 229.

There are some who would reduce the science of the oceans to its physical properties, and reserve for the distant future the study of marine life. [...] Is it not [...] a bad philosophical attitude to want to impede researchers, to pretend to determine in advance in what direction progress will be achieved, and to fix science to a track beyond which there will be no salvation[?]<sup>321</sup>

The prevalence of marine biology at the Marseille exposition was a source of comfort for Pérez, yet, while most of northern Europe was aligning to form a network for international cooperation in marine science, France remained outside of ICES until 1920. Others in France, aware of the scientific movement reshaping marine science outside of France were critical of the French scientific community's inability to adopt the new methodology. When the French geologist, and so-called "patriarch of French oceanography,"<sup>322</sup> Julien Thoulet (1843 - 1936) presented a request to the Director of Higher Education at the University of Nancy in 1886 for a six-month leave in order to undertake a voyage for oceanographic research, he made an important distinction between the work he proposed to conduct and the marine scientific research already carried out in France:

[I]n France, scientists have limited their work to the field of marine zoology and by and large, physics and chemistry have not been given the systematic treatment they require. The problems that need solving are numerous and of primary importance to applied sciences like meteorology and hydrography as well as to pure sciences like zoology and geology.<sup>323</sup>

French naturalists, including Alfred Giard (1846 – 1908), Charles Rabot (1856 – 1944), and Julien Thoulet, campaigned for the inclusion of France in the newly formed international program. As Eric Mills has shown, Thoulet was well aware of the extent of

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<sup>321</sup> Charles Pérez, "Études diverses – l'Exposition internationale d'Océanographie et des Pêches maritimes de Marseille," *Revue Scientifique (Revue Rose)*, Vol. 7, No. 7, (16 February 1907), 207.

<sup>322</sup> Eric Mills, *The Fluid Envelope of Our Planet*, 172.

<sup>323</sup> Thoulet to the Director of Higher Education – Nancy, March 1<sup>st</sup>, 1886, "official correspondence," Julien Thoulet, *A Voyage to Newfoundland*, 155.

the new oceanographic work being conducted abroad. For instance, Thoulet maintained correspondence with the Swedish marine chemist, and ICES founder, Otto Petterson.<sup>324</sup> In his introductory letter, sent in 1889, he informed Petterson that the previous year he had been “charged with a mission” – he does not say by whom, but presumably by the French State – to travel to Christiania and Edinburgh to study the state of oceanographic knowledge in Norway and Scotland. Thoulet also requested that he be sent several of Petterson’s publications.<sup>325</sup>

The decision to keep France outside of ICES seems to have been determined not by the scientific community but by government officials. Théophile Delcassé, director of the French merchant marine, submitted a report to the French parliament, which warned that French participation in ICES would require considerable state expenditure; the general consensus in parliament was that such spending would be redundant given that French fisheries research already received government funding.<sup>326</sup> French naturalists in favor of the ICES program saw their State’s reluctance to join as an affront both to the international scientific community and to the young discipline of oceanography. Thus, in a 1903 letter to Petterson, Thoulet wrote:

Unfortunately I do not have a very favorable response to give you regarding your request for the collaboration of vessels of the French State. Despite incessant efforts, I have not been able, for the past twenty years that I’ve been working, to

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<sup>324</sup> In the Thoulet Petterson correspondence is also repeated reference to Thoulet’s collaboration and correspondence with Danish physicist Martin Knudsen (1871 – 1949).

<sup>325</sup> Julien Thoulet to Otto Pettersson, 16 May 1889. Photocopy of letter in the Archives of the University of Gothenburg. Collection of Jacqueline Carpine-Lancre.

<sup>326</sup> On France’s reluctance to join ICES see Jens Smed, “The Accession of France Into ICES,” 9 – 17. It is a mistake, however, to conclude, as Dr. Smed does, that scientific opinion in France was unanimously in favor of the new research program that ICES embodied.

shake the French government out of its indifference or, better said, out of its hostility to oceanography.<sup>327</sup>

Thoulet placed all his hopes for the future of French oceanography in the hands of his patron Prince Albert, writing to Petterson, “you now know his serene highness, you have been in a position to appreciate how great and sincere is his devotion to the science of oceanography; I am certain that [he] will do all to facilitate the studies [...]. I must admit to you, between us, I have much more hope in [him] than in the real or effective cooperation of the French government, about which I have already expressed to you my thoughts.”<sup>328</sup> Petterson nevertheless saw in Thoulet a useful ally. A letter from Thoulet to Petterson sent in October 1905 indicates that Petterson extended an invitation for Thoulet to join ICES in an official capacity; but Thoulet felt unable to accept, the travel and shipping expenses required for such a position surpassing the means of his salary as a professor in the absence of financial support from the French State.<sup>329</sup> Though France would finally agree to join ICES in 1914, further postponement due to World War I meant that France only became a full member in 1921. In the meantime, Prince Albert offered the best hope of advancing a French program of deep-sea oceanography.

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<sup>327</sup> Julien Thoulet to Otto Pettersson, 11 March 1903. Photocopy of letter in the Archives of the University of Gothenburg. Collection of Jacqueline Carpine-Lancre.

<sup>328</sup> Julien Thoulet to Otto Pettersson, 9 May 1903. Photocopy of letter in the Archives of the University of Gothenburg. Collection of Jacqueline Carpine-Lancre. It should be noted that Thoulet did receive considerable support from the French Navy. By 1889 he was probably becoming aware of the limits of that aid. Nevertheless, his first expedition was aboard a naval vessel, the navy covered the cost of his first treaty on oceanography (1890), and for many years he held a position as an instructor of marine science at the *École supérieure de marine*. See Camille Vallaux, “Nécrologie – Julien-Olivier Thoulet (1843-1936),” 217 – 218.

<sup>329</sup> Julien Thoulet to Otto Pettersson, 4 October 1905. Photocopy of letter in the Archives of the University of Gothenburg. Collection of Jacqueline Carpine-Lancre.

“His yachts have been floating laboratories, cruisers of science”:<sup>330</sup>

Prince Albert set off on his first lengthy oceanographic cruise in the summer of 1885 aboard his yacht the *Hirondelle*.<sup>331</sup> This would be the first of four consecutive summers of oceanographic work<sup>332</sup> and his research in the North Atlantic, particularly his study of the Gulf Stream, received worldwide attention. A Lieutenant J. E. Pillsbury, commander of the U.S. Coast and Geodetic Survey steamer *Blake*, having learned of the Prince’s study of the Gulf Stream from newspapers, wrote asking that any results obtained be sent to him; in exchange, if the prince “should desire to adopt any of the methods that [he had] used, [he] should be much pleased to render any assistance[.]”<sup>333</sup>

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<sup>330</sup> Vicente Blasco Ibáñez, *The Enemies of Women*, 124.

<sup>331</sup> It should be noted that while Prince Albert had four different yachts, he only gave them two names: *Hirondelle*, and *Princess Alice*. It has become common practice to add “I” and “II” in order to differentiate between them. Albert provides a description of the *Hirondelle* crew in his autobiography. Prince Albert, *La carrière d’un navigateur*, 48 – 54.

<sup>332</sup> He went on a shorter trial cruise during the summer of 1884; nevertheless the expedition returned with important results, having recovered a new species of copepod and having gathered information showing a correlation between salinity variation and marine animal distribution. Jacqueline Carpine-Lancre, “La première campagne océanographique du Prince Albert de Monaco (juillet – août 1885),” *Acta geographica*, 3<sup>rd</sup> Series, No. 63, (1985), 3.

<sup>333</sup> J. E. Pillsbury to Prince Albert, 20 April 1887, Monaco Palace Archives. We know that Pillsbury received a reply from Albert as in a following letter he wrote: “It has given me a positive pleasure to read of what you have done, but the pleasure has been mixed with envy to think that I too, having the inclination to continue the examination of one of nature’s greatest wonders, cannot do so much longer, but must return to my legitimate profession, that of a naval officer on board a man of war.” The letter also indicates that Albert requested further information regarding the instruments Pillsbury employed for his researches. J. E. Pillsbury to Prince Albert, 10 September 1887, Monaco Palace Archives. A letter from Richard to Albert indicates that Albert requested information from an instrument maker in Washington D.C. regarding a current meter designed to Pillsbury’s specifications. Richard to Albert, 26 February 1888, Monaco Palace Archives. Prince Albert was well informed of the oceanographic work conducted by the United States Coast Survey. He maintained a correspondence with Pillsbury as well as with Alexander Agassiz, to whom he was introduced in Paris by Alphonse Milne-Edwards in 1898. Agassiz visited Monaco on Albert’s invitation in 1906 and Albert invited Agassiz to

The *Hirondelle*, a wooden schooner built in 1862<sup>334</sup> in a shipyard in Gosport on the south coast of England, lacked onboard laboratories and refrigerated storage compartments; however, it was fitted out with a deep-sea trawl, said by Albert to be similar to that employed aboard the U.S. survey vessel *Blake*. With the *Hirondelle*, Albert sounded and dredged in the Gulf of Gascony, near the Azores, and on the Grand Banks, attaining depths of up to 3000 meters. He also conducted drift experiments, launching 1700 floats (224 of which were recovered) in the North Atlantic over a period of three years.<sup>335</sup> As Albert later wrote in his autobiography:

I was a sailor, and my passion for science permitted me to recognize what useful work needed to be done; furthermore, I chose my crew and the staff of my laboratory; my plans were dependant only on me and I could modify them in course of the voyage following changes of circumstance. In one word, I centralized in my head ideas and will.<sup>336</sup>

By 1889, Albert had amassed enough material, using the *Hirondelle* on four cruises in the Mediterranean and Atlantic, to put his collections on display in the Monégasque pavilion then being assembled for Universal Exposition in Paris. Albert's

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serve on the scientific advisory of his Oceanographic Institute. In 1921 Albert travelled to the United States for the last time in order to receive his award of the Agassiz Medal from the U.S. National Academy of Sciences. Private communication, Jacqueline Carpine-Lancre. On Prince Albert's acquirement of an American-made current meter modeled after Pillsbury's current instrument, see Christian Carpine, *La pratique de l'océanographie au temps du Prince Albert Ier*, (Monaco: Musée Océanographique, 2002), 98. See also John Elliott Pillsbury, "The Grandest and Most Mighty Terrestrial Phenomenon: The Gulf Stream," *National Geographic Magazine*, Vol. 23, No. 7, (1912) 767- 778.

<sup>334</sup> Prince Albert describes his first sighting of the *Hirondelle*, then named *Pleiad*, in his autobiography. See Prince Albert, *La carrière d'un navigateur*, 43 – 44.

<sup>335</sup> Prince Albert, "A New Ship for the Study of the Sea," *Proceedings of the Royal Society of Edinburgh*, Vol. 18, (November 1890 to July 1891), 298. From Albert's float data he had a chart of surface currents made, "an experimental document worthy of complete confidence as regards the general direction and the mean velocity of the currents of the North Atlantic."

<sup>336</sup> Jacqueline Carpine-Lancre, *Albert I<sup>er</sup>, Prince de Monaco. Des oeuvres de science, de lumière et de paix. 150<sup>e</sup> Anniversaire de sa Naissance*, 24 – 25.

oceanographic displays took up half of Monaco's allotted exhibit space and the pavilion was transformed into one of the exposition's premiere attractions - receiving four awards.<sup>337</sup>

Carpine-Lancre has argued that Albert's participation in international conferences and expositions (Paris in 1889 and 1900, Saint Louis in 1904, Milan and Marseille in 1906, Brussels in 1910, and Genoa in 1914) served to amplify the prestige of Monaco on the world's stage.<sup>338</sup> Certainly the exhibits helped extend recognition for Albert's scientific work beyond the confines of Monaco. For instance, the author of an article published in 1896 in the French popular journal *La Science Illustrée*, in the same paragraph recalled the elegance of the 1889 pavilion, and praised Albert - "sincere friend of France" - for his scientific accomplishments.<sup>339</sup> In presenting his scientific work in the Monaco pavilion, Albert undoubtedly hoped to elevate international opinion of his principality, so often condemned as a gambling den. In the popular press Monte Carlo continued to cast a long shadow. A writer for the New-York Tribune gibed in 1898, "the Prince of Monaco has been delivering a series of lectures in London on oceanography, probably sustaining the theory that the ocean floor is laid off in sections of red and black

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<sup>337</sup> A partial list of visitors who left calling cards at the pavilion is recorded in a letter report to Albert from Jules Richard. Richard to Albert, 11 September 1889, Monaco Palace Archives. For a further description of some features of the 1900 Monaco exposition in Paris see Richard to Albert, 19 April 1900, Richard to Albert, 26 April 1900, and Richard to Albert, 29 April 1900, all in the Monaco Palace Archives.

<sup>338</sup> Jacqueline Carpine-Lancre, *Albert I Prince of Monaco (1848 - 1922)*, 10.

<sup>339</sup> Ferdinand Faideau, "Le prince Albert de Monaco," *La Science Illustrée*, Vol. 17, (1896), 95.

like the gaming tables of his principality.”<sup>340</sup> But in scientific circles, naturalists were quick to recognize Albert’s outstanding contributions.<sup>341</sup>

By 1891 he had acquired a new custom-built yacht, christened the *Princess Alice* after his second wife.<sup>342</sup> The new vessel, also constructed in Britain, was larger than the *Hirondelle*. A three-masted schooner rig with an auxiliary engine, she was a custom-built state of the art research vessel complete with an electric dynamo, a three hundred and fifty horse power engine, refrigerated compartments, three onboard laboratories outfitted with both distilled and salt water circulation systems, electric lighting, and gimballed tables.<sup>343</sup> On July 15<sup>th</sup>, 1891, Albert delivered a paper before the Royal Society of Edinburgh entitled, “A New Ship for the Study of the Sea.” Describing his ship as a “new scientific instrument” that had been “constructed entirely for scientific research,” Albert laid out the research program required for progress in the field of oceanography.<sup>344</sup>

To establish the laws of Oceanography it is necessary to know the temperature, the motion, the chemical constitution, the density, and the zoology of the waters of the ocean at all depths. It is necessary to borrow a little from all the natural sciences.<sup>345</sup>

These multiple scientific aims were reflected in the design of the new vessel.

Albert’s description of the *Princess Alice* stressed the efficiency with which a large number of samples could be gathered and sorted. Materials collected on the central deck

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<sup>340</sup> “Editorial,” *New-York Tribune*, (10 June 1898).

<sup>341</sup> A letter dated 21 March 1911 sent to Prince Albert from Museum of Natural History director Edmond Perrier informed the Prince that the professors had voted to bestow upon him a newly created honorary title, “Associate of the Muséum.” Letter to P. A. from Edmond Perrier, 21 March 1911, Monaco Palace Archives.

<sup>342</sup> Albert married the New Orleans-born aristocratic divorcee Marie Alice Heine (1858 – 1925) on October 30<sup>th</sup>, 1889.

<sup>343</sup> A detailed descriptions of some of the *Princess Alice*’s features is provided in Ferdinand Faideau, “Le Yacht ‘Princess Alice,’” 245 – 246.

<sup>344</sup> Prince Albert, “A New Ship for the Study of the Sea,” 295.

<sup>345</sup> *Ibid.*, 296.

were easily transferred to the central laboratory using an automated lift. The same lift could also be used to transport material directly to the refrigerated storage rooms two decks below. “After a first picking over, for the elimination of useless matter” Albert explained, “the zoological material is sent to the central laboratory, and the oceanographical material to a third laboratory in the after part of the ship, which is devoted to chemistry and physics.” There, tables were arranged so that “four or five persons” might work “without interfering with one another.” Albert cautioned, however that it was impossible “to carry too far an analysis or other delicate observations during the voyage.” Rather, he believed, arrangements should be made for “collecting a great number of facts at the most favorable moments, and for noting all the details which strike the eye and the mind.”<sup>346</sup>

Albert flattered his audience, praising the British precedent of the *Challenger* expedition; but he also criticized the national expeditionary model of research as outdated and inefficient. Nations could not carry out expeditions, he argued, because fundamentally nations were militaristic and would always favor military over scientific expenditure.

Sometimes the captain of the ship is not enough of a man of science to understand what science demands [...], he executes coldly the orders which he has received; sometimes it is the scientific men on board who are not sufficiently acquainted with the sea and life on board ship to be able to utilize their time to the best advantage of their scientific work. [...] Further, the keeping up of millions of men, the manufacture of hundred ton guns, and the launching of ironclads and torpedo vessels, do not leave much room in the budgets of most nations for intellectual work or for the labour of men who would willingly devote themselves to the best interests of their fellow men.<sup>347</sup>

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<sup>346</sup> Ibid., 301.

<sup>347</sup> Ibid.

His argument implied that his own expeditions were not the project of one State, but of one man. The first campaign of the *Princess Alice* took place during the summer of 1892 and over the next seven years Prince Albert employed her on oceanographic cruises in the Mediterranean and off the Azores.<sup>348</sup> The previous year Albert had been elected a “correspondent” of the Paris Academy of Sciences in the section of geography and navigation – an indication of the increasing recognition of his scientific contributions.

Prince Albert invited naturalists of several nationalities to accompany him on his expeditions. One of the most influential of Prince Albert’s scientific collaborators was the British naturalist John Young Buchanan (1844 – 1925), previously the chemist of the *Challenger* expedition. Buchanan took part in Prince Albert’s summer expedition of 1892, 1894, and 1898 aboard the *Princess Alice*.<sup>349</sup> Despite the many innovations for oceanographic work installed aboard *Princess Alice*, after seven years of cruises Prince Albert had begun to look for a replacement vessel. In a letter written in 1896 Prince Albert’s close friend, Buchanan offered his advice:

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<sup>348</sup> In 1900 she was sold and renamed the *Eberhard*. Three years later she was sold again and renamed *Ellinor*. Finally she was purchased by the British government for service during the 1<sup>st</sup> World War, after which no trace of her record can be found. See Jacqueline Carpine-Lancre, “‘...une trace de mes anciens sillage.’ Albert Ier de Monaco et la mer,” *Monaco port des Princes*, ed. by André Z. Labarrère, (Monaco: Yacht Club de Monaco, 1996).

<sup>349</sup> Buchanan also took part in the 1902 summer campaign of the *Princess Alice II*. He was a close friend of Prince Albert and they maintained an extensive correspondence (over 250 letters from Buchanan are preserved in Monaco Palace Archives). Buchanan had a standing invitation to join Albert during his summer cruises but was for the most part unable to do so due to poor health. He was, however, a frequent visitor to Monaco and was eventually appointed to the scientific advisory board of the Oceanographic Institute. He also served as an important intermediary between Albert and members of British scientific societies. See Jacqueline Carpine-Lancre and Anita McConnell, “Prince Albert and J. Y. Buchanan: Mediterranean Investigations,” *History of Oceanography*, No. 22, (January 2011), 24 – 31.

I have sent by this post a list of steamers for sale through a firm of shipbuilders in Liverpool. It will give an idea of what is actually in the market. [...] [N]one [are] good enough to replace the “Princess Alice.” It seems to me that what is wanted is a vessel, new if possible, capable of steaming at least 13 knots and preferably 15 or 16.<sup>350</sup>

Prince Albert’s third vessel, the *Princess Alice II*, was constructed in Liverpool and launched in 1897. Albert employed the *Princess Alice II* for twelve years - from 1898 to 1910. As with her predecessor, the *Princess Alice II* was custom built for oceanographic research but on an even grander scale. At seventy-three meters in length, with a displacement of one thousand four hundred metric tons (larger than her predecessor), and one-thousand horse power engine, the *Princess Alice II* was well equipped for deep-water work. She could cruise at a top speed of thirteen knots and, using the *Princess Alice II*, Albert ventured as far afield as Spitzbergen in the summers of 1898 and 1899. These northern expeditions seem to have been partly inspired by Nansen’s arctic work on the *Fram*, and Albert consulted with Nansen in preparation for his own arctic research.<sup>351</sup> These expeditions were also hunting excursions; hunting for sport and collecting for science not being treated by the Prince – an avid hunter, like others of his social class – as mutually exclusive activities. As one of the expedition members, Henry Bourée, later wrote, describing seal hunting in Spitzbergen:

The hunt finished, one returns aboard with his booty; the seal is weighed, measured, then given over to the scientific staff who immediately begin their observations. Once the subject is deemed healthy, we remove the part which will be confided to the good care of the cooks: the tongue and the liver are really

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<sup>350</sup> John Young Buchanan to Prince Albert, [no day given] June 1896. Monaco Palace Archives. Presumably increased speed would allow greater coverage, but a more powerful engine would also facilitate dredging operations.

<sup>351</sup> Prince Albert, “Croisière dans les régions arctiques,” *La Grande Revue*, Vol. 14 (1900), 1. See also Jacqueline Carpine-Lancre and William Barr, “The Arctic cruises of Prince Albert I of Monaco,” *Polar Record*, Vol. 44, Issue 1, (January 2008), 1 – 14.

excellent. Often the later contains parasites to the great chagrin of the gourmets, but to the great benefit of the laboratory.<sup>352</sup>

The first of the polar expeditions was notable for the international composition of the scientific staff, with five different nationalities represented. On the way to Spitzbergen, Albert made stops in Le Havre and Kiel where, always both scientist and diplomat, he invited prominent scientists and dignitaries – including the German emperor – to tour the vessel. Albert later wrote that the “*Princess Alice* was the object of a consideration that enlightened men of all nations reserve for scientific efforts for the formation of a better humanity.”<sup>353</sup> As with all his oceanographic work, Prince Albert promoted his research cruises as beneficial for all humanity and as examples of the scientific benefits of international cooperation. This showmanship may have rankled some naturalists’ sensibilities but undoubtedly contributed to Albert’s popular appeal. Even the British naturalist Buchanan, who joined the first of these northern expeditions later wrote to Albert: “I shall treat myself more as a showman, giving a magic lantern entertainment with a running commentary. The Royal Institution cannot object until it is finished and by then it does not matter.”<sup>354</sup>

Prince Albert’s fourth and final research vessel was the *Hirondelle II*. Unlike her predecessors, which had all been built in the UK, the *Hirondelle II* was built in France in the shipyards of La Seyne just outside of Toulon and launched on the 6<sup>th</sup> of February

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<sup>352</sup> Henry Bourée, *L’Océanographie vulgarisée: de la surface aux abîmes*, (Paris: Librairie Ch. Delagrave, 1912), 110 – 111. Bourée (1873 – 1940), a French Naval lieutenant, became Albert’s *aid de camp* in 1906. He possessed a rare talent for photography and cinematography and helped document Prince Albert’s expeditions and provide visual accompaniment for his lectures. See Jacqueline Carpine-Lancre, “Prince, océanographe et ‘cinématographe’: Albert Ier de Monaco,” 1895, No. 18, (September 1995), 90.

<sup>353</sup> Prince Albert, “Croisière dans les régions arctiques,” 2.

<sup>354</sup> John Young Buchanan to Prince Albert, 2 May 1900, Monaco Palace Archives.

1911. The first oceanographic campaign of the *Hirondelle II* took place the following summer. It was aboard the *Hirondelle II* that Prince Albert made a second visit to the United States in 1913. When a journalist came aboard in New York to interview him aboard his “yacht” Albert asserted: “This is essentially a scientific vessel and afterward a yacht.” The journalist was received “in the saloon of the *Hirondelle*, where on all sides were panels painted with scenes of hunting and fishing in many climes, the records of many voyages.” He described Prince Albert as:

Erect of figure, with an air of abounding vitality, he is the typical yachtsman and sportsman. His beard, slightly touched with gray, is the only evidence of his sixty-five years. His eye is clear and kindly, his step light and elastic. He says he felt as strong as a man of thirty, and certainly looks it. Harpooning whales, shooting big game and wooing the sea in all kinds of weather have kept him lithe and strong.

Albert proceeded to give a tour of his prized vessel, and the journalist faithfully described the ship and its facilities for his readers:

The *Hirondelle* is a steel twin-screw steam yacht, with an auxiliary brigantine rig. She carries unusually lofty masts, which seem to dwarf the single funnel. The yacht is 291 feet over all, 36 feet in beam and has a draught of 17 feet 8 inches. Her lines indicate that she is a very dry vessel indeed, with her high top gallant forecandle and the raised after deck. She has a clipper bow and her lines are trim and graceful. On the flag is the coat of arms of Monaco, with the Latin motto "Deo Juvante" (With God Aiding). Below decks there is every evidence of strength and careful workmanship. There are substantial bulkheads, with heavy doors. The crew, under command of Captain d'Arodes, of the French navy, consists of fifty men and the total number of persons on board is sixty-eight, including officers, scientists, photographers and artists. Not only has the *Hirondelle* every appliance which modern naval architecture has prescribed for a yacht, but it has special apparatus, which represents inventive talents of a high order.<sup>355</sup>

Prince Albert’s public roles determined that he would always be more than a contributor to oceanographic research. Having brought modernization and prosperity to

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<sup>355</sup> Unknown author, “Prince of Monaco Sees City After Forty-Five Years and Explains Musical Mystery of the Sea,” *New York Herald*, (11 September 1913), 5.

his principality in his role as monarch, Albert took it upon himself to direct, improve, and promote international oceanographic investigations. As a ruler, his duty was to serve his people, and as a scientist he sought to communicate beyond the closed networks of scientific specialists. He sought to popularize science, in part by tapping its spirit of “adventure,” and encouraged his collaborators to follow suit. As John Young Buchanan wrote to Albert, after a notice of the Prince’s scientific work appeared in a London newspaper:

It was exactly what was wanted for the information of the British public, of the serious work which is being done at Monaco and having appeared in the *Times* it is the duty of every British subject to know it, or, at any rate, to pretend to know it. A hundred communications to scientific periodicals would not have the same effect, and the genuine sporting spirit which pervaded, naturally appealed to the many who care little for science.<sup>356</sup>

It was clear to Albert early on that the ambitious program he envisaged would require a dedicated staff. By 1887 Albert had engaged the French naturalist Jules Richard (1863 – 1945) to his service. Richard served consecutively as secretary of scientific work, curator of scientific collections and head of the laboratory aboard the Prince’s yacht, then later as the first director of the oceanographic museum and scientific cabinet.<sup>357</sup> In the years following the appointment of Richard, Albert assembled an ever-growing list of specialists to his service, seeking out naturalists possessing particular and complementary

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<sup>356</sup> Buchanan to Prince Albert, 18 August 1896, Monaco Palace Archives. Buchanan explains in the same letter that it was he who supplied the original account to the *Times*, translated without permission from a private letter from Prince Albert. While this seems a breach of privacy, the result was in keeping with Albert’s aims to popularize the record of his oceanographic pursuits.

<sup>357</sup> By 1901 Richard complained that in his position as director of the museum he was overworked; having already abandoned his personal research on crustaceans, he asked Albert to confer to someone else the work of studying copepods, writing that he was “convinced that in acting thus, [he] would best serve [Albert’s] scientific interests.” Richard to Albert, 1 October 1901, Monaco Palace Archives.

expertise on various aspects of marine work.<sup>358</sup> A letter dated 9 February 1891 from the marine geologist Julien Thoulet, for instance, provides a list of instruments for “pure oceanography” that on Albert’s request and Thoulet’s recommendation are to be installed aboard Albert’s research yacht the *Princess Alice*.<sup>359</sup>

*The Oceanographic Museum at Monaco:*

Conceived by Albert as a “temple dedicated to science and art,” the *Musée Océanographique* clings to a cliff face overlooking the Mediterranean. At its inauguration ceremony on March 29<sup>th</sup>, 1910, Prince Albert declared: “Here, Gentlemen, [...] out of Monaco’s earth has sprung a proud and inviolable temple, dedicated to the new divinity which reigns over the best minds. I have lent the forces of my brain, my conscience and my sovereignty to the extension of scientific truth, the sole terrain upon which the elements of a stable civilization can grow, safeguarded against the inconstancy

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<sup>358</sup> A complete list of Prince Albert’s collaborators over the complete duration of his scientific campaigns cannot be provide in the space provided here. However, it is worth noting the international make-up of the scientists and officers who accompanied Prince Albert on his expeditions. To give one example, the members of the 1898 expedition to Svalbard included representatives France, Germany, Italy, the United Kingdom, and Norway. Jacqueline Carpine-Lancre and William Barr, “The Arctic Cruises of Prince Albert I of Monaco,” 5. The crew, in keeping with the practice of the French Navy, was overwhelmingly composed of Breton sailors. As Jules Richard explained: “The crew, since 1885, is formed in its majority of Bretons, fishermen for the most part, robust sailors and resistant to fatigue, appreciable qualities given the nature of the work executed aboard, because the operations necessary for oceanographic research, such as dredging, etc., are not done without great effort and work.” Jules Richard, *Les campagnes scientifiques de S.A.S. le Prince Albert Ier de Monaco*, (Monaco: Imprimerie de Monaco, 1900), 12. Prince Albert often praised the stamina of his crew, the work of dredging being extremely physically demanding, particularly when water-logged hempen line needed to be raised using a capstan bar.

<sup>359</sup> Julien Thoulet to Prince Albert, 9 February 1891, Monaco Palace Archives.

of human laws.”<sup>360</sup> As Albert made clear in his inaugural speech, the oceanographic museum was conceived as much more than a museum.

One of the principle functions of the museum was to collect existing oceanographic instrumentation and facilitate the creation of new instrument designs. As Christian Carpine has argued, the late nineteenth century witnessed dramatic improvements in oceanographic instrumentation in conjunction with technological improvements in other important areas of marine knowledge: metallurgy, naval construction, and engineering.<sup>361</sup> These innovations were possible in large part because of important advancements in the use of steel – a technological development that had been transferred from artillery design. Parallel developments were also taking place in the manipulation of copper, aluminum, and even plastic.<sup>362</sup>

However, serving primarily as a technological storehouse, the museum failed as an entertaining venue for the public. As one visitor lamented in 1912: “it must be confessed that the museum has not yet acquired the popularity it deserves. There does not seem to be anyone whose business it is to make it popular. People cannot be expected to understand unless some sort of explanation is given. A technical guide-book only increases the weariness of the visitor, as he fails to understand the meaning of the most important words.”<sup>363</sup> Nevertheless, the architecture of the new building – which took eleven years to complete – was enough to awe visitors to Monaco and as an emblem of the principality it rivaled Monte Carlo. As Albert explained in his inaugural address, with

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<sup>360</sup> Albert 1<sup>st</sup>, “Discours de S.A.S. le Prince de Monaco,” 7 – 8.

<sup>361</sup> Ibid.

<sup>362</sup> Christian Carpine, *La pratique de l’océanographie au temps du Prince Albert Ier*, 3.

<sup>363</sup> Adolphe Smith, *Monaco and Monte Carlo*, (London, Grant Richards Ltd., 1912), 184. Smith provides an extensive description of the interior layout of the museum.

the Oceanographic Museum he sought to unite art and science.<sup>364</sup> The building's ornate façade monumentalized pioneering oceanographic voyages. Immediately below the roofline, the names of oceanographic vessels are inscribed: *Challenger*, *Blake*, *Fram*, *Valdivia*, *Albatross*, *Hirondelle*, *Princesse-Alice*, *Princesse-Alice II*, and *Hirondelle II*, the last four being the research vessels of Prince Albert 1st.<sup>365</sup> On either side of the main entrance are two allegorical sculptures, "Truth" unveiling the forces of the world to science, and "Progress" coming to the aid of humanity. The interior of the building is no less impressive. Mosaic floors depict the *Princess Alice* and various sea creatures; light fixtures are shaped to resemble medusa and radiolarians, while sculptures and stained glass adorn a monumental central staircase. The museum houses three great exhibition halls designated as "physical oceanography," "applied oceanography," and "zoological

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<sup>364</sup> Albert 1<sup>st</sup>, "Discours de S.A.S. le Prince de Monaco," 5.

<sup>365</sup> See Christian Carpine, "Les navires océanographiques dont les noms ont été choisis par S.A.S. le Prince Albert 1<sup>er</sup> pour figurer sur la façade du Musée océanographique de Monaco," *Bull. Inst. océanogr. Monaco*, No. 2 (Congr. Int. Hist. Océanogr. 1, 1968), 627 – 638. A very interesting sketch of the proposed arrangement of vessel names is reproduced in Christian Carpine, *La Pratique de l'océanographie au temps du Prince Albert Ier*, 182 – 183. This sketch sent was to Buchanan by Richard 1904; Buchanan recommended replacing the *Investigator* with the *Buccaneer*, a sounding vessel which surveyed the Gulf of Guinea in preparation for the installation of a telegraph cable. Owen Hannaway has suggested, in a study of 17<sup>th</sup> century laboratory design, that architectural design can reveal "intellectual and ideological" features of scientific life. The care with which research vessels were selected for the façade, and their prominence in the Museum design, reveals the value both Albert and Buchannan placed on expeditionary science and the associations made between particular vessels and the data they were used to produce. For a discussion of the significance of laboratory design see Owen Hannaway, "Laboratory Design and the Aim of Science: Andreas Libavius versus Tycho Brahe," 585 – 610.

oceanography” – understood at the time as the three categories under which marine science might be classified.<sup>366</sup>

In describing the opening of the Museum, the British scientific journal *Nature* reported: “the Inauguration was an arresting function, which could not fail to impress the most regardless pleasure-seeker in the gayest haunt of the Côte d’Azur with the thought that science, even in, perhaps, its least known department, was a thing of high importance.” The author regretted the absence of any British representatives at the inauguration ceremony, “a cause of humiliation,” and a “slight upon a noble enterprise,” requesting that “on behalf of the British scientific public [they desired] to give an expression to this feeling in the most emphatic way.”<sup>367</sup> In fact, the British absence is noteworthy, particularly in light of tense diplomatic relations between the attending parties, France and Germany – who, unlike Britain, both relied on Prince Albert as a diplomatic intermediary.

Jules Richard described the aims of the newly built institution at a meeting of the international Geographical Congress in Berlin in 1899:

The museum will contain, not merely the collections of specimens and apparatus made by the Prince, but also everything which can be classed under the general head of oceanography. Thus understood, the Monaco Museum will become a unique institution. [...] Generally speaking, it will receive everything connected more or less closely with oceanography: the apparatus used in oceanographic research, and the concrete results obtained: floats, etc., for measuring the force and direction of currents: machines for sounding, with their accessories, and the specimens dredged from the depths of the ocean: various bottles for obtaining samples of water, with their temperature, from different depths, in order to facilitate the study of the density and chemical composition: apparatus for testing

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<sup>366</sup> See Jacqueline Carpine-Lancre and Eric Mills, “The Oceanographic Museum of Monaco,” *Ocean Frontiers, Explorations by Oceanographers on Five Continents*, ed. by E. M. Borgese, (New York: H. N. Abrams, 1992), 120 – 135.

<sup>367</sup> “The Oceanographical Museum at Monaco,” *Nature*, No. 2111, Vol. 83, (14 April 1910), 192.

the penetration of light into the ocean depths, &c. Further, the museum will contain all the various devices employed by the Prince and his assistants for catching marine animals; pelagic nets for the surface and the depths, dredges, trawls, swabs, tow nets, harpoons, fishing tackle of all kinds, windlasses, reels, accumulators, and other apparatus. Either the actual instruments or reduced models of them will be shewn [sic]. But the greater part of the museum will be devoted to the zoological collections whose true value can only be appreciated when they are rendered accessible.<sup>368</sup>

Richard also counseled Prince Albert to make the museum as accessible to researchers as possible, writing to him on October 22<sup>nd</sup>, 1901: “my opinion is that it would be good to do all that is possible to encourage naturalists to come [to the museum], in particular your collaborators must have all the facilities necessary to work without [additional] expense.”<sup>369</sup>

It was originally intended that an international oceanographic congress should convene in Monaco in conjunction with the inauguration of the Institute. The meeting never went ahead, perhaps thwarted by disunity between various Institute members.<sup>370</sup> However, while the meeting failed to materialize, correspondence related to the meeting indicates the extent of international support for Albert’s project. Particularly revealing is a letter from Otto Petterson:

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<sup>368</sup> Jules Richard, “The Oceanographic Museum of Monaco” [Translated from *Transactions of the International Geographical Congress*, Berlin, 1899], *The Museums Journal*, Vol. 2, No. 3, (September 1902), 77 – 78.

<sup>369</sup> Richard to Prince Albert, 22 October 1901, Monaco Palace Archives. The Museum could double as a marine zoological station – something that Albert had considered building as early as 1885. Plans had previously be drawn up for a marine station to be built at the western edge of Monaco which included laboratories, a library, and public aquarium, but the structure was never built. Eric Mills and Jacqueline Carpine-Lancre, “The Oceanographic Museum of Monaco,” 123, 124.

<sup>370</sup> Jacqueline Carpine-Lancre cites the disaccord between Paul Regnard and Louis Joubin over assignment of the post of Secretary General of Congress. Jacqueline Carpine-Lancre, “The Plan for an International Oceanographic Congress,” *Oceanography: The Past*, ed. by M. Sears and D. Merriman, (New York: Springer-Verlag, 1980), 163.

From my connection with the international oceanographic research of the North Sea powers and Russia I have experienced both the advantages and the difficulties of international scientific work. Every such enterprise must have its center. [...] Monaco fulfills most conditions for becoming the center of an international investigation of the sea, being independent of political changes and opinions of legislative bodies as well as the scientific rivalry of the universities and academies of the greater nations. The oceanographic museum of Monaco, if combined with an international investigation of the Atlantic and other oceans, might become the seat of this organization and the literary center for publishing the general results.<sup>371</sup>

A glowing summary of the museum's inauguration, published in the French scientific journal *Annales de Géographie*, reported that "this vast edifice, admirably situated" was not simply a museum. It would be first and foremost a "permanent station for local studies." The surrounding waters had already been sounded, noted the author; and, over the previous two years, had been the subject of weekly observations with a focus on plankton and oceanographic variations. A twenty-ton steam vessel, the *Eider*, was to be permanently assigned to the museum for this task.<sup>372</sup> Furthermore, the author writes, "the monument is, in the mind of the prince, destined to become a permanent international center for oceanographic studies, a sort of rally point for the oceanographers of the world, a foyer where the collective efforts that oceanography requires for it to progress will be elaborated."<sup>373</sup> As it happened, the completion of the Museum

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<sup>371</sup> Quoted in *Ibid.*, 161 – 162.

<sup>372</sup> The *Eider* was later used to great success by Alexander Nathansohn (1878 – 1940) in his studies of the annual plankton cycle in the Mediterranean. See Eric Mills, *Biological Oceanography: An Early History, 1870 – 1960*, 116; and Eric Mills and Jacqueline Carpine-Lancre, "The Oceanographic Museum of Monaco," 127.

<sup>373</sup> "Généralités – L'inauguration du Musée Océanographique de Monaco," *Annales de Géographie*, Vol. 19, Issue 106, (1910), 374 – 375. As a "station" the museum was also equipped with meteorological instruments; this is suggested in a letter from Richard offering to speak to Delefortrie (Paul Delefortrie 1843 – 1910, architect who designed the museum) about installing meteorological instruments to specifications given by Mascart, likely French meteorologist Éleuthère Mascart (1837 – 1908). In this same letter, Richard writes that the Museum is now entering its "active phase." Richard to Albert, 9 October

corresponded with a period of growing civil unrest in Monaco, culminating in the so-called Monegasque Revolution of 1910. As *The Washington Post* reported:

The information that Prince Albert wears high honors for services to science as the greatest oceanographer that ever lived does not tend to soothe the feelings of his subjects. They care nothing about science. [...] The only interest they have in fish is in the edible species, of which a fair ‘rake off’ from Monte Carlo gaming profits would give them their fill. By way of further grievance, has not the prince at enormous expense, set up a ‘bastille’ – which his recently constructed great museum of oceanography resembles, though up to the present only fishes have been doomed to confinement there? ‘Down with the bastille! Give us gold!’ [...] [T]his expensive museum building is regarded by Prince Albert’s subjects as ‘the last straw.’ That is ‘throwing gold to the fishes’ with a vengeance. So, listen for sounds of revolution in this smallest principality on earth, and perhaps the much to be hoped for abolition of the world’s chief gambling hell.<sup>374</sup>

But even so, the period between 1905 and 1910 is described by Carpine-Lancre as the height of Albert’s scientific activity. During this period Albert partook in regular summer research cruises aboard his yacht, traversing the North Atlantic “from the Azores to Spitzbergen.”<sup>375</sup>

Perhaps further inflaming his subjects, Albert’s activities as a scientific patron had by now expanded well beyond the confines of Monaco. As early as 1903 Albert arranged for a lecture series on oceanography to be delivered at the *Conservatoire National des Arts et Métiers* in Paris. Shortly thereafter, in 1904, these lectures were transferred to the Sorbonne. Finally, in 1911, Albert inaugurated his *Institut Océanographique* – a

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1901, Monaco Palace Archives. In addition to oceanography, Prince Albert was also interested in marine meteorology and aviation. These dual interests are reflected in the Oceanographic Institute’s Latin motto: “ex abyssis ad alta.” The lower levels of the museum included laboratory rooms and aquaria. See Louis Joubin, “The Deep Sea Explorations of the Prince of Monaco,” *The International Quarterly*, Vol. 10, (1905), 387.

<sup>374</sup> “Prince of Monaco an Autocrat,” *The Washington Post*, (24 October 1910).

<sup>375</sup> Jacqueline Carpine-Lancre, “The Plan for an International Oceanographic Congress Proposed by H.S. the Prince Albert 1<sup>st</sup> of Monaco,” 157.

permanent institutional home for oceanographic instruction in the heart of Paris.<sup>376</sup> Sometimes described as an “Oceanographic School,”<sup>377</sup> the Institute, which shared an administrative council with the Oceanographic Museum in Monaco, was designed to promote oceanographic science through university courses offered in conjunction with the University of Paris, scientific publications, and public lectures.<sup>378</sup> As laid out in a report on the inauguration of the institute in the American journal *Science*: “the new institute is at once French and international in character. This aspect of the foundation is marked by the presence on the committee of Sir John Murray, Professor Buchanan, Professor von Drygalski, Dr. Nansen and other foreign men of science. In addition there is an administrative council composed of French men of science.”<sup>379</sup> Included among the French members of this committee were Yves Delages (director of the Roscoff marine station), Paul Fabre-Domergue (former assistant director at the marine station of Concarneau and General Inspector of Fisheries), Louis Joubin (a veteran of the *Travailleur* and *Talisman* expeditions and former director of both the marine stations of

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<sup>376</sup> Paul Regnard (1850 – 1927) influenced Albert’s decision to build the institute in Paris. Private communication, Jacqueline Carpine-Lancre, text of speech delivered by Thomas Fouilleron and Jacqueline Carpine-Lancre on the occasion of the centenary of the Oceanographic Institute, 21 June 2011. Former director of the Oceanographic Institute, Lucien Laubier, in a speech given in 2002, stated: “today, the foundation [...] of the Oceanographic Institute represents perhaps one millionth of French oceanography; in 1905, at the moment of her creation, she represented probably more that 90% of French oceanography.” Lucien Laubier, “Le role du prince Albert 1er de Monaco,” *Compte rendu des entretiens Science et Ethique 2002*. [Accessed online 14 August 2014], [http://www.science-ethique.org/site\\_ES/programme.php?internum=829&PHPSESSID=094f66e39aeaa9d1b37a18d9a20ae7bb](http://www.science-ethique.org/site_ES/programme.php?internum=829&PHPSESSID=094f66e39aeaa9d1b37a18d9a20ae7bb).

<sup>377</sup> “Généralités – L’inauguration du Musée Océanographique de Monaco,” 375.

<sup>378</sup> The British oceanographer William Herdman, wrote of the relationship between the Museum and the Institute in 1923, “the factory is at Monaco, the sale-room at Paris.” William Herdman, *Founders of Oceanography and Their Work*, 132.

<sup>379</sup> “Scientific Notes and News,” *Science*, Vol. 33, No. 841, (10 February 1911), 214.

Banyuls sur Mer and Roscoff; in 1918 he became director of the *Office Scientifique et Technique des Pêches Maritimes*), Edmond Perrier (director of the Paris Museum of Natural History, veteran of the *Talisman* and *Travailleur* expeditions, and founder of the marine station at Tatihou), Paul Portier (trained in medicine and physiology, he had previously accompanied the Prince on a voyage to Spitzbergen), Jules Richard, and finally, Julien Thoulet. An important source documenting the origin of the Oceanographic Institute survives in the form of letter from Albert to the French Minister of Public Instruction dated 25 April 1906.<sup>380</sup> This letter is worth quoting in length:

Monsieur le Ministre, - Having devoted my life to the study of Oceanographic Sciences I have been struck by the importance of their action on several branches of human activity, and I have striven to obtain for them that place which they should occupy in the solicitude of governments not less than in the preoccupations of the learned. Several States have already organized scientific cruises in all the seas of the globe and have established a solid basis for the development of Oceanography; but France, notwithstanding that the science of the sea presents for her special interest, has not treated it with the same liberality as she has treated other branches of Science. Nevertheless, for some years past I have caused to be given in Paris a series of lectures which have been followed by audiences each time more numerous and more attentive, while the public powers, in the persons of President Loubet<sup>381</sup> and members of the Government, have shown a certain interest in them by their presence. I then wished to fill a gap by myself creating and establishing in Paris a center of Oceanographic Study closely connected with the laboratories and collections of the Oceanographic Museum at Monaco, where for the past twenty years I have gathered the results of my personal labours and those of eminent collaborators who have come to me from all the countries of Europe. Informed by the friends of the University that a scheme of enlargement, necessary to the prosperity of that illustrious body, had met with difficulties and delays in its realization, I thought that the combination of the two plans would be beneficial to both; and I offered to the Vice-Rector my collaboration therein. Subsequently it became possible for me to take my part in raising the capital necessary to acquire the land which the Sorbonne needed, and in return, the

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<sup>380</sup> This letter is reproduced at the head of the Institute's statutes. [Accessed online 22 July 2014]. <http://www.institut-ocean.org/images/articles/documents/1365757236.pdf>. In quoting this letter I have used a translation reproduced in Adolphe Smith's 1912 text.

<sup>381</sup> Émile Loubet (1838 – 1929), President of the French Republic (1899 – 1906). Loubet succeeded Albert as second president of the Oceanographic Institute's administrative council, serving briefly from 1922 to 1923.

University granted me a site, [...] on which I wish to erect the Oceanographic Institute whose Statutes I now communicated to you. [...] Desirous that this institution shall survive me under the conditions which have appeared to me likely to assure the services which I expect from it for the progress of Science, I beg the French Government to recognize it as of public utility and to approve its Statutes.<sup>382</sup>

The idea of an oceanographic institute was not entirely original. As Prince Albert was well aware, the *Institut für Meereskunde* opened in Berlin in 1900; Albert was present for the inauguration ceremony, along with his cousin Kaiser Wilhelm II. The *Institut für Meereskunde*, however (the project of German explorer, scientist, and geographer Ferdinand von Richthofen (1833 – 1905), the Imperial German Navy, and the University of Berlin), was primarily a showcase for Germany’s navy. A naval exhibit was the centerpiece of the attached museum, and public lectures and publications were produced to promote “awareness of the national importance of the ocean and its naval affairs.”<sup>383</sup> Despite its distance from the sea, the Berlin Institute provided an institutional home for German naturalists willing to adopt the new quantitative approaches to oceanography which were emerging in Scandinavia: Alfred Grund (1874 – 1914), succeeded by Alfred Mertz (1880 – 1925).<sup>384</sup> In contrast to the *Institut für Meereskunde*, the *Institut Océanographique* in Paris was a purely scientific organization rather than one with both scientific and practical aims.<sup>385</sup> Also in contrast with the *Institut für Meereskunde*, the *Institut Océanographique* operated in conjunction with an existing

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<sup>382</sup> Quoted in Adolphe Smith, *Monaco and Monte Carlo*, 163 – 164.

<sup>383</sup> Quoted in Walter Lenz, “The Museum für Meereskunde in Berlin,” *History of Oceanography: Newsletter of the ICHO*, No. 18, (September 2006). 18.

<sup>384</sup> For a discussion of the *Institut für Meereskunde* see Eric Mills, *The Fluid Envelope of Our Planet*, 139. See also, Lynn K. Nyhart, *Modern Nature: The Rise of the Biological Perspective in Germany*, (Chicago: Chicago University Press, 2009), 278 – 288.

<sup>385</sup> “Généralités – L’inauguration du Musée Océanographique de Monaco,” 375.

scientific institution: the Sorbonne.<sup>386</sup> And as an additional function the *Institut* provided a venue from which to further popularize the science of oceanography by hosting public lectures and slide shows. These lectures were wildly successful, and word of their popularity was reported as far away as San Francisco. As the author of a 1913 article in the *San Francisco Chronicle* wrote:

[I]n a most magnificent lectures hall, addresses on the deep sea and its inhabitants are now riveting the attention of studious and fascinated audiences. The lectures are usually at 9 o'clock in the evening. Two hours before they begin there is not a place to be had. There is no such thing as standing room, for when all the seats are occupied no more people are allowed to enter the hall. The Lectures are free. The magic lantern and the cinematograph are pressed into the lecturer's service and seats are arranged in semi-circles and so raised that all can see. The lecturers are mostly from the Sorbonne, but the most popular lecturer of them all is Prince Albert of Monaco, who just now is one of the idols of Paris. Whenever this princely oceanographer [sic] is announced for a lecture, the poorer holders of tickets sell their right of admission for a handsome price. And the demand is enormous.<sup>387</sup>

Certainly Prince Albert succeeded in capturing the public imagination; but did he succeed in directing French government support towards marine research? A report sent to Albert in September 1910 informs us that he had begun to exert his influence upon one of the most important of the French marine stations, the biological station at Roscoff in northern Brittany. There is no evidence to suggest that the Prince ever conducted research at Roscoff, or that he even visited the station. However, the author of the report (unfortunately unknown) explains that at the Prince's request he has undertaken the installation of a number of "oceanographic and chemical instruments" at Roscoff to

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<sup>386</sup> Similarly, Albert created an Institute of Human Paleontology, erected in Paris in 1912 and strategically placed near the Museum of Natural History. For an architectural history of both the *Institut Océanographique* and the *Institut de Paléontologie Humaine* see Christelle Inizan, "L'institut océanographique de Paris," *In Situ*, (23 November 2011), [Accessed online 23 July 2014]. <http://insitu.revues.org/865#text>.

<sup>387</sup> "Wonders of Deep Shown in Paris," *San Francisco Chronicle*, (16 March 1913).

“serve oceanographic research” and equip the table rented by the Prince. The author explains that he was instructed to install these instruments “after the principles in use at the [oceanographic] museum in Monaco.” Other tasks undertaken included the “instruction of personnel, designated by the station director, on the principle oceanographic procedures, such as: sounding, taking water samples, taking temperature readings, collecting plankton, chemical analysis of sea water.”<sup>388</sup> It remains difficult to fully assess the degree to which Albert influenced the direction of scientific work at the Roscoff Station. He was, after all, but one of several philanthropists who gave donations to the station; he, along with Roland Bonaparte, Belgian botanist-philanthropist Jean Chalon, and members of the Rothschild family, was recognized by Yves Delage primarily for his financial contributions, not his intellectual ones.<sup>389</sup>

*A Vision of Global International Science - The General Bathymetric Chart:*

The General Bathymetric Chart of the World, also known as the GEBCO –one of the most ambitious scientific projects of the late 19<sup>th</sup> century – is certainly the most ambitious scientific project with which Prince Albert is associated.<sup>390</sup> By 1895 sufficient sounding measurements had been made in international waters – by naval vessels,

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<sup>388</sup> Photocopy of a single page of the original letter is held in the Roscoff Station Archives. The letter bears the stamp of the Oceanographic Museum of Monaco Archives where, presumably, the original may be found.

<sup>389</sup> Their names and the amount they gave are still mounted on marble plaques in the central aquarium room of the station. Kofoid notes that the annual rental rate for a table at the station at this time was 1500 francs. Charles Atwood Kofoid, *The Biological Stations of Europe*, 96.

<sup>390</sup> When the American oceanographer Marie Tharp famously drew her bathymetric charts of the Worlds’ oceans in the 1950s, she relied in part on information gathered for the General Bathymetric Chart of the World. Marie Tharp, “Connect the Dots: Mapping the Seafloor and Discovering the Mid-ocean Ridge,” *Lamont-Doherty Earth Observatory of Columbia: Twelve Perspectives on the First Fifty Years 1949 – 1999*, ed. by Laurence Lippsett. [Accessed online 26 June 2014], <http://www.whoi.edu/sbl/liteSite.do?litesiteid=9092&articleId=13407>.

telegraph companies, and oceanographic expeditions – to suggest that a global map of submarine topography was now possible.<sup>391</sup> What was required to complete this ambitious project was a master chart compiling and standardizing all available sounding data.

The General Bathymetric Chart project was the product of a meeting of the Seventh International Geographical Congress in Berlin in 1899 at which time a commission was formed with the task of creating a standardized bathymetric chart of the world's oceans. Progress was slow until Prince Albert agreed to become chair of the commission in 1903 and assumed all of the financial expenses. The first meeting of the commission took place in Wiesbaden, Germany, on April 15<sup>th</sup> and 16<sup>th</sup> of 1903. At this first meeting the commission determined the nomenclature of geological features to be employed.

Julien Thoulet, who had created a set of guidelines for the map in 1901, and Charles Sauerwein (1876 – 1913), a French naval officer and member of Albert's staff, assumed much of the responsibility for the arrangement of the work. Albert appointed Sauerwein "Chef du Service de la Carte générale des océans."<sup>392</sup> In this capacity, Sauerwein oversaw the assembly of a vast amount of bathymetric data from hydrographic offices, oceanographic expedition reports, and cable-laying companies. With the help of six draughtsmen he prepared preliminary drafts of the compiled data and a first

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<sup>391</sup> By 1895 two general bathymetric charts had already been produced, an 1893 chart by the German navy, and an 1895 chart produced by John Murray using *Challenger* sounding data. Jules Richard, *L'Océanographie*, (Paris: Vuibert & Nony Éditeurs, 1907), 44.

<sup>392</sup> Carpine-Lancre suggests that Sauerwein was woefully unprepared for this task. See Jacqueline Carpine-Lancre, "The Origin and Early History of 'La Carte Générale Bathymétrique des Océans,'" *The History of GEBCO 1903 – 2003*, (Netherlands: Lemmer, 2003), 23.

manuscript was completed in June 1904. As Jules Richard later wrote, the production of the general bathymetric chart “marked an important date in the history of oceanography.”<sup>393</sup> On May 19<sup>th</sup>, 1905 a first copy of the chart was presented to Prince Albert. Unfortunately, it was at this point that the Bathymetric chart project faced its first hurdle. The prominent French geographer Emmanuel de Margerie (1862 – 1953) published a critique of the chart in the *Annales de géographie*, the leading French journal of geography.<sup>394</sup> The chart was flawed by the presence of many inconsistencies in terminology and transcription of errors from the original sources. As Eric Mills explains, proofreading by a competent geographer might have avoided the errors observed by De Margerie, but Thoulet, the project member with the most experience in geographical work did not participate in the final production of the chart. Sauerwein seems to have been the one primarily at fault; nevertheless, the debacle permanently soured the relationship between Julien Thoulet and Prince Albert.<sup>395</sup> Yet, while De Margerie’s critique permanently tarnished the chart project, Prince Albert did not abandon it and subsequent versions of the bathymetric chart were greatly improved, though publication was delayed by the outbreak of World War I.<sup>396</sup>

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<sup>393</sup> Jules Richard, *L’Océanographie*, 48.

<sup>394</sup> De Margerie also addressed a private letter to Thoulet and Sauerwein in which he questioned the “intelligence of the draughtsmen.” See the excerpt reproduced in Carpine-Lancre, “The Origin and Early History of ‘La Carte Générale Bathymétrique des Océans,’” 31.

<sup>395</sup> Eric Mills, *The Fluid Envelope of Our Planet*, 175. Mills argues that Thoulet’s fall from grace undermined the adoption of a mathematical approach to physical oceanography in France.

<sup>396</sup> Improvements were made largely thanks to Henry Bourée and Alphonse Tollemer (1850 – 1919).

*Conclusion – Prince Albert’s Legacy:*

In 1921, the year before his death, Prince Albert made his third and final voyage to the United States. The *Times Herald* reported that he was “amiable and enthusiastic, [...] wide-awake, ruddy of countenance, calm of manner, dignified to a nicety, and fairly radiates health.” Even at the age of 73, Prince Albert’s energies had not diminished; he complained that he had not enough time in the day “to accomplish all [he wished] to accomplish.”<sup>397</sup>

When Albert died in 1922, the fate of Monaco seemed once again in jeopardy. As an American paper announced in an article titled “A Royalty Worth a Struggle,” “it is not surprising that Prince Albert’s death, coupled with the fact that he had obtained an annulment of the marriage of which his only son was born, has stirred the collateral branches of the Grimaldi family to assert their claims as the legitimate successors to the Monacan royalty – the royalty in question being that paid by the Casino concession.”<sup>398</sup> Albert’s son Louis II inherited the throne. But Louis, who had never been close to his father, did not share Albert’s passion for oceanographic science. Another article (accompanied by a cartoon by Charles Henry Sykes entitled “the black wins” showing Albert slumped in his chair and death standing across from him at a gambling table), stated simply: “In contrast to his father, Prince Louis, who succeeds to the throne, it is

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<sup>397</sup> “Veteran Prince Thinks It’s Fun to Discuss Science With American Savants,” *Times Herald*, (21 April 1921), 33.

<sup>398</sup> “A Royalty Worth A Struggle. That of Monaco Means a Fat Income to the Grimaldi Who Wins It,” *The San Francisco Chronicle*, (5 July 1922).

understood, has no great love for the sea. He is proud of his title of colonel in the French Army and delights in military science.”<sup>399</sup>

Albert, perhaps foreseeing his son’s disinterest in marine science, had sought to secure the future of his oceanographic program after his death. In his will he bequeathed seven hundred thousand francs to his longtime collaborator Jules Richard of which six hundred thousand was “intended to complete the scientific and literary work” left unfinished.<sup>400</sup> This included the publication of the results of the oceanographic cruises and the bathymetric chart of the oceans. However, after Albert’s death the network of collaborators on which Richard had previously relied slowly dissolved. And, by the late 1920s, global economic depression had considerably diminished the value of Albert’s bequest, further delaying publication of updated versions of the general bathymetric chart. By this time, new regional bathymetric charts had been produced abroad employing techniques developed during World War One. These new charts effectively made the data compiled under Albert’s direction obsolete.

In 1921, the year before Albert’s death, and as a result of a series of international hydrographic conferences, it was decided that an International Hydrographic Bureau should be established with the task of making “navigation easier and safer in all the seas of the world.”<sup>401</sup> Monaco, traditionally a neutral country with a legacy of oceanographic research, was selected as the base for the newly formed bureau. The Hydrographic

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<sup>399</sup> “The Scientist Who Ruled Monte Carlo,” *The Literary Digest*, Vol. 74, No. 3, (15 July 1922), 38.

<sup>400</sup> Quoted in Jacqueline Carpine-Lancre, “The Origin and Early History of ‘La Carte Générale Bathymétrique des Océans,’” 42.

<sup>401</sup> Thomas Wayland Vaughan, *International Aspects of Oceanography: Oceanographic Data and Provisions for Oceanographic Research*, (Washington D.C.: National Academy of Sciences, 1937), 97.

Bureau, an organization initially composed of twenty-one member states, provided a lifeline to the GEBCO project and took over responsibility from Richard in 1929.

While the oceanographic institute in Paris and the museum in Monaco continue to operate to this day, their international activities were greatly diminished in the wake of Albert's death. The *Hirondelle II*, one of the most advanced research vessels of its time, was put up for sale. Otto Pettersson and Christian Fredrik Dreschel, Vice-President and General Secretary of ICES, briefly explored the possibility of purchasing the vessel and outfitting it for a worldwide oceanographic expedition that she might serve as a "new *Challenger*." But this project ultimately collapsed due to a lack of funding. Instead, the *Hirondelle II* was sold to an American film company and languished for many years at a berth in New York.<sup>402</sup>

When Albert died, a key source of support for oceanography in France was extinguished. The advantage that made Albert the most influential promoter of oceanography in the late 19th century – a monarch's financial and political independence – also made the long-term sustainability of his oceanographic program, dependent as it was upon dynastic succession, untenable. Albert was successful as a scientist and scientific patron because as an individual, in his own words, he united "ideas and will."

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<sup>402</sup> Jens Smed, "Abortive Plans for a World-Wide Oceanographic Expedition," *History of Oceanography*, No. 12, (September 2000), 10 - 14. Smed cites Pettersson as writing that Prince Albert I wrote to Henry Maurice (President of ICES) in 1922, shortly before Albert's death, and that he expressed his desire that ICES become a leader for oceanographic exploration. Otto Pettersson, "Förslag till en världsomfattande internationell havsforskningsexpedition," *Ymer*, No. 1, (1924), 39. While it is often reported that the *Hirondelle* was eventually converted into a coal depot pontoon in the Panama Canal, Jacqueline Carpine-Lancre has disputed this claim. According to Carpine-Lancre, the vessel was eventually sold to a company in the Philippines. She was seized by the Japanese during World War II but survived the war, and was operated out of the Philippines for many years. However, she was finally demolished in 1965. Jacqueline Carpine-Lancre, private communication.

The longevity of a scientific program for oceanography, however, depended on networks of State support, international scientific organizations, and institutionalized practices.

In France, as I have shown, institutional linkages existed between the Navy and the fishery, between the fishery and coastal marine stations, and between marine stations and universities. These institutional networks were strengthened by a culture that placed great value on the democratization of science education; a tradition stemming from the French revolutionary ideals of "liberté" and "fraternité." But the political and financial realities of France in the aftermath of the Franco-Prussian war hindered the development of a deep-water oceanographic program.

France's inability to participate effectively in an internationalist program for the scientific management of fisheries, had created a vacuum into which Prince Albert stepped. His work as a scientist was part and parcel of his political role as a state sovereign and diplomat. Thus, his efforts to promote and popularize oceanography went hand in hand with his aims to promote the prestige of his state as a promoter of peace and international cooperation. Yet, he alone could never elevate French oceanography to the same extent that backing from the French State might have allowed. We can even hypothesize that Albert's institutional support for Oceanography in France, "filling a gap" as he put it, may have actually discouraged broader State support for marine science. Albert subsidized pre-existing marine science networks: the professors at the Sorbonne and the Museum of Natural History who were interested in marine work and, to a certain extent, the network of French marine stations with which the French education establishment was allied. The history of "the failure of French Oceanography" suggests that centralized state supported marine science, as carried out in England and the United

States was, over the long term, a more effective means for promoting international scientific collaboration than a de-centralized institutional network supported by private patronage.

## Chapter 4:

### The Fair as Research Center: Science, Internationalism, and the Making of a “Pacific World”

*Introduction – The Promise of Pacific Oceanography, a Mare Incognitum:*

In the previous chapter I discussed Prince Albert I<sup>st</sup> of Monaco’s important role as one of the early patrons of marine science in France. I also stressed the growing importance, by the early twentieth century, of international scientific networks for the coordination of scientific surveys of the marine environment, and cited Prince Albert’s collaboration with the International Council for the Exploration of the Sea and efforts to promote international cooperation in the scientific institutions he created in Paris and Monaco. Having described some of the early developments in the marine sciences in Western Europe, the North Sea, and the Atlantic, I want to now shift focus to the Pacific.

Writing as early as 1873, the then-future chief scientist of the *Challenger* expedition, Charles Wyville Thomson wrote:

The Atlantic Ocean, with the accessible portions of the Arctic Sea, has naturally, from the relation in which it stands to the first maritime and commercial nations of the present period, been the most carefully surveyed[.][...] We have still but scanty information about the beds of the Indian, the Antarctic, and the Pacific oceans[.]<sup>403</sup>

In the wake of successive oceanographic expeditions in the Atlantic, the absence of oceanographic data about the Pacific had become increasingly evident to marine scientists both in Europe and in North America. But even for naturalists in the United States, the Pacific remained remote. Alexander Agassiz, in an 1881 letter to Wyville Thomson, hoped that there was “some chance of having a government vessel off Panama” later that year; if so, Agassiz hoped he could “persuade [the] Captain to let

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<sup>403</sup> Charles Wyville Thomson, *The Depths of the Sea*, 226 – 227.

[him] go to the Galapagos.”<sup>404</sup> Agassiz first oceanographic voyage to the Galapagos, however, would only occur in 1891.<sup>405</sup> Launching an expedition from Europe to travel to the Pacific remained both costly and dangerous. Steam ships could travel quickly and carry out oceanographic work in the open ocean, but they were limited in their range and dependent on the accessibility of coaling stations. Furthermore, travel around Cape Horn was a time-consuming and notoriously risky endeavor. On October 10<sup>th</sup>, 1913, however, the Pacific Ocean suddenly became a much more tempting research destination. On that day, president Woodrow Wilson sent a telegraph signal from the White House, detonating eight tons of explosives in Panama, destroying the final barrier between the Atlantic and Pacific, and officially opening the Panama Canal.<sup>406</sup>

In a May 20<sup>th</sup>, 1913 letter to the British oceanographer William Herdman, Scottish oceanographer John Murray, veteran of the *Challenger* expedition, exclaimed: “could I afford it at present, I would be off to the Pacific in a Diesel-engined ship!”<sup>407</sup> Murray had begun to plan a Pacific-bound oceanographic expedition in 1911 but had difficulties raising sufficient funds. His sudden death in an automobile accident on March

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<sup>404</sup> Alexander Agassiz to Wyville Thomson, (6 February 1881). Correspondence of Alexander E. R. Agassiz (1835-1910), University of Edinburgh Library Special Collections and Archives. To be clear, access to the Pacific Ocean was limited, not access to the Pacific coast. Alexander Agassiz traveled extensively on the west coast of South America in 1875, during which time he wrote to the members of the Challenger expedition then working in the Pacific. See John Murray, “Alexander Agassiz: His Life and Scientific Work,” *Bulletin of the Museum of Comparative Zoology*, Vol. 54, No. 3, (Cambridge: Museum of Comparative Zoology, 1911).

<sup>405</sup> See Larry T. Spencer, “Four Men and an Albatross: The Growth of American Oceanography, 1882 – 1921,” *Oceanographic History: The Pacific and Beyond*, ed. by Keith Benson and Philip Rehbock, (Seattle: University of Washington Press, 2002), 288 - 297.

<sup>406</sup> Sarah J. Moore, *Empire on Display: San Francisco’s Panama-Pacific International Exposition of 1915*, (Norman: University of Oklahoma Press, 2013), 68.

<sup>407</sup> Quoted in William Herdman, *Founders of Oceanography*, 88.

16<sup>th</sup>, 1914, prevented him from realizing his Pacific expedition.<sup>408</sup> But Murray was not the only oceanographer turning his attentions to the Pacific. The Great War forced a suspension of most oceanographic research in Europe. With the end of the war, however, the Pacific seemed to offer the promise of a new beginning. The German oceanographer and director of the Berlin Institute of Oceanology, Alfred Merz, began planning for an expedition for the systematic study of Pacific basin in 1921.<sup>409</sup> Merz believed the Pacific offered “an almost infinite field, which has been there all along, inviting large scale research[.]” A German Pacific oceanographic expedition, a “great cultural act,” would both reinvigorate German science, and re-inspire nationalist pride in the wake of military defeat.<sup>410</sup> But, despite Mertz’s best efforts, the *Meteor* expedition was eventually forced to limit the region of study to the Atlantic basin, the cost of a voyage to the Pacific proving prohibitive in the postwar German economy.<sup>411</sup> The *Meteor*’s confinement to the Atlantic ultimately meant restructuring the scientific aims of the project. Whereas in the Pacific an “open station network” might “have yielded fundamental results,” in the Atlantic, morphology and hydrology was already well established. Instead Merz devised a program using a “close-knit network of stations” in order to measure ocean circulation using quantitative methods.<sup>412</sup> While in the aftermath of World War One European oceanographers envisioned the Pacific as a tantalizingly remote *mare incognitum*, on the

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<sup>408</sup> Ibid., 97.

<sup>409</sup> F. Spiess, *The Meteor Expedition: Scientific Results of the German Atlantic Expedition, 1925 – 1927*, Trans. by William J. Emery, (New York: Amerind Publishing Co., 1985), 10.

<sup>410</sup> Ibid., 10 – 11.

<sup>411</sup> Eric Mills explains that a lengthier voyage to the Pacific would have required refitting the coal-burning *Meteor* with diesel engines. Eric Mills, *The Fluid Envelope of Our Planet*, 155.

<sup>412</sup> Ibid., 15, 17.

other side of the world, others had already turned their attention to the scientific study of the Great Ocean.<sup>413</sup>

Despite the incredible loss of life, the First World War stimulated the American economy, boosting both the agricultural and fisheries industries. A 1917 article in the *New York Tribune* reported that the California fishing industry had grown to “undreamed-of proportions.” In Seattle, the author cheerfully reported, whale meat was being consumed at a rate of eight tons a day at a cost of 10 cents a pound. War’s demands had also given “new impetus” to the tuna and sardine industries. The Pacific, the author argued, was being transformed into a new American breadbasket. “Certain waters of the Pacific can be made to produce more food to the square mile than a section of wheat land”, he wrote, adding that “here, again, the Kaiser and his war are proving to be very efficient American industrial agencies. [...] Germany is waging this war to fill its larder but is really spreading the American table.”<sup>414</sup> The Pacific fisheries industry was growing exponentially, and with it, scientists working on the western coast of the United States recognized the increasing need for scientific investigation of the Pacific Ocean.

Other events and actors, though, allow us to put these Pacific aspirations into a broader context, one exemplified by the World’s Fairs held on the U.S. West Coast

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<sup>413</sup> It should be noted that first voyage of the U.S. Fish Commission research vessel *Albatross* into the Pacific, lead by Alexander Agassiz, took place in 1891. On its first voyage into the Pacific, the *Albatross* trawled near the Galapagos Islands and in the Gulf of California. Agassiz used the *Albatross* for extensive Pacific work in 1899 and 1900 on a track that took him from San Francisco, through Polynesia and Micronesia, and ended in Yokohama. Larry T. Spencer, “Four Men and an Albatross: The Growth of American Oceanography, 1882 – 1921,” 290 – 291. See also Walter Lenz, “The Aspirations of Alfred Merz, George Wüst, and Albert Defant: From Berlin to Pacific Oceanography,” *Oceanographic History: The Pacific and Beyond*, ed. by Keith Benson and Philip Rehbock, (Seattle: University of Washington Press, 2002), 118 – 123.

<sup>414</sup> Theodore M. Knappen, “The Sinews of War: California Fish Industry Has Been Stimulated to Undreamed-Of Proportions,” *New York Tribune*, (10 August 1917).

during the 20<sup>th</sup> century. In 1939 my grandmother, Elizabeth Haverstock, had just moved from the sleepy outskirts of Minneapolis, Minnesota, to the exciting cultural capital that was San Francisco. 1939 was also the year of the Golden Gate International Exposition, a celebration of the completion of what were at the time the two largest bridges in the world, the San Francisco to Oakland Bay Bridge and the famous Golden Gate Bridge, the “gateway to the Pacific.” Events associated with the exposition were going on all over the Bay area. Among our family papers is a ticket for a “Fantasia Pacifica” pageant and ball, a “benefit for artists,” held on a Friday night on April 21<sup>st</sup>, 1939. The ticket notifies guests that costumes will be “restricted to the peoples and land of the Pacific Basin [...] None other can be admitted to the dance floor.” I can only assume that my grandmother enthusiastically took to the dance floor that night as we have several photographs of her in costume as well as a letter from her aunt “Tot” which teasingly admonishes her: “Shades of Salome! Would your mother do a back-flip could she have seen her only daughter clad in the seventh and last veil, a string of pearls, and a tin ‘bra,’ staggering home at four A.M.”

Three months later, on July 24<sup>th</sup> 1939, a far more serious event, but one also tied to the Golden Gate Exposition, began on the UC Berkeley campus. It was the sixth meeting of the Pacific Science Congress. Dr. Herbert Gregory (1869 -1952), director of the Bishop museum in Honolulu, delivered the opening address. Like my grandmother, however, there was little “Pacific” about Dr. Herbert Gregory’s origins. Born in Middleville, Michigan on October 15<sup>th</sup>, 1869, he completed both his bachelor’s degree and Ph.D. at Yale, graduating in 1896. After receiving his degrees, Gregory stayed on at Yale as an instructor of biology, physical geography, physiography, and geology, retiring

as professor emeritus in 1936. Early on, however, he developed a fascination with the Pacific, and it was this passion, that seems to have directed much of his later work. As a colleague later recalled:

[Gregory] used to tell of the map of the world which he and some friends drew early in the twentieth century, coloured to show the stage of knowledge reached in natural history. For the Pacific, the area coloured red to indicate exploratory work was huge; blue for reconnaissance appeared in detached patches and strips; whereas yellow, for detailed knowledge was mostly in dots. They estimated that the adequately investigated part of the Pacific was the equivalent of a plow furrow across a 20-acre lot.<sup>415</sup>

One of the original founders, and the first president of the Pacific Science Congresses, the first of which had been held in Honolulu in 1920, Gregory held a place of honor at the congress meeting in 1939. Once again he was one of the main organizers. Though the conference was officially arranged under the auspices of the National Research Council, this had been done largely under the supervision of the “Committee on Pacific Investigations,” of which Gregory was chair.<sup>416</sup>

Gregory likely saw the opening of the Sixth Pacific Congress as crucial to his own legacy as a scientific organizer of the Pacific. Previous meetings had been held in Honolulu, Melbourne, Tokyo, Batavia, and Vancouver. “We are going to become Pacific-minded, instead of Atlantic-minded” Gregory declared at the fifth Pacific Science Congress, held in Vancouver in 1933. “[I]n the generations to come this is the part of the world that is going to see the greatest progress, and I hope the greatest welfare of

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<sup>415</sup> A. P. Elkin, “Pacific Science Association: It’s History and Role in International Cooperation,” *Bernice P. Bishop Museum Special Publication No. 48*, (Hawaii: Bishop Museum Press, 1961), 7.

<sup>416</sup> Roy Elwood Clausen, “The Sixth Pacific Science Congress,” *Science*, Vol. 90, No. 2342, (17 November 1939).

peoples.”<sup>417</sup> It was these terms that Gregory outlined his vision for an international cooperative scientific investigation of the Pacific, focused on a shared, ocean-based, geographic space. The sixth congress was the first to be held within the continental United States, and the first opportunity for the Pacific Science Congresses to receive national recognition from the continental American public. After providing an overview of the history of the Pacific Science Congresses in his opening public address, Gregory assured his audience that it was “safe to say that since the meeting of the First Congress more has been learned of the structure and life of the Pacific than in all preceding time.”<sup>418</sup>

While Gregory might have viewed the sixth congress as the culmination of a program promoting the scientific exploration of the Pacific that he had helped to create in the early 1920s, in some ways the Golden Gate Exposition was a lifeline for the 1939 meeting of the Pacific Science Congresses. Initially organizers had feared that a sixth meeting would be impossible. In 1939 the political landscape of the Pacific was beginning to unravel. At the fifth meeting in Vancouver it had been resolved that “preference be given to one of the small islands in the Pacific, or to some place on the Asiatic mainland” as a meeting site, however, proposals to hold the meeting in Hong Kong and Fiji both fell through due to local political unrest. Gregory intervened in July 1938 and suggested San Francisco as the meeting location. Funding for the congress was provided in part by National Research Council funds and in part by the Golden Gate

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<sup>417</sup> Herbert H. Gregory, “Address,” *Fifth Pacific Science Congress Proceedings*, Vol. 1, (Vancouver: Pacific Science Association, 1933), 131.

<sup>418</sup> “Public Sessions,” *Sixth Pacific Science Congress Proceedings*, 49.

Exposition. The Exposition's Director of the Department of the Pacific Area, Philip N. Youtz, organized the latter.<sup>419</sup>

There is reason to juxtapose these two historical accounts, one the story of my grandmother at a costume ball, the other the opening of the Sixth Pacific Science Congress. Together, these two stories capture the strange mixture of popular culture and scientific aspiration that gave birth to the idea of the existence of a "Pacific World" in the first half of the twentieth century. How does the granddaughter of Baptist minister from the Midwest, or for that matter, a Yale scientist originally from the Midwest, end up impersonating an imagined "person of the Pacific"?

The premise of this chapter is that the model of the "Pacific World" may be a useful framework for understanding the connection between science, commerce, and popular culture in the Pacific basin during the early twentieth century. I focus in particular on how science was perceived, in the United States, as integral to the promotion of peaceful commercial relations between nations bordering the Pacific. This emphasis on the interwar period represents a departure from most scholarship on twentieth-century oceanography. While it may be true that ocean-oriented and militarily driven science of the Second World War and Cold War dwarfed the scientific accomplishments of the interwar period, pre-war ocean science should not be dismissed as little more than a prelude.<sup>420</sup> While I do not wish to deny the significance of naval power in post-war ocean science, I would like to suggest that interwar Pacific science

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<sup>419</sup> Ibid., 51.

<sup>420</sup> Historians of ocean science have, for instance, emphasized the military origins of post-war Pacific-based scientific programs like those at the Scripps Institution of Oceanography. See, for instance, Jacob Darwin Hamblin, *Oceanographers and the Cold War*.

should be read on its own terms. Two broad questions that must be asked are: what does interwar science look like and how was it tied to the commercial and popular culture of the 1920s and 30s?

*Science and the Making of the Pacific World:*

Even before the mid-twentieth century rise of “Big Science,” field research in the Pacific had already given rise to institutions for compiling and disseminating large-scale scientific field data by the early twentieth century.<sup>421</sup> Oceanography in particular, a science reliant on international cooperation and extensive field observations, was already dependent on international efforts to gather data on a large scale by the 1920s. When trying to understand why scientists working in the Pacific basin sought to establish international cooperation it is helpful to consider what Helen Rozwadowski has termed, the “environmental necessity” of conducting science at sea.<sup>422</sup> In her study of the formation of ICES (International Council for the Exploration of the Sea), Rozwadowski suggests that marine scientists have long held the shared conviction that oceans can only be systematically studied by means of international collaboration for the very simple reason that fish and water masses know no national frontiers. In short, science at sea requires observation over a geographic space surpassing the monitoring capabilities of any single nation. Jacob Hamblin has made a similar claim in his study of Cold War oceanography; he writes that “[t]he lack of national borders at sea, the indiscriminately

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<sup>421</sup> A 1924 issue of the *Pan-Pacific Union Bulletin*, describes the proposed function of the Pan-Pacific Science Institute as serving as “a clearing house for scientific information.” G. E. Allen, “Pan-Pacific Scientific Research Work,” *Pan-Pacific Union Bulletin*, No. 61 (November, 1924).

<sup>422</sup> Helen Rozwadowski, “Internationalism, Environmental Necessity, and National Interest: Marine Science and Other Sciences,” *Minerva*, 42, 127 – 149, (2004).

hostile environmental conditions, and the global scope of observations have long lent oceanography the reputation of being an inherently international endeavor.<sup>423</sup>

In the Pacific, as in Rozwadowski's example of the development of ICES in the Atlantic, appeals for internationalist science were often made with appeal to national and commercial interests. From the vantage point of the United States, an orientation towards the Pacific can be traced as far back as the early 1800s. Though nationalistic and commercial interests drove public interest in the Pacific, the exploration of the region was also often connected with scientific work, or at least given popular appeal by embracing the rhetoric of scientific progress. Connecting their work with the exploration of the Pacific, naturalists sought to uphold the utility of science for the promotion of national interests. In 1840, for example, the celebrated pioneer of marine science, Matthew Fontaine Maury, published a series of editorials advocating naval reform in which he decried the lack of cartographic data dealing with America's pacific frontier.

If you have a map of the world at hand turn to it, and placing your finger at the mouth of the Columbia River, consider its geographical position and the commercial advantages which, at some day not far distant, that point will possess. To the South, in one unbroken line, lie seven thousand miles of coast indented with the rich markets of Spanish America – to the West, Asiatic Russia and China are close at hand – between the South and the West, are New Holland and Polynesia; and within good marketable distance are all the groups and clusters of islands that stud the ocean, from Cape Horn to the Cape of Good hope, from Asia to America. Picture to yourself civilization striding the Rocky Mountains, and smiling down upon the vast and fruitful regions beyond, and calculate, if you can, the importance and future greatness of that point to a commercial and enterprising people. Yet the first line in the hydrography of such a point remains to be run.<sup>424</sup>

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<sup>423</sup> Jacob Darwin Hamblin, *Oceanographers and the Cold War*, xix.

<sup>424</sup> Matthew Fontaine Maury (Anonymous), "Scraps from the Lucky Bag", *The Southern Literary Messenger*, (April 1840), 238.

Similarly, Jefferson's orders to Meriwether Lewis in 1804 commanded that their exploring expedition find the river "offering the best communication with the Pacific Ocean," for "the purposes of commerce," while during the 1840s, Charles Wilkes' South Seas Exploring Expedition sought to "extend the empire of commerce and science" into the Pacific while "carrying the moral influence of our country wherever our flag has waved." Thus, it was argued, scientific progress was tied to the expansion of American influence in the Pacific basin, and scientific knowledge was the gift that the United States could give to other Pacific nations. When Commodore Perry successfully signed a trade agreement with the Emperor of Japan in 1854, for instance, his gifts to the Emperor included a three hundred yard railway with steam engine, an electric telegraph, a printing press, a set of Audubon's American Ornithology, plates of American Indians, maps, and agricultural implements with "all the modern improvements." The New York Times noted that while the Japanese were initially "astonished" by the telegraph "they will speedily understand it, and may possibly by this time be laying down the wires for themselves."<sup>425</sup>

In the early twentieth century, however, a new vision of science in the Pacific emerged. No longer tied to the expansion of American empire, the new vision of Pacific science embraced international collaboration. Science was no longer the exclusive domain of the United States; in fact, science was seen as the lynchpin to the formation of a new transnational community, one based on a shared geographical location – bordering the Pacific – and linked by communal needs to manage and exploit the resources of that

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<sup>425</sup> "Japan Opened. Satisfactory Result of Commodore Perry's Visit. [...]," *New York Times*, (13 June 1854).

marine environment. As set out in the resolutions of the fourth Pacific Science Congress, held in Bandoeng, Indonesia, in 1929:

Whereas the oceanographic problems of the Pacific Ocean because of its vastness cannot be solved in any reasonable time by any one institution or any one country and in view of the efforts that are being made by the International Committee on the Oceanography of the Pacific to bring about co-ordinate action by the different countries bordering the Pacific and by other countries interested in the necessity for the complete exploration of that Ocean, it is proposed: That every endeavour should be made in the direction of urging the need for the setting up of oceanographical stations in the various lands bordering on or lying within the Pacific Ocean where such stations do not already exist, with a view to ensuring a complete international oceanographic survey of the Pacific Ocean[.]<sup>426</sup>

By the 1933 meeting, however, Thomas Wayland Vaughan was happy to report that there were now marine stations throughout the Pacific basin, in New Zealand, New Caledonia, Australia, Indonesia, French Indo-china, the Philippines, China, Japan, Siberia, Canada, and the United States.<sup>427</sup> He also suggested that an “international station” be constructed on “some easily accessible island in the tropical Pacific.”<sup>428</sup>

The 1933 Proceeding Reports on oceanographic work carried out in United States were disproportionately lengthy in comparison to the other national reports, something that Vaughn regretted. In apology, he argued that the discrepancy was due to the facility with which the American institutions were able to exchange reports of their activities.<sup>429</sup> Nevertheless, it was certainly true that, with respect to the establishment of marine stations, the United States was particularly active in the late 1920s and early 1930s. With an institutional network in place by the early 1930s, marine scientists working in the Pacific basin were eager to form new international collaborations.

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<sup>426</sup> “Resolutions Adopted at the Fourth Pacific Science Congress,” *Fifth Pacific Science Congress Proceedings*, Vol. 1, (Vancouver: Pacific Science Association, 1933), 250.

<sup>427</sup> *Ibid.*, 254.

<sup>428</sup> *Ibid.*

<sup>429</sup> *Ibid.*, 249.

*A Letter from Japan: Internationalism and Pacific Oceanography in the Early 20<sup>th</sup> c.:*

In the archives of the Scripps Institution of Oceanography is a letter, dated January 13<sup>th</sup> 1921, sent by the Japanese marine scientist Kamakichi Kishinouye, professor of fisheries in the faculty of agriculture at the Imperial University in Tokyo, to Scripps oceanographer George McEwen. In his letter Kishinouye provides a short account of “oceanographical work in relation to fisheries” in Japan.

Very little has been written (or at least translated into English) about the history of marine science in early 20<sup>th</sup> century Japan. However, Kishinouye’s letter sheds light on a little known chapter in the history of Pacific oceanography and provides an early example of scientific cooperation between Japan and the United States. Kishinouye provides the following summary of Japanese marine investigations:

The oceanographical work in relation to fisheries was done at first in 1892 to know the direction of ocean currents round our islands by drift bottles. In 1900, observations of the temperature, salinity, meteorological data, plankton, etc. were undertaken at five stations (Funakoshi; Tsushima; Ogi in the Peninsula of Noto on the Japan-sea coast; Same; Somori – ken; Shionomisaki, Wakayama-ken; Hososhima; Miyazaki-ken, on the Pacific coast), four times a year, at the beginning of February, May, August, and November. Besides this several trips of a steamboat were tried in the sea near the Tokyo Bay to carry on intensive oceanographical investigation. In 1918, a special steamboat was constructed for the oceanographical investigations, and since 1919 she is engaged in this work. Thus so far we are observing our coastal waters, ocean-currents near our coasts, and the plankton in these waters; but the observation and the study of the high seas are very [scarce?]. Therefore we hope that someone would undertake expeditions to explore such region minutely.<sup>430</sup>

Both of these men were prominent scientists of their time. Dr. Kishinouye’s obituary in *Science*, published Feb. 14<sup>th</sup>, 1930, describes him as one of the “leading scientific men of Japan” remembered as “a good example of the courteous Japanese

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<sup>430</sup> Scripps Archives, George McEwen Papers and Correspondence (MC21), Box 7, Folder 6. Note that he states “five” but appears to list nine stations.

gentleman of the old school.” Regarded as an expert on both coral and mackerel, we learn that he died in November of 1929 while on a research trip to China.

McEwen, who had come to Scripps as a graduate student in 1908, was a leading figure in the development of that young institution. His influence was crucial in transforming what had been previously but a small seaside laboratory into the vanguard center for the scientific investigation of the Pacific. Eric Mills writes that no other North American oceanographer “could match the combination of ability and opportunity that met in McEwen, allowing him to apply mathematical physical oceanography to North American waters.”<sup>431</sup> Like his mentor, William E. Ritter, McEwan was vocal in his advocacy for the promotion of international cooperation in Pacific waters. As he was quick to point out, a successful model for international cooperation in marine science had already long been established for the Atlantic basin in the form of the International Council for the Exploration of the Seas, founded in 1902. In a paper McEwan delivered at the 1919 meeting of the meeting of the Pacific Division of the American Association for the Advancement of Science, McEwan bemoaned the fact that no similar international organization existed for the Pacific: “for every paper pertaining to the Pacific, there are scores of voluminous reports devoted to the North Atlantic and neighboring seas and gulfs.”<sup>432</sup> McEwen’s research dealt primarily with physical oceanography, but we can imagine that he would have looked favorably upon the international fisheries programs that were taking form in the early 1920s. An international fisheries commission, a

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<sup>431</sup> Eric Mills, “Useful in Many Capacities. An Early Career in American Physical Oceanography,” *Historical Studies in the Physical and Biological Sciences*, Vol. 20, No. 2, (1990), 268.

<sup>432</sup> George McEwen, “The Distribution of Temperature and Salinities, and the Circulation in the North Pacific Ocean,” *Bulletin of the Scripps Institution for Biological Research of the University of California*, No. 9 (15 December 1919), 63.

partnership between the United States and Canada, was founded in 1923. This organization was later renamed the International Pacific Halibut Commission. Even so, this was largely a regional organization. A true trans-pacific fisheries research program only took shape in the years after World War II with the formation of the International North Pacific Fisheries Commission (INPFC) by Canada, the United States, and Japan in 1951.<sup>433</sup>

That a Japanese marine scientist should have been in correspondence with an American marine scientist at Scripps in the early 1920s is an important reminder of efforts made in the early twentieth century to build a program for international scientific cooperation in the Pacific prior to World War II. Many Japanese scientists visited and studied at scientific institutions in the United States, and American scientists travelled to scientific institutions in Japan. Scripps founder William Emerson Ritter, George McEwen's mentor, traveled to Japan as part of a world tour in 1906 and en-route visited the University of Tokyo's marine biological laboratory at Misaki.<sup>434</sup>

In the 1920s and 30s considerable headway was made towards a cooperative program for oceanography in the Pacific; the Pacific Science Association was created in 1926 and a meeting of the Pan-Pacific Science Congress was held in Tokyo later that

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<sup>433</sup> Sara Tjossem, *The Journey to PICES: Scientific Cooperation in the North Pacific*, (Fairbanks: University of Alaska, Alaska Sea Grant Program, 2005), 16 – 17. See also Lissa Wadewitz, *The Nature of Borders: Salmon, Boundaries, and Bandits on the Salish Sea*, (Seattle: University of Washington Press, 2012), 158 – 167.

<sup>434</sup> "To Make Tour of World," *San Francisco Chronicle*, (28 January 1906). A history of the Misaki marine station is available on the station's website (accessed 22 January 2014). <http://www.mmbs.s.u-tokyo.ac.jp/en/overview/history/history1.html>.

year. At the Tokyo meeting the oceanography sessions were overwhelmingly composed of Japanese and American scientists.<sup>435</sup>

For a brief period of time at the beginning of the twentieth century it appeared to scientists working in the Pacific region as though their program for a new science of the Pacific was on the verge of exponential growth. “Oceanography is the science that coordinates the results of research done in all branches of science, as these pertain to the ocean, its contents and its boundaries” declared Charles McLean Fraser, the head of the department of zoology at the University of British Columbia, in an article published in *The Scientific Monthly* in 1937.<sup>436</sup> “As such,” he continued, oceanography “is of recent development.” Whereas, in the past, scientists had only been able to collect “scraps of information,” Fraser explained – the scientific disciplines metaphorically confined as in “water-tight compartments” – this period had now come to an end. Rather, Fraser declared “the most striking single feature in the progress of science [...] [was] the spirit

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<sup>435</sup> An expanded version of this section previously appeared as a “research note.” See Antony Adler, “A Letter From Japan: Internationalism and Pacific Oceanography,” *Bulletin of the Pacific Circle*, (April, 2014). On international cooperation and Pacific oceanography during this period see Eric Mills, “The Oceanography of the Pacific: George F. McEwen, H. U. Sverdrup and the Origin of Physical Oceanography on the West Coast of North America,” *Annals of Science*, Vol. 48, (1991), 241 – 266. See also Philip Rehbock, “Organizing Pacific Science: Local and International Origins of the Pacific Science Association,” *Pacific Science*, Vol. 45, No. 2, (1991), 107 – 122. Russian scientists were also increasing survey work in the eastern Pacific during this period, spearheaded by the Pacific Scientific Research Fisheries Center (TINRO). See, N. N. Mikhailov, E. D. Vyazilov, V. I. Lomonov, N. S. Studyonov, M. Z. Shaimardanov, “Russian Marine Expeditionary Investigations of the World Ocean,” *International Ocean Atlas and Information Series*, Vol. 5, (Obninsk – Silver Spring: National Oceanic and Atmospheric Administration, 2002), 37.

<sup>436</sup> Born in Ontario in 1872, Charles McLean Fraser served as curator of the Pacific Biological Station at Nanaimo from 1912 to 1924. He became a professor at the University of British Columbia in 1920. For more on McLean Fraser see Kenneth Johnstone, *The Aquatic Explorers: A History of the Fisheries Research Board of Canada* (Toronto: University of Toronto Press, 1977), 92.

of cooperation and coordination.” Thus, “oceanography,” Fraser affirmed, could be understood as “a product of the present century; Pacific oceanography, largely that of the last two decades.” In sum, he informed his readers, “[t]here was no real cooperation in Pacific work before the First Pacific Science Congress in Honolulu in 1920.” And, if the birth of “pacific” oceanography could be traced to 1920, then Fraser felt he could say with confidence that “more had been accomplished in Pacific oceanography during the preceding four years, 1929 – 33, than in all previous time.”<sup>437</sup>

*Re-framing Science for the Pacific:*

The Pacific World was first imagined not by historians, but by inhabitants of the Pacific region in the early twentieth century as a way of understanding and conceptualizing their own geographically framed region.<sup>438</sup> This coincided with a period in which science had moved to the center stage of social and political discourse, and thus, for most of its history, the Pacific World has been understood and imagined through the lens of science. Perhaps most revealing on this point is an address delivered by the president of the newly minted Pacific Scientific Institution, William Alanson Bryan, at a

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<sup>437</sup> Charles McLean Fraser, “Oceanography: Marine Zoology,” *The Scientific Monthly*, Vol. 44, No. 1, (January 1937), 62.

<sup>438</sup> Eckhardt Fuchs writes that Pacific “Internationalism [...] found its institutional expression in the Pan-Pacific Union, founded by Alexander H. Ford in 1917. Ford [...] came to [Hawaii] as a journalist in 1907 [...] Under the doctrine of ‘Patriotism of the Pacific,’ the primary goal of the Pan-Pacific Union was to promote mutual cultural understanding among Pacific peoples [...] Ford’s idea of holding international congresses to create this ‘international brotherhood’ coincided with [William Alanson] Bryan’s efforts toward scientific exploration of the Pacific.” Eckhardt Fuchs, “The Politics of the Republic of Learning: Internationalism Scientific Congresses in Europe, the Pacific Rim, and Latin America,” *Across Cultural Borders: Historiography in Global Perspective*, ed. by Eckhardt Fuchs and Benedikt Stuchtey, (Maryland: Rowman & Littlefield Publishers Inc., 2002), 217 – 218. See also Roy MacLoed and Philip Rehbock, “Developing a Sense of the Pacific: the 1923 Pan-Pacific Science Congress in Australia,” *Pacific Science*, Vol. 54, No. 3, (2000).

meeting of the American Association for the Advancement of Science in Chicago in 1907 in which he addressed the urgent need to advance the scientific study of the Pacific in its entirety – a region he referred to as a “great storehouse of knowledge, adventure, and discovery.”

That which is true of the Polynesian race as a people is equally true of the material in every department of natural history [...] [A]n exhaustive examination of any one subject in the Pacific is so interwoven with others, that the study of the one is remarkable involved by the lack of knowledge of the other. This is true to such an extent that in order to be of high character, any ethnological survey of the region requires as a starting point information which is today sadly lacking of the oceanology, climatology, geology, zoology, and botany of the entire ocean.<sup>439</sup>

In his address Bryan then went on to discuss his plans for a scientific expedition on a “yacht of from five to seven hundred tons capacity” promising that “the study of each island will be made with an understanding of the great ultimate object, namely, knowledge of the Pacific Ocean as a whole.”<sup>440</sup> In Bryan’s view, scientific knowledge in the Pacific could only be achieved as part of a trans-disciplinary project.<sup>441</sup> But, to observe the natural phenomena of the Pacific as interwoven was also to conceive of the geographical space of study and experiment on a truly grand scale.<sup>442</sup> Western science,

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<sup>439</sup> William Alanson Bryan, “The Pacific Scientific Institution: An Address by William Alanson Bryan,” *Pacific Institution Publications*, Special Series, No. 2, (Chicago: 1908), 5.

<sup>440</sup> *Ibid.*, 8.

<sup>441</sup> Surprisingly, this was not a new interpretation of nature in the Pacific. Writing in 1778 Johann Reinhold Forster, the naturalist who accompanied Cook on his second Pacific Voyage, declared that his object was “an investigation of Nature, in its greatest extent; the earth, the sea, the air, the organic and animated creation, and more particularly mankind itself, so far as all these came within the reach of examination, in the course of a voyage round the world.” Johann Reinhold Forster, *Observations Made During a Voyage Round the World*, ed. by Nicholas Thomas, Harriet Guest, and Michael Dettelbach, (Honolulu: University of Hawaii Press, 1996), lxxvii.

<sup>442</sup> As Roy MacLoed and Philip Rehbock have argued, “in the Pacific lay opportunities for phenomena to be observed and theories to be tested. What applied to botany and geology applied equally to native peoples – as it would to oceanography, meteorology,

relocated to the Pacific, would take on new configurations. We find evidence of this transformation in Worlds Fairs on the west coast of the United States; there “science” was presented to the public as a collaborative enterprise, responsible for forging an emerging Pacific-based transnational community.

Let us to now return to San Francisco, to the 1939 opening of the Golden Gate Exposition. Robert Rydell, historian of World’s Fairs, suggests that the Golden Gate Exposition should to be understood primarily as “an imperial dream city” which had been “animated” by “the dreams of Empire.”<sup>443</sup> He points out that many of the organizers of the Exposition had previously been involved in the creation of the San Francisco Panama-Pacific International Exposition that had been created to celebrate the opening of the Panama Canal in 1915. However, it is difficult to define the 1939 fair as having a single message; it was as much a patriotic display as it was vaudeville entertainment, or promotion of consumerism. However, the unifying theme of the fair was a “Pageant of the Pacific.” Thus, the fair was a celebration of San Francisco’s pride of place, not only has an American city, but also as a booming metropolis within a broader transnational Pacific World. Likewise, the 1939 San Francisco meeting of the Pacific Science Congress, the first congress to meet on the continental United States, can be interpreted as a celebration of transnational Pacific science.

If the Golden Gate Exposition in 1939 can be considered as marking the culmination of a scientific program for the Pacific, then a potential starting marker is the Panama-Pacific Exposition held in San Francisco in 1915. Like the Golden Gate

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marine biology, and eventually nuclear weapons.” See Roy MacLoed and Philip Rehbock, “Preface,” *Darwin’s Laboratory: Evolutionary Theory and Natural History in the Pacific*, (Honolulu: University of Hawaii Press, 1994), ix.

<sup>443</sup> Robert Rydell, *World of Fairs: The Century-of-Progress Expositions*, 85.

Exposition, the Panama-Pacific was held in conjunction with a scientific conference, the first meeting of the American Association for the Advancement of Science to be held on the west coast. In an address delivered at the AAAS meeting titled, “Problems of the Pacific Islands,” Harvard professor of geology, Reginald Aldworth Daly, set out a proposal for how the scientific study of the Pacific, “the last great field for scientific conquest,” might be accomplished.<sup>444</sup> “Is not the piercing of the Panama a suggestion, a brilliant symbol, for American Geographical science?” he asked his audience. The solution for a comprehensive study of Pacific islands, Daly suggested, was to divide the Pacific into different regions that would fall under the responsibility of different nations to investigate.

To the government bureaus, or scientific bodies of the different nations concerned, may be assigned the duty of scientific exploration in the Aleutian, Kurile, Japanese, and East Indian archipelagoes; but Polynesia, Micronesia, and Melanesia need different treatment [...] the thorough study of these oceanic islands offers a highly desirable program for large-scale private enterprise in science, and [...] is highly appropriate for American enterprise in particular.<sup>445</sup>

While rhetoric concerning the Pacific was an important aspect of the Panama-Pacific exposition, it was the all-encompassing theme of the Golden Gate Exposition in 1939. A colossal 80 ft. “theme statue” titled “Pacifica” was a center piece of the fair overlooking the “Court of the Seven Seas,” while at the center of the Exposition stood a building called “Pacific House,” the officially designated theme building for the fair. Our best description of Pacific House comes from an article published in the *San Francisco Chronicle*, titled “Pacific House Popular” which is worth quoting at length:

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<sup>444</sup> R. A. Daly, “Problems of the Pacific Islands,” *The American Journal of Science*, Vol. XLI, (Feb., 1916), 154.

<sup>445</sup> Ibid.

Treasure Island's monument to peace, [...] Pacific House is the theme building of the Fair, uniting in [...] brotherhood all nations served by the boundless Pacific. Thousands [...] visited the glistening temple, erected in the hope of promoting understanding among races of the Pacific [...] Outside the crowds may roar [...] but the gorgeous Pacific parlor is somehow aloof, remote, reflective. [...] [T]here is a library of rare books, a silent reading room, attentive librarians. Upstairs there is a conference room, with motion picture equipment for future illustrated lectures. But most [...] will be drawn immediately to the Sotomayer fountain, [...] an enormous terra cotta map depicting the physical appearance of the Pacific area. [...] [It gives a] bird's eye view [...] Every tiny island of the Pacific is shown, as well as every vast country. The ocean itself is caught in seven shades of blue showing the various depths and currents. [...] Trade routes [...] are pictured in a stained glass window that spans the north portal of the building, its florescent colors gleaming like jewels [...] But dominating the entire building are the Covarrubias murals, brilliantly colored, that picture the fauna, flora, peoples, economy and arts of the Pacific area. Directors of the building have sought to bring [...] the verdant fascination of each section of the Pacific by installation of plants indigenous to North and Central America; South America, Australia, New Zealand and vicinities and Asia. Such is the exposition's temple of peace – dignified, elegant, possessed of an almost ineffable serenity.<sup>446</sup>

Pacific House served as a human-scaled representation for what was in reality an enormous geographical space. Visitors could view the Pacific in miniature from a “bird's eye view” and better comprehend the urgent need for international peace and cooperation in a bounded region. As the exhibits made clear, the Pacific was a vast, yet interconnected system. “Science,” the project of mapping, classifying, and studying these connections, logic followed, was necessarily the path towards ever-greater transpacific communication and cooperation.

Pacific House was the main venue for the public lectures organized by the Pacific Science Congress. These included: “public health conditions in China,” “the origins of cultivated plants in relation to the origins of civilization,” “explorations in the lesser Sunda Islands,” “the structure of the Pacific Ocean as indicated by earthquakes,” and,

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<sup>446</sup> Carolyn Anspacher, “Pacific House Popular” *San Francisco Chronicle, Exposition Extra*, (20 February 1939).

“Ocean Currents of the Pacific and their Bearing on the Climates of the Coasts” delivered by the now famous oceanographer Harald Sverdrup.

All events in Pacific House took place under the direction of Philip N. Youtz. Youtz had a very eclectic background. After returning to the US from China, where he had lived for several years, Youtz served as curator at the Pennsylvania Museum of Art and as assistant director of the Brooklyn museum of art before becoming director of Pacific House in 1938. At some point in 1940, as the fair was winding down, Youtz drafted a “Proposal for a Permanent Pacific House.” Arguing that America’s “manifest destiny”<sup>447</sup> lay in the extension of a “Good Neighbor policy through the Pacific Hemisphere,” he projected:

The institution might be the permanent home of certain scientific organizations with a secretary to keep in touch with the research work carried on in each of the pacific countries and to correspond with the different scholars [...] [T]here would be an unusual opportunity for publication of the contributions of those men in more than one language [...] [and] Pacific House might well sponsor scientific expeditions to different parts of the area and serve as a clearing house for the findings of these investigations.

San Francisco, Youtz argued, was “in a position to become the capital of a new Pacific empire.” As fate would have it, none of this was to be. On September 29<sup>th</sup> 1940, the fair closed. The Navy quickly moved to acquire Treasure Island for the duration of the “national emergency.” Less than three months later, on December 7<sup>th</sup> 1941, Japan attacked Pearl Harbor, and the United States entered the War of the Pacific. The fair grounds were dismantled and replaced by a Naval base and all planning for future Pacific Science Congress meetings was put on hold. The dream of a “Pacific world,” defined by peace, scientific cooperation, and mutually beneficial commerce, had been supplanted by

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<sup>447</sup> Philip N. Youtz, *Proposal for a Permanent Pacific House*, typed document in the San Francisco Public Library Special Collections, GGIE folder, 2.

a nightmare: a Pacific theatre of war. President Roosevelt, in his fireside chat of February 23<sup>rd</sup>, 1942, asking his listeners “to take out and spread before [them] a map of the whole earth,” informed Americans that the oceans had now become “endless battlefields on which we are constantly being challenged by our enemies.”<sup>448</sup>

*World War II – The Lights Go Out on Treasure Island and Pacific Dream Ends:*

At the closing ceremonies on October 29<sup>th</sup>, 1939, Leland Cutler, the President of the Exposition remarked that the fair had been “the dream of many.”<sup>449</sup> With the coming of the Pacific War, however, the dream of a peaceful and collaborative Pacific World was gone. The war reshaped memories of what the fair had been. As the military author of an official naval history of Treasure Island recalled in 1946: “Yes, Treasure Island had its days of festivals – but they were ominous days, and there was treachery at the feast. Supposedly fostering better relations with the nations bordering the Pacific Ocean – the South Seas, the Antipodes, Central and South America, and the Orient ... there was one amongst them whom we knew not[.]”<sup>450</sup> Fair visitors remembered with suspicion the

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<sup>448</sup> Franklin D. Roosevelt, “Fireside Chat on Progress of the War,” *Public Papers of the Presidents of the United States: F. D. Roosevelt, 1942*, Vol. 11, (Best Books, 1950), 106. It is worth noting that F.D.R., like his uncle Theodore, served as Secretary of the Navy prior to his presidency. In this capacity F.D.R. was a vocal advocate for the expansion of American Naval power in the Pacific. See Frank Freidel, *Franklin D. Roosevelt: The Apprenticeship*, (Boston: Little, Brown and Company, 1952), 220 – 235.

<sup>449</sup> Jack James and Earle Weller, *Treasure Island, “The Magic City,” 1939 – 1940. The Story of the Golden Gate International Exposition*, (San Francisco: Pisani Printing and Publishing Company, 1941), 17.

<sup>450</sup> R. W. Cary, *The Naval History of Treasure Island*, (Treasure Island, California: U.S. Naval Training and Distribution Center, 1946), 25. There is some evidence to suggest that similar reframing of the fair occurred in Japan. As Katherine Caldwell, who served as the Director of Education at the Palace of Fine Arts during the fair later recalled: “The terrible thing was that some of the people in Japan who lent their treasures were accused of being pro-American. One of them, an elderly collector of refinement, who was interested in art, not politics, was jailed for a while.” *The San Francisco Fair: Treasure*

presence of Japanese tourists seen taking snapshots of the Bay while visiting the fairground.<sup>451</sup> For many, the closing of the fair marked the end of a peaceful era. As one visitor later recalled, “closing night of the Fair was perhaps the most moving time for all of us. [...] I remember going with my husband up to Telegraph Hill to watch the lights go out on Treasure Island. Soon after, we would go to the same spot to see ships depart for the South Pacific.”<sup>452</sup>

Shortly before the end of the war, San Francisco hosted the first meeting of the United Nations. Secretary of State Edward Stettinius proposed San Francisco as the site of the meeting having been inspired by a vision he had had in a dream. “I saw the golden sunshine,” he recalled; “I could almost feel the fresh invigorating breeze air from the Pacific.”<sup>453</sup> The first meeting went ahead as planned on April 25<sup>th</sup>, 1945, but under the watchful gaze of anti-aircraft gunners on the lookout for Japanese incendiary balloons that might be carried in on a western breeze.<sup>454</sup>

When the Pacific Science Congress was finally able to re-convene in New Zealand in March of 1949, Herbert Gregory once again delivered the opening address. His message once more stressed the importance of scientific cooperation in the Pacific, but this time some representatives were noticeably absent. There were no delegate members from Japan, the host of the Third Pacific Congress in 1926. Following Gregory’s speech the president of the congress, Dr. R. A Falla, director of the Dominion

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*Island 1939 – 1940*, ed. by Patricia F. Carpenter and Pail Totah, (San Francisco: Scottwall Associates, 1989), 47.

<sup>451</sup> *Ibid.*, 147.

<sup>452</sup> *Ibid.*, 56.

<sup>453</sup> Quoted in Stephen Schlesinger, *Act of Creation: The Founding of the United Nations*, (Boulder, CO: Westview Press, 2003), 61.

<sup>454</sup> *Ibid.*, 117.

Museum of Wellington, N.Z., took to the stage. His speech is recorded in the third person in the congress proceedings:

The coordinating responsibility of the Pacific Science Congress had grown immeasurably in the interval between the sixth and seventh. Not only was the field of science itself extending further into the knowledge and use of ionosphere and atomic structure alike, but once again war and its aftermath had stimulated the organization and direction of research to a degree that all our planning of the past could hardly have foreseen. One could detect in the program now before members an increased proportion of papers dealing with wide application of the physical sciences. Other cooperative sciences, like oceanography, would appear also to be past the pioneering stage in which, as far as the Pacific was concerned, they were in 1939.<sup>455</sup>

War had reshaped the nature of science in the Pacific basin and with it, re-oriented the scientific landscape for what would soon become the Cold War. Pacific science no longer depended on “large-scale private enterprise;” it now depended on military patronage. The utility of oceanographic science for naval warfare was proven in the Pacific. Woods Hole plankton biologist Mary Sears, given the task of providing oceanographic science intelligence in advance of troop landings on Pacific islands, relied heavily on captured Japanese hydrographic charts.<sup>456</sup>

In the wake of World War II, the United States and the Soviet Union alone would dominate the exploration of the marine environment. Perhaps the most enduring reminder of the lost cooperative aspirations of Pacific scientists is a note that to this day can be found displayed in American marine laboratories around the country. This note, written by the Japanese marine biologist Katsuma Dan, was found posted to the door of the

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<sup>455</sup> “Address of R. A. Falla,” *Seventh Pacific Science Congress Proceedings*, Vol. 1, (Wellington, NZ: R.E. Owen, Government Printer, 1952), 46.

<sup>456</sup> Much has been written about the war-time work of Mary Sears, but see in particular, Kathleen Broome Williams, “From Civilian Planktonologist to Navy Oceanographer: Mary Sears in World War II,” 243 – 272. See also Susan Schlee, *The Edge of an Unfamiliar World*, 311.

Misaki Marine Biological station in Japan when Allied troops arrived on September 2nd 1945, the day of Japan's surrender to the Allies.<sup>457</sup> In his note Dan wrote:

This is a marine biological station with her history of over sixty years. If you are from the Eastern coast, some of you might know Woods Hole or Mt. Desert or Tortugas. If you are from the West Coast you may know Pacific Grove or Puget Sound Biological Station. This is a place like one of these. Take care of this place and protect the possibility for the continuation of our peaceful research.<sup>458</sup>

Time magazine re-published Dan's note on December 10<sup>th</sup> 1945 in an article titled "Appeal to the Goths." The military officer who retrieved the note sent it on to Woods Hole Laboratory in Massachusetts where it was copied and distributed to other marine stations.

*The Fair as Research Center – The 1962 Seattle World's Fair:*

While the belief that the Pacific might become the terrain for scientific internationalist cooperation lost its luster with the beginning World War Two, the idea that the fairground could serve as space in which scientific data could be generated did not. In fact, it is still possible to see the legacy of the conflation of fair and research center if we examine the science center movement in the second half of the twentieth century. To clarify what I mean by science centers, here is a contemporary definition: "science centers are distinguished from museum by their emphasis on interactive exhibits and lack of specimen collection." Science centers are also sometimes described as providing "edutainment."<sup>459</sup> The two best examples on the west coast of the United States are: the Exploratorium in San Francisco, and the Pacific Science Center in downtown

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<sup>457</sup> See my lengthier discussion of this letter, Antony Adler, "A Letter From Japan: Internationalism and Pacific Oceanography."

<sup>458</sup> From a reproduction at the Friday Harbor Biological laboratories.

<sup>459</sup> Marc – Denis Weitze, "Science Centers: Examples from the U.S. and from Germany," *Proceedings of a Conference held in Pognana sul Lario, Italy, June 1 – 6, 2003*, (Munich: Deutsches Museum, 2004), 1.

Seattle. It is no coincidence that both were built in the post-war, post-Disneyland, America of the early 1960s, a time when Fairs were slowly re-emerging from the long interruption brought about by World War II and by the rise of the Cold War.<sup>460</sup> The 1962 Seattle Worlds Fair, the so-called Century 21 fair, provided the seedbed for the Pacific Science Center. As will be seen, however, the initial vision of what a “science center” could be was very different from the “edutainment” aimed at children that we now associate with such museums.

*The Seattle World’s Fair – Century 21:*

The victorious emergence of the United States at the end of World War Two encouraged public confidence in America’s seemingly limitless technological potential. This optimistic vision of American science, as an “endless frontier” was best articulated in Vannevar Bush’s 1945 call for increased government support for science.<sup>461</sup> As Bush predicted, “advances in science when put to practical use mean more jobs, higher wages, shorter hours, more abundant crops, more leisure for recreation, for study, for learning how to live without the deadening drudgery which has been the burden of the common man for ages past.”<sup>462</sup> Yet, the ever-growing threat of the cold war, and advances in atomic science, also brought the threat of nuclear apocalypse. Thus, popular perceptions of science in the early 1960s were shaped by diametrically opposed visions of how science might shape the future. Those who sought to encourage public support for

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<sup>460</sup> John Findlay, *Magic Lands: Western Cityscapes an American Culture After 1940*, (Berkeley: University of California Press, 1992), 214.

<sup>461</sup> Vannevar Bush served as head of the U.S. Office of Scientific Research and Development during World War II and was instrumental in the creation of the National Science Foundation.

<sup>462</sup> Vannevar Bush, *Science the Endless Frontier: A Report to the President*, (Washington D.C.: National Science Foundation, 1990), 5.

science, and by extension government support for science, recognized the need to encourage a positivist view of the future in which science offered “the endless frontier.” As in San Francisco in 1939, the 1962 fairground in Seattle was used as a site to popularize science and encourage an optimistic vision of international cooperation in the service of science and peace.

President Kennedy declined to attend the opening ceremony for the Century 21 Fair citing a “cold,” in reality dealing with the Cuban Missile Crisis at the height of the Cold War. In his stead vice-president Lyndon B. Johnson delivered an address at the dedication of the fair’s NASA Space Exhibit on May 10<sup>th</sup>, 1962. “We are hopeful of achieving fruitful cooperation with the Soviet Union” he told the assembled crowd, citing the possibilities for future jointly coordinated research in “communications, weather forecasting, mapping the earth’s magnetic fields and space medicine.”<sup>463</sup> Others, such as Secretary of State Dean Rusk, used the fair as an opportunity to paint a far more dystopian view of future. Without “international law and supervision” Dean warned, “the frontiers of space might be pierced by huge nuclear-propelled dreadnaughts, armed with thermonuclear weapons. The moon might be turned into a military base. Ways might be found to cascade radioactive waves upon an enemy. Weather control might become a military weapon.”<sup>464</sup> As urban historian John Findlay has argued, cold war tensions “ensured the transformation [of the Seattle fair] from a “Festival of the West” to

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<sup>463</sup> “Astronautical and Aeronautical Events of 1962: Report of the National Aeronautics and Space Administration to the Committee on Science and Astronautics U.S. House of Representatives Eighty-Eight Congress First Session,” (Washington D.C.: U.S. Government Printing Office, 1963), 74.

<sup>464</sup> *Ibid.*, 87.

“America’s Space Age World’s Fair.”<sup>465</sup> While initially conceived as a way for local businesses to generate tourism revenue and rejuvenate the downtown area, the fair soon became a platform for the federal government, and a means for promoting the achievements of federally supported scientific research programs.

A centerpiece of the fair grounds was the Federal Science Exhibit. Designed by Seattle-born Japanese-American architect Minoru Yamasaki, the exhibit consisted of five futuristic buildings grouped around a series of pools, fountains, and gothic arches. As an article published in *Time* magazine the following year described the Science Exhibit building:

[I]t looked as if it could have been the setting from a poem by Coleridge. From any angle it cast a spell. It had reflecting pools, stage-set lighting, delicate bridges, six buildings decorated with Gothic tracery. Inside, it subtly lured visitors along, stopped them just where the designer intended that they should pause and look. Probably no building put up in 1962 caused such a world of comment or brought into action so many cameras.<sup>466</sup>

*The “Futurist” Athelstan Spilhaus:*

The man placed in charge of the Federal Science Exhibit was Dr. Athelstan Spilhaus, a South African émigré to the United States whose life strangely mimicked the displays of the Science Pavilion. After obtaining a M.S. in aeronautical engineering from MIT in 1933, Spilhaus had gone back to South Africa; there he served as assistant director of technical services for the Union of South Africa Defense Forces. His work while in the military dealt primarily with upper atmosphere meteorology and he went on

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<sup>465</sup> John Findlay, *Magic Lands: Western Cityscapes and American Culture After 1940*, 228.

<sup>466</sup> “Art: The Road to Xanadu,” *Time Magazine*, (18 January 1963).

to earn a doctorate in meteorology from the University of Cape Town in 1948.<sup>467</sup> In 1936 he returned to the US as a research assistant at the Woods Hole Oceanographic Institution where he developed oceanographic instruments, most notably the bathythermograph, used to measure variations in water temperature at various depths. Spilhaus' device would have important naval applications during the Second World War, providing crucial calibration information for sonar instruments. During the war Spilhaus served in the United States Army, teaching meteorology and traveling throughout Europe and China, eventually achieving the rank of Lieutenant Colonel.<sup>468</sup> After the war, Spilhaus obtained a doctorate in oceanography from the University of Cape Town in 1948 before returning to the United States where he went on to create and chair a department of meteorology and oceanography at New York University. He then left NYU in 1948 to become Dean of the Institute of Technology at the University of Minnesota.

A short biography, written by a former director of Scripps, notes that “no biography of Spilhaus would be complete without reference to his toy collection.” His home in Virginia was a veritable museum; he was said to have constructed additional rooms in order to house his collection of mechanical toys. He also built his own jigsaw puzzles, including one designed to illustrate plate tectonics.<sup>469</sup> Spilhaus described himself as a “futurist,” and indeed some of his ideas now sound quixotically utopian such as his projection in an article published in the *Bulletin of the Atomic Scientists* in 1964 that soon

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<sup>467</sup> He had completed the degree work in 1935, but the award of the degree seems to have been postponed by the war. For the chronology of Spilhaus' career I am relying on a short biography provided by the WHOI. “MC-46: Athelstan Frederick Spilhaus papers,” *Woods Hole Oceanographic Institution Data Library and Archives*. [Accessed online 11 November 2014], <http://dla.whoi.edu/manuscripts/node/196143>.

<sup>468</sup> Ibid.

<sup>469</sup> William Nierenberg, “Athelstan Spilhaus,” *Proceedings of the American Philosophical Society*, Vol. 144, No. 3, (September 2000), 344.

“people will drive down to underwater resorts, park their submobiles, check into submarines, and participate in one of the many available recreations.” In the same article he proposed that dolphins might be trained to service fisheries, writing that, “one day sea ‘shepherds’ or ‘cowboys’ may ride bucking one-man submarines.” Other predictions were much more prescient; he foresaw the increasing need for “a permanent network of stations observing and reporting conditions,” as well as a “satellite network” that would “receive, collect, and retransmit the worldwide synaptic ocean data to central storage, analysis, and forecasting computers in various countries.” But, in an ever-more extensively exploited ocean, Spilhaus also predicted the need for the creation of new international treaties. “As more is taken from the sea” he wrote, “we shall need more international agreements [...] An international seaborne control force will be necessary to enforce these agreements.”<sup>470</sup> Despite voicing these concerns, however, Spilhaus seems to have been primarily an optimist. For over a decade, he produced a Sunday morning comic strip, titled “Our New Age,” which described ongoing scientific projects and presented confident predictions for the science of the future. Thus, Spilhaus was the ideal candidate to organize the forward-looking science exhibits for Century 21.

*The ‘Jewel Box’ of Wonders:*

In an op-ed published in the Seattle Post-Intelligence in advance of the opening of the fair in March 1961, Senator Warren Magnuson raved “scientists by the dozens [had] taken time to develop, supervise, coordinate and plan the ‘science at work’ theme.”

Future visitors, who Magnuson described as “the unhurried, knowledgeable and only

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<sup>470</sup> Athelstan Spilhaus, “Oceanography: A Wet and Wondrous Journey,” *Bulletin of the Atomic Scientists: Journal of Science and Public Affairs*, (December 1964), 11 – 15. Statements like these likely inspired Arthur C. Clark’s 1957 novel *The Deep Range*.

curious,” would be greeted by a “panorama that challenges and entrances.” This, Magnuson explained, “was not a museum. It was a ‘jewel box’ arrangement where man could look ahead to the year 2000 instead.”<sup>471</sup>

Visitors began their visit to the Federal Science Exhibit with a thirteen-minute film titled “The House of Science.” In his final report, Spilhaus praised the filmmaker for having “talked with hundreds of scientists in many countries, and visited more than 50 laboratories with his camera.”<sup>472</sup> The short film, projected as a collage of images, showed images of scientists and work, as well as various scientific buildings. “A laboratory can be many things and many places”, explained the narrator. “It can be a stagnant pool, or the light of the sun, or the sun itself.” As scenes of radio telescopes, rockets, space phenomena, and scientific instruments flashed by on the screens, it was made to appear as though nothing was beyond the reach of scientific enquiry. The narrative presented science as a shared enterprise, and scientists as not so different from common people as visitors might have at first assumed. “Science is essentially an artistic or philosophical enterprise carried on for its own sake,” the narrator told the audience. “In this it is more akin to play than to work. But it is quite a sophisticated play in which the scientist uses nature as a system of interlocking puzzles.”

Having been introduced to the Pavilion via this democratized portrayal of science, visitors then proceeded into Building II, “The History of Science,” where the exhibits

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<sup>471</sup> Warren G. Magnuson, “Magnuson Preview: Century 21 Science Pavilion To Be ‘Jewel Box’ Of Wonder,” *Seattle Post-Intelligence*, (5 March 1961). Not all shared this optimistic view of science. See for instance the science fiction writer Robert Heinlein’s critique quoted in Erik Ellis, “Dixy Lee Ray, Marine Biology, and Public Understanding of Science in the United States (1930 – 1970),” Doctoral Dissertation, (Oregon State University, 2005), 180.

<sup>472</sup> Athelstan Spilhaus, *U.S. Science Exhibit Seattle World’s Fair: Final Report*, (Washington, D.C.: U.S. Department of Commerce), 7.

told the “story of the development of science from the simplest beginnings to its present day refinements[.]” From here visitors entered Building III, “The Spacearium,” sponsored by Boeing, where they were shown another thirteen-minute film titled “Journey to the Stars” on, what was at the time, the largest screen in the world.

From here visitors then moved on into Building IV, “The Methods of Science,” the largest of the exhibition buildings. Displays here were grouped into six major subject areas: the nature of our surroundings, the sources of energy, the structure of matter, the nature of life, the functioning of living organisms, and the sources of behavior, animal and human. The highlight of building IV was the “transit tracking station,” funded by the Bureau of Naval Weapons and staffed by the Johns Hopkins University Applied Physics Laboratory. Visitors stood beneath a model of the Transit 4A satellite while a presenter explained how satellites had allowed scientists to “determine the true shape of the earth.” Other exhibits described rocket and satellite research programs, and included a diagrammatic exhibition on “Project Argus,” described as a “large-scale scientific experiment involving the explosion of a nuclear device in the upper atmosphere.” This “experiment,” the visitor was informed, had given scientists a better understanding of the aurora. Though funded by the Bureau of Naval Weapons, exhibits downplayed the military applications of the research being described.

Building IV also included exhibits on the human body, heredity, and animal behavior. Female “Science Demonstrators” who had been “selected on personality, appearance, scholastic record, recommendations, outside activities and interests, science background, and general enthusiasm” staffed the exhibits and gave public demonstrations for the public under the supervision of an “older woman with tact, understanding, and

firmness.” Spilhaus writes in his report that the girls “were hired for a serious purpose, and that a great deal was expected from them.” Before staffing the exhibits, demonstrators were required to complete a study program and testing under the direction of a credentialed “Science Coordinator.” Spilhaus notes that, having completed their training, some of these demonstrators became efficient lab technicians:

[A] Vassar student, was assigned the task of learning to inject radioactive isotopes into rats to make autoradiograms from their tissue. The techniques involved were relatively new and far beyond those normally taught undergraduates. In a short time she produced several excellent autoradiograms in which the movements of dividing cells could be traced by following the path of the isotope. A second from Goucher College, was asked to extract water-soluble products from leaves of *gymnema sylvestra*, an Indian vine. To do this, she learned to use water and other solvents in the Soxhlet extractor, followed by the new thin-layer gell chromatography technique. She isolated the components from the extracted mixture, and in a few cases even succeeded in obtaining crystalline forms. The level she reached bordered on original work.<sup>473</sup>

In Building IV, these demonstrators staffed an exhibit titled “the modern laboratory” which Spilhaus described as “one of the most entertaining and successful exhibits in the building.” Here technicians performed demonstration experiments on the optical nervous systems of horseshoe crabs, recorded data on the effects of radiation on the growth of mold, and practiced chemical extraction techniques.

Additional exhibits in the Pavilion included a lecture hall, and a “Junior Laboratory” where hands-on exhibits were designed to appeal specifically to children. Spilhaus notes in his report however, that the junior laboratory was “neither failure nor complete success.” He bemoaned the fact that “it was a rare child who used the exhibits as intended, read the texts with attention, or asked intelligent questions.”<sup>474</sup>

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<sup>473</sup> Athelstan Spilhaus, *U.S. Science Exhibit Seattle World's Fair: Final Report*, 48.

<sup>474</sup> *Ibid.*, 41.

Finally, in Building V “The Horizons of Science,” visitors were carried by a moving carpet past exhibits, models, and films showing scenes from nature and abstract patterns, while a recorded voice reinforced a connection between science with peace. The narrator’s closed by stating, “it is the benefits of science that men quarrel about, not science itself.”

The same positivist message could be found in many other displays throughout the fairground, in the British, French, Canadian, and Japanese exhibits. The British pavilion showcased a hovercraft and freeze-dried food, while in the French exhibit elegant “young hostesses” led tours through an exhibit which compared the threats of “street mobs and rock-‘n’-roll singers, racing cars and shouting demagogues” with “the rewards of research,” exemplified by a model of Jacques Cousteau’s diving saucer submersible. In a similar gesture at the future of marine exploration technology, the Canadian exhibit showcased the potential for the colonization of the arctic; a diorama depicted “submarines shuttling beneath the ice” carrying people and supplies to dome-covered towns on frozen sea ice.<sup>475</sup>

*The Fair Closes, The Science Center Opens:*

Echoing the aspirations of the organizers of Pacific House at the Golden Gate International Exposition just over two decades earlier, the organizers of the Federal Science Exhibit began discussing the possibility of turning the science exhibits into a permanent institution after the Seattle World’s Fair closed in October of 1962. The proposals of the scientific advisory committee included turning the science exhibits into a “Smithsonian of the Northwest,” a center for television broadcasting, or a meeting site for

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<sup>475</sup> Carolyn Bennett Patterson, “Seattle Fair Looks to the 21<sup>st</sup> Century,” *National Geographic*, Vol. 122, No. 3, (September, 1962), 420 - 424.

scientific conferences.<sup>476</sup> Unlike Pacific House, however, the Pacific Science Center became a reality. An important actor in bringing about this transformation was marine biologist Dixy Lee Ray, who had previously served with Spilhaus on the National Academy of Sciences Committee on Oceanography.

Ray, already a public figure and a well-known science instructor, assumed directorship of the Pacific Science Center in 1963.<sup>477</sup> She argued that the new institution be “a great experiment” designed to “amuse, beguile, stimulate, inspire, [and] inform”, and make the people “of the Pacific Northwest scientifically the most literate” of the nation.<sup>478</sup> Under Ray’s leadership, the future of the Pacific Science Center was secured. But, having lost its connection to the World’s Fair the national science exhibits had become a local institution. The internationalist rhetoric of the fairground was gone, as was the pre-war dream of a Pacific-wide regional identity.<sup>479</sup>

#### *Conclusion – The End of “Pacific World” Science?*

*“The atomic bomb is a wonderful oceanographic tool.”*  
- Roger Revelle, (1947)<sup>480</sup>

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<sup>476</sup> Erik Ellis, “Dixy Lee Ray, Marine Biology, and Public Understanding of Science in the United States (1930 – 1970),” 186 – 187.

<sup>477</sup> The science exhibits did not close with the termination of the fair in 1962, an NSF grant of \$100,000 allowed some of the exhibits to remain open. *Ibid.*, 187.

<sup>478</sup> From a 1963 meeting with the board of trustees, quoted in *Ibid.*, 188.

<sup>479</sup> It should be noted, however, that after her brief tenure as director of the Science Center, Ray went on to serve as a chief scientist with the International Indian Ocean Expedition (1962 – 1965). Rachel White Scheuering, *Shapers of the Great Debate: A Biographical Dictionary*, (Westport, CT: Greenwood Press, 2004), 92. See also, Jacob Hamblin, *Oceanographers and the Cold War: Disciples of Marine Science*, 120 -127.

<sup>480</sup> Quoted in Pamela M. Henson, “The Smithsonian Goes to War: the Increase and Diffusion of Scientific Knowledge in the Pacific,” *Science and the Pacific War: Science and Survival in the Pacific, 1939 – 1945*, ed. by Roy Macleod, (Dordrecht: Kluwer Academic Publishers, 2000), 44.

*This was the moment when Don felt like a god, able to hold within his hands a circle of the Pacific twenty miles across, and to see clear down to the still largely unexplored depths two thousand fathoms below.*  
- Arthur C. Clarke, *The Deep Range*, (1957)<sup>481</sup>

The marine sciences that emerged from World War II had been shaped by naval warfare. Marine geology, geophysics, and marine acoustics were growth fields in the postwar period due in large part to the increased military need for underwater mapping and sonar detection with the advent of nuclear powered submarines. Scripps Institution of Oceanography in particular benefitted from military patronage, for the war had demonstrated to the Navy the importance of oceanographic research in the Pacific.<sup>482</sup> The newly created Office of Naval Research began its first contract with Scripps on July 1<sup>st</sup>, 1946 and became the leading source of funding for oceanography in the United States.<sup>483</sup> While this partnership required that some of the scientific research remain classified, the benefits of collaboration out-weighed the hindrances of maintaining military secrecy. As Scripps oceanographer Walter Munk later recalled, while there were disagreements over declassification issues, “this was not a battle of the Navy against the oceanographic community. [...] [D]ecisions were made by an *interacting* group of Navy officers, some with deep scientific interests, and academic oceanographers who were unusually well informed on, and cared about, Navy matters.”<sup>484</sup>

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<sup>481</sup> Arthur C. Clarke, *The Deep Range*, (New York: Bantam Books, 1957), 4.

<sup>482</sup> It should be noted, however, that initial efforts to forge collaboration between oceanographers and the U. S. Navy predate World War II. See Sara Tjossem, *The Journey to PICES*, 4.

<sup>483</sup> Elizabeth Noble Shor, *Scripps Institution of Oceanography: Probing the Oceans 1936 to 1976*, (San Diego: Tofua Press, 1978), 36.

<sup>484</sup> Walter Munk, “Glimpses of Oceanography in the Postwar Period,” *Oceanography*, Vol. 21, No. 3, (September 2008), 19.

With growing Cold War tensions and the institutionalization of a new military patronage network in place, the 1950s and 1960s was a period of dramatic growth for oceanography. Popular interest in scientific exploration was fuelled by postwar nationalism. And enthusiasm for the conquest of “inner space” accompanied the national obsession with the conquest of “outer space.”<sup>485</sup> But, as Jacob Hamblin has argued, if “oceanography was a cold war science” [...] “[i]t’s most crucial component was international cooperation[.]”<sup>486</sup> Thus, Hamblin argues, “oceanography presented a paradox: it was both a major outlet for military research funds and a model field of inquiry in which all nations could cooperate.”<sup>487</sup> However, as we have seen, internationalist approaches to Pacific oceanography predated the rise of the cold war. The idea of oceanographic internationalism had but re-emerged after a period of wartime dormancy. From this perspective, the efforts to achieve of international cooperation in oceanography during the cold war appear less as a “paradox” and more as the continuation of one of the central characteristics of marine science.

As in the pre-war period, the marine sciences found form in both scientific and popular forums in the decades following the end of World War II. “Oceans” become a buzzword topic in both political and popular discourse. Arthur C. Clarke published a utopian vision of the future conquest of the sea in his 1957 science fiction novel *The*

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<sup>485</sup> See, for example, John Steinbeck’s plea for increased funding for oceans exploration. Steinbeck suggested that the ocean exploration technology offered a more peaceful outlet for Cold War innovation than rockets. John Steinbeck, “Let’s Go After the Neglected Treasures Beneath the Seas: A Plea for Equal Effort on ‘Inner Space’ Exploration,” *Popular Science*, (September 1966), 84 – 87.

<sup>486</sup> Jacob Darwin Hamblin, *Oceanographers and the Cold War*, xviii.

<sup>487</sup> *Ibid.*, 260.

*Deep Range*.<sup>488</sup> While president John F. Kennedy, promising improvements to the national education system, bemoaned in his first State of the Union address in 1961 that “we have neglected oceanography[.]”<sup>489</sup> Yet, as evidenced by an article in the 1959 July issue of *Time* magazine, there was little truth to this statement:

With the ocean now transformed from barrier to a new and menacing frontier from which guided missiles could be launched upon U. S. cities, the Navy’s concern with oceanography has expanded. That concern has brought U. S. oceanographers money, men and resources they never dreamed of before the war, made their specialty perhaps the fastest-growing science in the world.<sup>490</sup>

So long as the military was willing to heft the bill, oceanographers were happy to accept funding. As the wartime director of the Woods Hole Oceanographic Institute, Columbus Iselin, informed *Time* magazine, “the cold war and the scientific effort run parallel much of the time. They’re both geared toward our learning more. Each has a different motivation. One is survival, and the other is curiosity.”<sup>491</sup> However, both military officials and marine scientists shared the desire to ever increase the scale of observation and experimentation at sea. As Robert W. Morse, Assistant secretary of the Navy for Research and Development, explained in a 1966 speech: “the scientist must understand that the Navy’s problems with the environment are as large as the oceans

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<sup>488</sup> See Helen Rozwadowski, “Arthur C. Clarke and the Limitations of the Ocean as a Frontier,” *Environmental History*, Vol. 17, No. 3, (2012), 578 – 602.

<sup>489</sup> John F. Kennedy, *State of the Union Address*, January 30<sup>th</sup>, 1961.

<sup>490</sup> “Ocean Frontier,” *Time*, Vol. 74, Issue 1, (6 July 1959), 46.

<sup>491</sup> *Ibid.* On Iselin, and his pre-war role as intermediary between oceanographers and the navy, see Gary E. Weir, “Fashioning Naval Oceanography: Columbus O’Donnell Iselin and American Preparation for War, 1940 – 1941,” *The Machine in Neptune’s Garden: Historical Perspectives on Technology and the Marine Environment*, ed. by Helen Rozwadowski and David K. van Keuren, (U.S.A.: Science History Publications, 2004), 65 – 91.

themselves and as long range as science itself.”<sup>492</sup> Thus, as historian of Scripps Elizabeth Nobel Shor has argued, with naval backing the “golden age of global oceanography” had begun.<sup>493</sup>

While internationalism remained an important feature of the marine sciences in the postwar period, military patronage brought dramatic changes. The most important of these was a shift in scale of the field of observation. “The Pacific” had become too small an area of study for an emerging super-power concerned with maintaining global naval supremacy. In addition, the need for oceanographic observations on a global-scale was further confirmed by several important scientific discoveries: mounting evidence in support of the theory of plate tectonics, and an improved understanding of global circulation, mesoscale eddies, and marine meteorology – discoveries made possible in large part because of resources, both financial and technological, that the military provided.<sup>494</sup> In a sense, the era of “Pacific World” science had come to a close. Despite increased military backing, the need for a constantly expanding scale of observation meant that internationalism remained an integral component of the marine sciences.<sup>495</sup> However, with the entrance of State powers as the primary backers of oceanographic

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<sup>492</sup> Quoted in Elizabeth Noble Shor, *Scripps Institution of Oceanography: Probing the Oceans 1936 to 1976*, 85 – 86. For an example of large-scale naval acoustic surveillance see Gary Weir, “The American Sound Surveillance System: Using the Ocean to Hunt Soviet Submarines, 1950 – 1961,” *International Journal of Naval History*, Vol. 5, No. 2, (August 2006).

<sup>493</sup> *Ibid.*, 34.

<sup>494</sup> See for example, Naomi Oreskes, “A Context of Motivation: US Navy Oceanographic Research and the Discovery of Hydrothermal Vents,” *Social Studies of Science*, Vol. 33, No. 5, (October, 2003), 697 – 742.

<sup>495</sup> The international collaborative oceanographic surveys of the postwar period include the International Geophysical Year (1956 – 1959), the International Indian Ocean Expedition (1962 – 1967), and the International Decade of Ocean Exploration (1971 – 1980).

work, international collaboration was subject to new limitations. As set out in the 1966 Marine Sciences Act, collaboration “with other nations and groups of nations and international organizations” was considered important, “when such cooperation is in the national interest.”<sup>496</sup> Science in the Pacific World was no longer motivated by a common interest in peace; instead, science would serve as the currency for garnering allies in an extensive geopolitical conflict zone.<sup>497</sup>

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<sup>496</sup> Quoted in Edward Wenk, *The Politics of the Ocean*, (Seattle: University of Washington Press, 1972), 212.

<sup>497</sup> A good example is probably Roger Revelle’s efforts to solve the problem of desalinating agricultural irrigation water in Pakistan in the early 1960s – described by him as an alternative to giving the Pakistani military weapons. See “Interview with Dr. Roger Revelle, La Jolla, CA, 3 February 1989,” *American Institute of Physics*. [Accessed online 11 November 2014], <http://www.aip.org/history/ohilist/5051.html>.

## Chapter 5:

### The Ship as Laboratory: Making Space for Field Science at Sea<sup>498</sup>

#### *Introduction:*

Because oceanography encompasses several disciplines, including chemistry, biology, physics, and geology, historians have found it difficult to chart the history of such a chimera and have emphasized its distinctiveness from other field sciences. As Eric Mills has stated, oceanography “does not lend itself to neat formulations, scientific or historical.”<sup>499</sup> Early histories of oceanography, whether written for professional oceanographers or lay publics, dealt with this problem by categorizing oceanographic science into clearly defined periods which paralleled the major national expeditionary voyages of the nineteenth and twentieth centuries.<sup>500</sup> Histories of field science too have treated oceanography as a case apart, requiring special analytical attention. In their

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<sup>498</sup> This chapter was published under the same title in *The Journal of the History of Biology*, Vol. 47, Issue 3, (2014), 333 – 362.

<sup>499</sup> Eric Mills, “The History of Oceanography: Introduction,” *Earth Science History*, Vol. 12, No. 1, (1993), 1. Mills dates the origin of the history of oceanography as a recognized sub-discipline of the history of science to the First International Congress of History of Oceanography held in Monaco in December 1966. See Eric Mills, “The Historian of Science and Oceanography After Twenty Years,” *Earth Sciences History*, Vol. 12, No. 1, (1993), 5.

<sup>500</sup> See for example Georg Wüst, “The Major Deep-Sea Expeditions and Research Vessels 1873 – 1960,” 1 - 52. While acknowledging that progress in oceanography was not continuous, Wüst used three criteria to delineate distinctive “eras” in its development: new scientific results and improved interpretation of data, improvement of instruments and methods, and development of theory. Wüst’s divisions can still be found in contemporary physical oceanography textbooks. See Robert Stewart, “Introduction to Physical Oceanography.” [Accessed online 17 November 2014], [http://oceanworld.tamu.edu/resources/ocng\\_textbook/contents.html](http://oceanworld.tamu.edu/resources/ocng_textbook/contents.html). As former chief scientist aboard one of the last national oceanographic ventures, the German *Meteor* expedition (1925 – 1927), Wüst’s inclination towards periodization may have been shaped by a desire to see his own work as part of a progressive history of investigation.

introduction to the 1996 special issue of *Osiris* entitled *Science in the Field*, Robert Kohler and Henrika Kuklick write:

Even more than geology and geography, oceanography was created by imperialism [...] [I]t was intended to provide navies and commercial fleets with vital intelligence [...] Seagoing scientists were often accommodated on the vessels of their nations' navies and were obliged to fashion physical and social niches within the distinctive maritime culture of ships. They appropriated both the instruments and the work organization of naval operations [...] Oceanography exemplifies the formative linkage between knowledge and power. It was an offspring of Western expansionism, could hardly have existed without it, and persists in large part thanks to military patronage.<sup>501</sup>

These assertions may reflect a bias shaped by naval support for oceanographic research in the United States during World War II and later during the Cold War.<sup>502</sup> Certainly nineteenth-century, land-based exploration was closely tied to national military interests, while the link between intelligence gathering and field collecting has been well established.<sup>503</sup> But advances in oceanographic instrumentation were not solely appropriated from the navy; they were, and continue to be, driven by private industry.<sup>504</sup> Furthermore, the work organization of a modern research vessel today little resembles that of a modern naval vessel. As a field science, Eric Mills has argued, oceanography may be exceptional only for depending “on the combination of ships, expeditions and

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<sup>501</sup> Robert Kohler, and Henrika Kuklick, “Science in the Field,” *Osiris*, Vol. 11, No. 2, (1996), 9.

<sup>502</sup> Since the end of the Cold War, the National Science Foundation (NSF) has become a more important source of funding for oceanographic research than the Office of Naval Research (ONR).

<sup>503</sup> For a description of French naturalists' espionage see chapter 1 and Richard Burkhardt, “Naturalists' Practices and Nature's Empire,” 327 – 341. For an example of exploration linked to military interests see William Goetzmann, *Exploration and Empire: The Explorer and the Scientist in the Winning of the American West*, (New York: Viking Press, 1986). On meteorology see James Fleming, *Meteorology in America, 1800 – 1870*, (Baltimore: Johns Hopkins University Press, 1990). See also footnote 30.

<sup>504</sup> See for example Anita McConnell, *No Sea Too Deep: The History of Oceanographic Instruments*, (Bristol: Adam Hilger Ltd., 1982). Modern advances in the field of underwater robotics have been closely tied to the offshore oil industry.

instruments.”<sup>505</sup> In fact, the history of oceanography may tell us much about the nature of fieldwork in all science. How do scientists transport knowledge? How is scientific work in the field legitimated? What kinds of social reorganization are required by scientific fieldwork?

There is an important history to be examined and it is the history of a field science - part of a complex “mosaic” of social and scientific changes that gave new cohesion to a hitherto fragmented collection of marine sciences.<sup>506</sup> My aim here is to explore questions surrounding the changing usages of shipboard space, to offer a description of how expedition vessels became “floating laboratories” and, taking distance from earlier approaches to the history of oceanography, to show – by examining the ways in which shipboard space has been appropriated for scientific work – that these changes do not lend themselves to simple periodization.

*The Ship as Instrument:*

In his influential article “The Ship as a Scientific Instrument In the Eighteenth Century,” Richard Sorrenson re-imagines the vessels of the Age of Exploration as tools of investigation - not merely vehicles of transport, but instruments used to obtain geographical information.<sup>507</sup> New geographical data were gathered as the ship traced the contours of a foreign shore while charting its relative positions. As Sorrenson explains: “on a map, the ship’s track is a representation of the probing course of the instrument through the sea, whereas the coastal outlines are the mark of that instrument’s interaction

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<sup>505</sup> Mills, “The Historian of Science and Oceanography After Twenty Years,” 7.

<sup>506</sup> “There has not been a neat, linear, logical development of oceanography as a science [...] we suggest a far more subtle (and more confusing) suite of social and scientific developments, a mosaic of change [.]” Mills, “The History of Oceanography: Introduction,” 1.

<sup>507</sup> Richard Sorrenson, “The Ship as Scientific Instrument in the Eighteenth Century,” *Osiris*, Vol. 11, No. 2, (1996), 221 – 236.

with the coasts under investigation.”<sup>508</sup> While maps made aboard ship only served as representations of geographic realities, the ship as instrument gathered information in its course through real space in the field. Thus, “[ships] mediated the complex interplay between representation and reality that lies at the heart of eighteenth-century geography.” Sorrenson insists that the 18<sup>th</sup> century vessel was never “*merely* a vehicle”. This is a key point if we are to see the difference between ship “as instrument” and ship as “platform,” a term often used by oceanographers to describe research vessels today. While modern research vessels transport scientific instruments chosen for specific research projects into the field where *they* are deployed, the 18<sup>th</sup> century vessel was both a platform for research *and* an instrument used for surveying. This is not to say that the 18<sup>th</sup> century vessel of exploration, as distinct from its users, had agency. It does suggest, however, that a ship used as an instrument would have to meet certain specifications to serve that purpose. Only vessels of a particular design could be used for surveying.<sup>509</sup> Modifications, or resistance to modification, reveal the relative status of a ship’s users insofar as design for one usage took precedence over other possibilities.

The vessels Sorrenson describes, used by early British and French exploring expeditions, were commissioned for the primary purpose of charting the seas and discovering new territories. Naturalists accompanied these voyages, yet the work of natural history was subordinated to the work of mapping and territorial exploration. Vessels were chosen and modified to meet the requirements of naval priorities. And it is to these tasks that Sorrenson’s model is most applicable. For example, the surveying method used by the U.S. Exploring Expedition (1838-1842), termed a “running Survey,”

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<sup>508</sup> Ibid., 229.

<sup>509</sup> For example allowing surveying in shallow coastal waters. Ibid., 226.

employed gunfire to determine ‘base line’ distances between ships, and took horizontal angular measurements by sextant to fix geographic positions (Figure 1). By observing the time between the flash and report of gunfire, officers could measure angles between the ships and the shore in order to calculate distances. By repeating the procedure as the ships moved around Pacific islands, triangulations were plotted and the contours of the islands charted.<sup>510</sup> Here, then, the essential characteristics of the naval vessel – its armaments – defined scientific practice, just as imperial context defined the objects of scientific research.

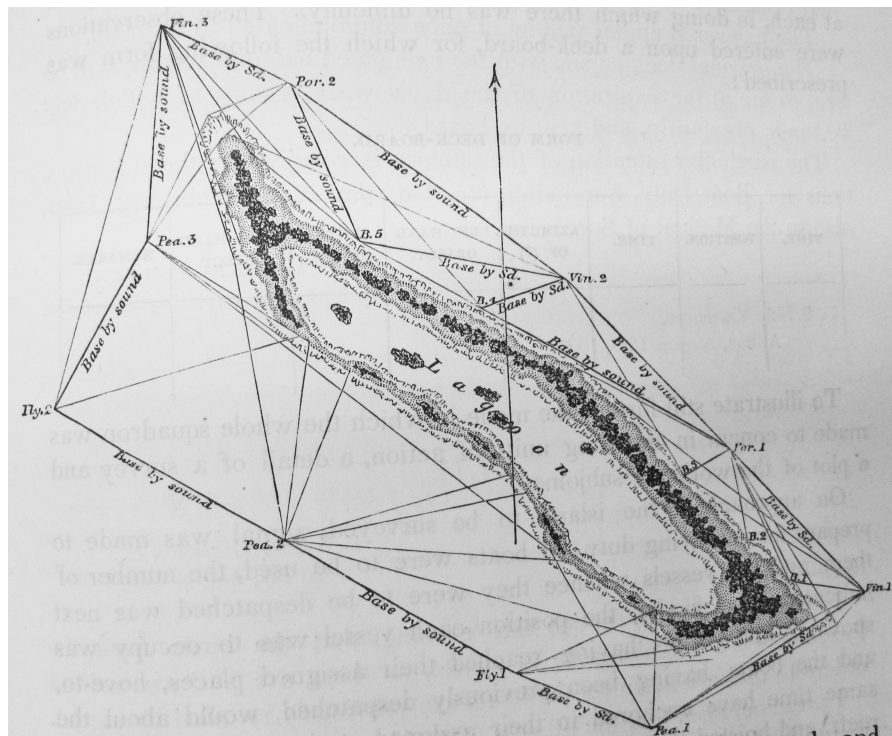


Fig. 1. Diagram showing the method for surveying an island in the Paumotu group by the U.S. Exploring Expedition. This survey was completed in three hours and thirty-five minutes.<sup>511</sup>

<sup>510</sup> R. E. Ehrenberg, J. A. Wolter, and C. A. Burroughs, “Surveying and Charting the Pacific Basin,” *Magnificent Voyagers: U.S. Exploring Expedition, 1838 – 1842*, ed. by Herman J. Viola and Carolyn Margolis, (Washington D.C.: Smithsonian Institution Press, 1985), 169.

<sup>511</sup> Charles Wilkes, *Narrative of the United States Exploring Expedition During the Years 1838, 1839, 1840, 1841, 1842*, Vol. 1, (Philadelphia: Lea & Blanchard, 1845), 452.

However, exploring expeditions were not mounted solely for the purpose of surveying and charting; and naturalists assigned to these voyages sought to turn the ship and its spaces to other scientific uses. The journal entry of U.S. Exploring Expedition naturalist Titian Peale, expressing frustration that survey work was being prioritized over natural history collection, is suggestive:

Reached the island of “Raraka,” [...] *No Naturalists were permitted to land.* The men collected a few shells differing from those on the other islands we have visited, but its other zoological productions are left for future and more fortunate Naturalists. [...] [A] survey is made, *nothing more* is requisite [...] *What was a Scientific Corps sent for?*<sup>512</sup>

Margaret Deacon’s study of early marine science suggests that the value and quantity of scientific work accomplished during expeditions was largely determined by the degree to which scientific work was valued by the captain and officers.<sup>513</sup> However, there is ample evidence that as the work of naturalists was accorded enhanced priority, and shipboard space was redesigned to accommodate them, social relations between scientists, officers, and crew altered as well. Attention to the evolution of scientific space aboard expedition vessels thus throws light on the modification of mission priorities, on the changing shipboard status of naturalists, and on tactics serving to legitimize a new science at sea.

Sorrenson’s model, casting vessels of exploration as instruments for creating knowledge, draws our attention to these ships as spaces for doing science. Though he focused on ships of the eighteenth century, his attention to the ship as more than a vehicle

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<sup>512</sup> Jessie Poesch, *Titian Ramsay Peale and his Journals of the Wilkes Expedition 1799 – 1885*, (Philadelphia: American Philosophical Society, 1961), 153 – 154.

<sup>513</sup> Margaret Deacon, *Scientists and the Sea 1650 -1900: A Study of Marine Science*, 192.

of transport can be extended to throw light on the evolution of shipboard scientific space in later periods.

*The Challenger Expedition:*

The voyage of H.M.S. *Challenger* (1872 -1876), commanded by naval Captain George Nares, and undertaken at the prompting of the expedition's chief scientist, Scottish naturalist Charles Wyville Thomson, with backing from the Royal Society, is frequently cited as the event that gave rise to modern oceanography.<sup>514</sup> This pioneering accommodation of shipboard science by modifications of vessel space changed the social relations of scientists and crew and was pivotal in paving the way towards the development of the modern oceanographic research vessel or “floating laboratory.”

The eighteenth-century “ship as instrument” in which the world external to the vessel was made to yield knowledge by means of the ship's passage, was supplemented in the nineteenth century by the “ship as laboratory,” where elements of the external world were made to yield knowledge by being severed from the field and brought into the scientific spaces of the vessel. In the late nineteenth and early twentieth centuries, ships also came to serve as mobile marine observatories, extending the work of coastal marine stations and allowing the observation of magnetic or meteorological conditions at sea.<sup>515</sup>

In our own time, oceanographic research vessels can, I believe, be conceived as “invisible

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<sup>514</sup> Gary Weir, *An Ocean In Common: American Naval Officers, Scientists, and the Ocean Environment*, 3. John Murray, a member of *Challenger*'s scientific corps, wrote: “[*Challenger*] circumnavigated the world, traversed the great oceans in many directions, made observations in nearly all departments of the physical and biological sciences, and laid down the broad general foundations of the recent science of oceanography.” Johan Hjort and John Murray, *The Depths of the Ocean: A General Account of the Modern Science of Oceanography Based Largely on the Scientific Researches of the Norwegian Steamer Michael Sars in the North Atlantic*, (London: Macmillan and Co., 1912), 11.

<sup>515</sup> *Carnegie* (1909 – 1929) was used for terrestrial magnetism observations.

technicians,” their remote-sensing equipment being deployed to gather data that is no longer analyzed aboard but instead transferred to land-based research centers.<sup>516</sup> These models are not mutually exclusive. While the modern research vessel, unlike any eighteenth-century ship, might sometimes serve as an “invisible technician,” for many scientists oceanographic vessels retain earlier usages: as instrument, laboratory, and observatory.

*“The Field” and the Extension of the Laboratory:*

Sorrenson’s model of exploration vessels as instruments draws upon Bruno Latour’s examination of the processes by which knowledge is moved from peripheries to metropolitan centers.<sup>517</sup> Latour draws attention to the transport of scientific knowledge from the field to what he terms “centers of calculation,” focusing on the necessity of gathering information in ways that allow its transport, and favor its acceptance as valid in places where scientific results are confirmed and publicized. For our purposes, it is worth noting that in the nineteenth century the laboratory (which was of course land-based) was widely perceived as the space producing authoritative science.<sup>518</sup>

“The field,” as a type of space in which scientific knowledge is produced, has only recently come under serious investigation. Historians of science have urged that field practices be analyzed as “practices of place,” with scientists forced to adapt

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<sup>516</sup> I am applying to a new context the concept developed by Steven Shapin with reference to Boyle’s seventeenth-century laboratory. Steven Shapin, “The Invisible Technician,” *American Scientist*, Vol. 77, No. 6, (1989), 554 - 563.

<sup>517</sup> Bruno Latour, *Science in Action: How to Follow Scientists and Engineers Through Society*, 220.

<sup>518</sup> Usage of the word “laboratory” increases dramatically after the mid nineteenth century. See google Ngram Viewer, search term “laboratory.”

procedures to particular environments.<sup>519</sup> Fieldwork may not allow the particular exclusions provided by the metropolitan laboratory, and may require the assemblage and cooperation of people who would not be part of the same work world outside the field.<sup>520</sup> The ocean was a field environment where naturalists, officers and crew, all of whom maintained distinctive and exclusionary social worlds, were forced into new associations.

Robert Kohler, building on the work of Owen Hannaway and Steven Shapin, recognized that one of the cultural practices western scientists brought to the field was the conception of the “laboratory.” As Kohler explains: “laboratory and field are different cultural terrains, to be sure, but they are contiguous, and there is a steady traffic across the border; and field scientists regularly mix and match lab and field methods.”<sup>521</sup> Kohler raises the question: how is an audience not present in the field (a place with no cultural standing as a space for the production of scientific knowledge) to be persuaded that the knowledge produced there is as valid as that produced in a laboratory? Kohler argues that field scientists were compelled to bring laboratory practices into the field because they carried the authority that had become associated with laboratory spaces in metropolitan centers. Kohler’s insight helps elucidate the introduction of laboratory space on expedition vessels.

*The Ship as Laboratory:*

Marine scientists have long considered vessels bearing scientific instrumentation as scientific spaces. As early as 1855, Matthew Fontaine Maury, the so-called “father” of modern oceanography, advocating the use of a standardized system of wind and current

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<sup>519</sup> Robert Kohler, “Place and Practice in Field Biology,” 189.

<sup>520</sup> Robert Kohler and Henrika Kuklick, “Science in the Field,” 2.

<sup>521</sup> Robert Kohler, “Place and Practice in Field Biology,” 189.

observation charts, declared: “every ship that navigates the high seas, with these charts and blank logs on board, may henceforth be regarded as a floating observatory, a temple of science.”<sup>522</sup> Yet, surprisingly, the equation between laboratories and research vessels has until recently received little attention from historians. A notable exception is the work of Anne-Flore Laloë. Building upon the work of Sorrenson, Laloë has shown that the story of *Bathybius haeckelii*, the chemical precipitate mistakenly identified as a marine organism by Thomas Henry Huxley, reveals the ways in which nineteenth-century vessels served as “spaces of science.” Laloë writes: “[b]oth the space of the ship and the science performed aboard the ship altered the concept of the ship, indeed re-inventing it as more akin to that of the laboratory where sciences and practices interact in deeply prescriptive ways.”<sup>523</sup> Another example is Ralph Kingston’s case study of Nicolas Baudin’s 1800 expedition. Dubbing Baudin’s vessel a “floating laboratory,” Kingston describes how naturalists competed with one another for research resources both during and after the voyage, and he shows how science on board ship was shaped by social dynamics similar to those of a laboratory. But though employing the phrase “floating laboratory,” Kingston does not focus on the history of its adoption by marine scientists, or upon the development of shipboard scientific space.<sup>524</sup> What did the categorization of

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<sup>522</sup> Matthew Fontaine Maury, *The Physical Geography of the Sea*, [19<sup>th</sup> ed.] (London: Thomas Nelson and Sons, 1883), vii.

<sup>523</sup> Ann-Flore Laloë, “Where is *Bathybius haeckelii*? The Ship as Scientific Instrument and a Space of Science,” *Re-inventing the Ship: Science, Technology, and the Maritime World, 1800 – 1918*, ed. by Don Leggett and Richard Dunn, (Surrey, England: Ashgate, 2012), 129.

<sup>524</sup> Ralph Kingston, “A Not So Pacific Voyage: The ‘Floating Laboratory’ of Nicholas Baudin,” *Endeavour*, Vol. 31, No. 4, (2007), 145 – 151. The primary mission of the Baudin Expedition (1800 – 1803), which consisted of two vessels, was to map the coast of Australia. Upon departure the expedition included a complement of twenty-three

some shipboard space as laboratory space imply for working relationships on board vessels? The answers throw light on the origins of modern oceanography in the late 1800s, a period in which, it is important to note, the term “laboratory” was gaining general currency.

*“As No Ship of Any Nation Was Ever Equipped Before”:*

When the naturalist Sir Joseph Banks, who accompanied Captain James Cook on his first voyage, had the vessel modified prior to its second voyage in ways calculated to better serve his own research agenda, Cook refused to embark, contending that the vessel was top heavy. Cook prevailed, with the backing of the Admiralty, and the ship was refitted to his specifications while Banks withdrew from the expedition.<sup>525</sup>

Naturalists regularly competed with officers over space needed to work and store specimens. The French naturalist Adelbert Von Chamisso wrote in his journal during a Russian voyage of exploration in 1815:

My berth and three of the drawers under it comprise the only space on the ship that belongs to me. [...] In the narrow room of the cabin four people sleep, six live, and seven eat. [...] In the intervals [between meals] the artist takes up two sides of the table with his drawing board, the third side belongs to the officers, and only when they leave it unoccupied may the others compete for its use. If one wishes to write or engage in some other occupation [...] he must wait and seize the scarce fleeting moments, then utilize them greedily. But I can't work that way.<sup>526</sup>

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scientists and artists. The marine work was carried out by naturalist François Péron (1775 – 1810).

<sup>525</sup> Sorrenson, “The Ship as Scientific Instrument in the Eighteenth Century,” 227. See also J. C. Beaglehole, *The Life of Captain James Cook*, (Palo Alto: Stanford University Press, 1974), 293. As Beaglehole explains: [Cook's ship] “was not chosen as a passenger ship or a floating laboratory or as an artist's studio, but precisely because she was what she was – a soundly-built collier, with adequate room for her crew and her stores.”

<sup>526</sup> Adelbert Von Chamisso, *A Voyage Around the World with the Romanzov Exploring Expedition in the Years 1815 – 1818 in the Brig Rurik, Captain Otto Kotzebue*, trans. and ed. by Henry Kratz, (Honolulu: University of Hawaii Press, 1986), 21.

The conchologist Joseph Couthouy, who accompanied the United States Exploring Expedition (1842-1844), found competition over space a problem when trying to secure storage for his sizeable collection of coral. As Couthouy came out of his cabin one morning, he was confronted by the expedition's commander, Lieutenant Charles Wilkes, who barked that he "would not have the whole ship lumbered up with coral[.]" He claimed it gave off an unpleasant smell and "endangered the health of the crew by producing malaria." When Couthouy protested that previous expeditions had collected as many specimens, and that to do less would reflect badly on the scientific mission, Wilkes responded that he "did not care a damn for what had been previously done" and forbade Couthouy to store his specimens anywhere below deck.<sup>527</sup> Powerless in the face of naval command, Couthouy wrote in his journal: "of course there is no reply to this."<sup>528</sup> Couthouy's experience was not unique for scientists at sea during the nineteenth century. What measures could naturalists take to surmount these sorts of obstacles and secure greater control over their working environment?

At the annual meeting of the Royal Society on November 30<sup>th</sup>, 1876, Joseph Dalton Hooker, the society's president, a celebrated botanist and veteran of five expeditions, addressed the assembled members.<sup>529</sup> The society had an unusual achievement to celebrate that year: the return of *H.M.S. Challenger* from its four-year expeditionary voyage. The first expedition to be devoted primarily to marine exploration

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<sup>527</sup> Elizabeth Green Musselman, "Science as a Landed Activity: Scientifics and Seamen aboard the U.S. Exploring Expedition," *Surveying the Record: North American Exploration to 1900*, ed. by Edward L. Carter, (Philadelphia: American Philosophical Society, 1999), 86.

<sup>528</sup> William Stanton, *The Great United States Exploring Expedition*, (Berkeley: University of California Press, 1975), 121.

<sup>529</sup> Joseph D. Hooker, "Address of the President – Anniversary Meeting," *Proceedings of the Royal Society of London*, Vol. 25, No. 175, (1876), 339.

and sounding, *H.M.S. Challenger* had circumnavigated the globe, travelling nearly 70,000 nautical miles. The Royal Society had selected the ship's scientific crew, while the ship itself, a steam corvette, was provided by the Admiralty, who modified it to suit its scientific mission. Guns were removed and laboratory and living spaces for the civilian corps of scientists constructed in their place.<sup>530</sup> In the words of the expedition's chief scientist, Charles Wyville Thomson, the *H.M.S. Challenger* had been equipped for scientific research "as no ship of any nation was ever equipped before."<sup>531</sup>

Certainly Hooker recognized the scale of the achievement as he addressed his audience: "the most important scientific incident of the year is unquestionably the return of the 'Challenger' from her voyage round the world and three years and a half of persevering exploration [...] It is impossible for any one who has not taken an active part both in the organization and conduct of such an expedition as this of the 'Challenger,' to estimate the number and value of the factors that have mainly contributed to its success."<sup>532</sup>

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<sup>530</sup> Margaret Deacon, *Scientists and the Sea 1650 – 1900*, 335. As a naval vessel, *Challenger* participated in several military actions before being refitted for dredging: an unsuccessful intervention in Mexico and a punitive shelling of the Fijian Island of Rewa in 1860 (twenty years after the US. Exploring Expedition carried out a comparable punitive military action in Fiji). The shipboard modifications were satirized in a humorous poem published in *Punch* magazine: "broadside guns have made room for ship batteries magnetic; Apparatus turns out ammunition; From main-deck to ground-tier I'm a peripatetic, Polytechnic marine exhibition." Unknown author, "The Challenger Her Challenge," *Punch Magazine*, Vol. 63, (1872), 255.

<sup>531</sup> Charles Wyville Thomson, *The Depths of the Sea*, xi. Even Z.L. Tanner, captain of the U.S. Fish Commission Steamer, *Albatross*, the first vessel specifically constructed for oceanographic research, later wrote of *Challenger*: "[She] was the largest and best-appointed vessel ever employed in deep-sea exploration[.]" Z.L. Tanner, *Deep-sea Exploration: A General Description of the Steamer Albatross [...]*, (Washington D. C.: Government Printing Office, 1897), 345.

<sup>532</sup> As H. Charnock has noted, "the *Challenger* expedition was a huge undertaking, [...] possible only in the prosperity of Victorian England." H. Charnock, "H.M.S. Challenger

There was, however, an element that only a veteran explorer could truly appreciate. “Essential to complete success as all these requirements were,” Hooker continued, “they would have been wholly unavailing but for another [...] and that is, concord. The trials of social life on shipboard are proverbial; and, according to the early traditions of the naval service, a philosopher afloat used to be considered as unlucky a shipmate as a cat or a corpse. In this case, thanks to the admirable spirit in which the Commander and his executive worked with the head of the Scientific Staff and his subordinates, I am informed that harmony reigned on board throughout the voyage.”<sup>533</sup>

To the modern reader it might seem odd that Hooker highlighted this concord between what were then often called “natural philosophers” and crew. Today we might assume that scientific operations on a ship specifically commissioned for research would not suffer from lack of “concord” between scientists and crew or from the absence of a specific chain of authority for its scientific staff. But *Challenger* marks one of the first expeditions that left little record of having been plagued by problems reported since the time of Cook.<sup>534</sup> Unsurprisingly, considering the confined space of a sailing vessel, many of the conflicts between scientists and crew reported in earlier expeditions arose over uses of space.

The lower decks of a nineteenth century wooden sailing vessel were not conducive to setting up a scientific laboratory. The pitching of the ship, the cramped quarters, the varying temperature and humidity, and the danger of using any combustible

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and the Development of Marine Science,” *The Journal of Navigation*, Vol. 26, No. 1, (1973), 4.

<sup>533</sup> Hooker, “Address of the President – Anniversary Meeting,” 351.

<sup>534</sup> Eric Mills writes of the *Challenger* expedition: “its success provided a model for future expeditions and a sense of community, an esprit de corps, that still has a significant influence on oceanography[.]” Eric Mills, “Problems of Deep-Sea Biology,” 19.

chemicals under these conditions might dissuade anyone from attempting to build a space suitable for work with microscopes and chemicals. However, that is precisely what the Royal Society set out to do when it provided guidelines for refitting *Challenger*. There were of course major problems to surmount. As Thomson noted in the voyage narrative: “ship-life is generally unfavorable to steady work, and during a great part of the time the motion of the ship makes it impossible to have even the limited space at one’s command in his cabin.”<sup>535</sup>



Fig. 2. Zoological laboratory on the main deck of *Challenger*.<sup>536</sup>

Thomson provided lengthy and detailed descriptions of the scientific workspaces aboard *Challenger*, almost in defiance of the assumption that scientific work on board a vessel would not be feasible (Figure 2, 3).

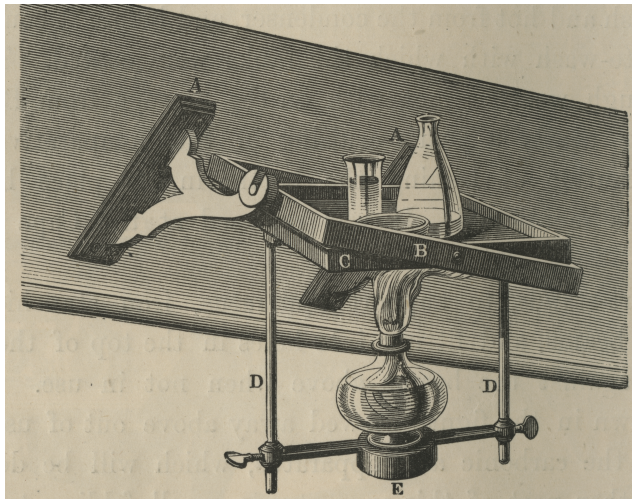
The Particular build of the ‘Challenger’ gives her an immense advantage for her present purpose [...] Sixteen of the [...] guns have been removed, and the main-deck is almost entirely set aside for the scientific work. [...] Two sets of cabins

<sup>535</sup> Charles Wyville Thomson, *The Voyage of the ‘Challenger’: The Atlantic: A Preliminary Account of the General Results of the Exploring Voyage of the H.M.S. ‘Challenger’ [...]*, (New York: Harper, 1878), x.

<sup>536</sup> *Ibid.*, 4.

have been specifically built on the after part of the main-deck for the [...] scientific work.<sup>537</sup>

Paying particular attention to the numerous gimbals and fasteners employed to keep scientific apparatuses upright and stable (Figure 4), Thomson described the “natural history work-room” which, he noted, was a “novel addition to the equipment of a surveying ship.”



*Fig. 3. Sea-going Sand-Bath.* Thomson writes of this apparatus that it “suited itself so easily to the motion of the ship, that even in very rough weather the lamp was perfectly safe as shown, and there was no danger of spilling the contents of even the flattest evaporating dish.”<sup>538</sup>

He concluded with an assurance that despite the many extra precautions required, “the operations carried on in the work-room on ship-board are [...] very much the same as the ordinary routine work of a museum work-room and a physiological laboratory, [...] only

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<sup>537</sup> Ibid., 27. Helen Rozwadowski has called attention to “[t]he unprecedented step of dislodging the captain from his traditional place as lone occupant of the aft cabin[.]” Helen Rozwadowski, “‘Small World’ Forging a Scientific Maritime Culture for Oceanography,” *Isis*, Vol. 87, No. 3, (1996), 415.

<sup>538</sup> T.H. Tizard, *Narrative of the Cruise of the H.M.S. Challenger with a General Account of the Scientific Results of the Expedition*, (London: Her Majesty’s Stationary Office, 1885), 14.

modified by the special nature of our work.”<sup>539</sup> In short, the work of the land-based laboratory could be conducted at sea in “much the same” way. Whatever the accuracy of Thomson’s claim, it was in the interest of the chief scientist of the expedition to present the laboratories of *Challenger* and, by association, the knowledge produced in them, as equivalent to those of land-based science. Laboratory space, as emblematic scientific space, conferred legitimacy on both its workers and their work.

This was not the first time an expedition vessel had been refitted with spaces specifically designed for scientific work. For instance, the flagship of the U.S. Exploring Expedition had been modified to include, in addition to the ship library, a reading room to house the many scientific texts brought along for reference.<sup>540</sup> The commander of the expedition, Charles Wilkes, explicitly tried to reserve this space for the scientific work of the mission and to forestall its private appropriation by his officers:

The accommodations, though not large, will [...] be found to be ample, and will naturally prevent any one from appropriating its small conveniences to himself; or using its table for writing (intended for books and the facility of reference to them), as there no doubt exists sufficient room in the several apartments appropriated to the different officers for that purpose, without incommoding any one.<sup>541</sup>

The Austrian frigate *Novara* provides another example of early efforts to refit naval space for science. The gunroom (the junior officers’ mess room) was converted into

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<sup>539</sup> Wyville Thomson, *The Voyage of the ‘Challenger,’: The Atlantic: A Preliminary Account of the General Results of the Exploring Voyage of the H.M.S. ‘Challenger’ [...]*, (New York: Harper, 1878), 15 – 16.

<sup>540</sup> As Helen Rozwadowski has argued, while ships had a long history of carrying books, scientists required larger library collections for their work, including species monographs with which to analyze and compare newly collected specimens. Helen Rozwadowski, *Fathoming the Ocean: The Discovery and Exploration of the Deep Sea*, 204. The *Albatross* library contained over 400 volumes. See Tanner, *Deep-Sea Exploration*, 404.

<sup>541</sup> Quoted in Harry Skallerup, *Books Ashore & Afloat: A History of Books, Libraries, and Reading Among Seamen During the Age of Sail*, (Hamden, Connecticut: Archon Books, 1974), 189.

a reading room, providing both officers and scientists with space in which to use the expedition's collection of charts and books (Figure 5). But no separate laboratory space was provided. Each member of the scientific staff was still to consider his own cabin as his private designated workspace.<sup>542</sup>

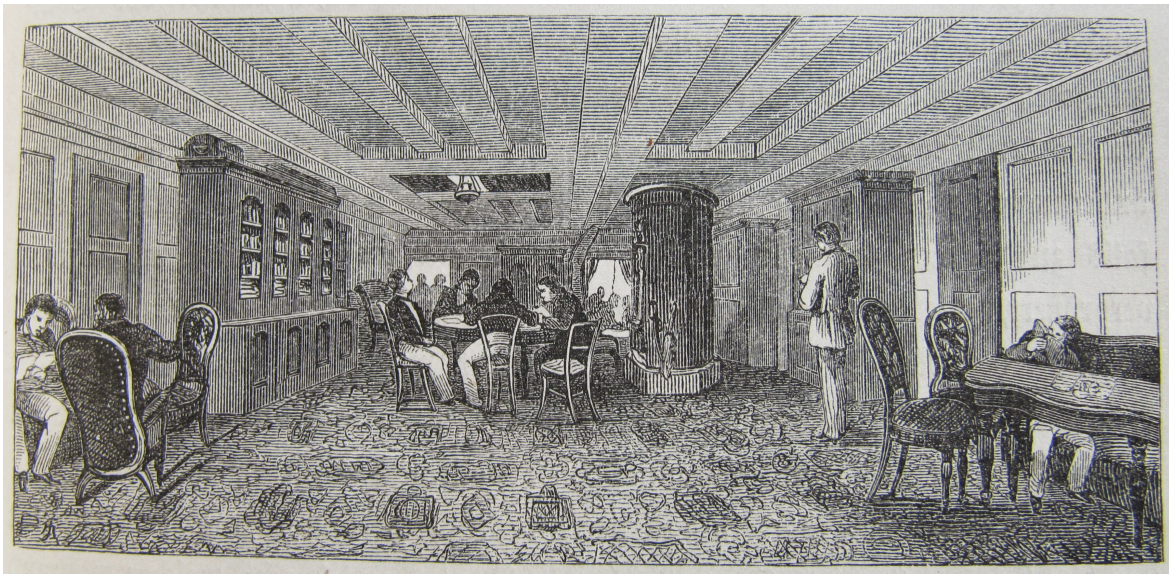


Fig. 4. Converted gunroom aboard the refitted *Novara*.<sup>543</sup>

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<sup>542</sup> Michael Organ, “‘Osterreich in Australien’: Ferdinand von Hochstetter and the Austrian Novara Scientific Expedition 1858 -9,” *Historical Records of Australian Science*, Vol. 12, No. 1, (1998), 1 – 13.

<sup>543</sup> Karl Scherzer, *Narrative of the Circumnavigation of the Globe by the Austrian Frigate Novara, Undertaken by Order of the Imperial Government, in the Years 1857, 1858, & 1859, [...]*, Vol. 1, (London: Saunders, Otley, and Co., 1863), 4.



Fig. 5. The Naturalists' workroom aboard *Challenger*.<sup>544</sup>

*A Place for Shipboard Science:*

In a letter to his mother dated July 15<sup>th</sup> 1873, Joseph Matkin, Steward's Assistant on *Challenger*, enthused:

[I] had the privilege of examining some of the curiosities in the Analyzing room the other night, & was much surprised & interested by what I saw. The mud that comes up from the bottom of the sea is softer than velvet [...] The wonderful Prawn was in spirits of wine in a glass jar & was almost as large as a small Lobster. He had a pair of wings folded over his back like a pigeon's. I also saw several things through a large Microscope, even more wonderful.<sup>545</sup>

<sup>544</sup> T.H. Tizard, *Narrative of the Cruise of the H.M.S. Challenger with a General Account of the Scientific Results of the Expedition*, 509.

<sup>545</sup> Joseph Matkin, *At Sea with Scientifics: The Challenger Letters of Joseph Matkin*, ed. by Philip F. Rehbock, (Honolulu: University of Hawaii Press, 1992), 89.

Matkin's description of the "Analyzing room" stands out in sharp contrast to the impression of the work of the "scientifics" recorded thirty years earlier by Lieutenant William Reynolds of the U.S. Exploring Expedition.<sup>546</sup>

The Scientifics cut up & dissect and overhaul, and use magnifying power to better see, and make drawings & paintings, and search their books, and write down learned descriptions [...] and tell *us* all about the mysteries of organization, &c., &c. And they have dead & living lizards, and fish floating in alcohol, and shark jaws, & stuffed turtles, [...] and many other equally interesting pieces of furniture hanging about their beds & around their state rooms – such sweet looking objects as doubtless glad scientific eyes to behold. Catch any of them in my *room* – no, no! – I'll *visit*, when I have a curiosity in that way.<sup>547</sup>

These two passages record two different types of workspace: the private cabin of the landlubber naturalist, and the collective workroom of the scientific crewmembers. The "analyzing room," representative of the expedition's mission, unlike the private cabin of one of the "scientifics," carried with it an aura of "privilege" to those permitted to enter. Helen Rozwadowski has argued that oceanographic research vessels of the late nineteenth century became sites of a new maritime culture shared by sailors and scientists.<sup>548</sup> These descriptions suggest how new uses of shipboard space were being experienced and negotiated.

But what was driving this cultural change? Historian Philip F. Rehbock notes that conditions of service in the royal navy were improving in the late nineteenth century. A career at sea was becoming attractive to middle-class men and a series of reforms instituted by the Admiralty were elevating the status of the common sailor to that of a

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<sup>546</sup> During the late nineteenth century, writers referring to scientists on board expedition vessels used the following terms: "philosophers," "naturalists," "scientifics," "scientists," "civilian scientific staff."

<sup>547</sup> William Reynolds, *The Private Journal of William Reynolds: The United States Exploring Expedition, 1838 – 1842*, ed. by Nathaniel Philbrick and Thomas Philbrick, (New York: Penguin Press, 2004), 13.

<sup>548</sup> Helen Rozwadowski, "Small World," 410.

skilled working man.<sup>549</sup> This set the groundwork for some common acknowledgement of craft skills between men of different social classes and occupations. Skills of the crew now sometimes received explicit recognition by the scientists, while the scientific hierarchy, whose status was marked by the spaces it controlled, received marks of respect from the crew that sometimes paralleled those accorded naval officers. In reference to the common sailor, the “blue-jacket,” Thomson recorded in his narrative of the *Challenger* voyage: “I must not omit to record my debt of gratitude to my friends the blue-jackets, who, greatly to their credit, treated us civilians throughout with as much respect and consideration as they did their own officers.”<sup>550</sup>

The scientists hoped to be accepted by the officers as equals. Thomson, exhibiting some deference to the professional knowledge of the naval officers, observed:

[T]here are many things in Lisbon to interest “philosophers” as our naval friends call us, - not I fear from the proper feeling of respect, but rather with good-natured indulgence, because we are fond of talking vaguely about ‘evolution,’ and otherwise holding on to loose ropes; and because our education has been badly neglected in the matter of cringles and toggles and grummets, and other implements by means of which England holds her place among the nations.<sup>551</sup>

This new etiquette of mutual acknowledgment was encouraged by the civilian and naval expedition leaders, chief scientist Thomson and Captain Nares. For instance, Matkin records in one of his letters that early in the voyage Thomson lectured the ship’s company on the scientific objectives of the mission:

I have been asked by the Captain to try & explain to you, as well as I am able, what is the object of our expedition & what we are doing from day to day. [...] [I]t gives me pleasure so to do, for we are to be common shipmates for the next few years, & doubtless, each one has some interest in the work, & the results, if

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<sup>549</sup> Joseph Matkin, *At Sea with Scientifics*, 11.

<sup>550</sup> Wyville Thomson, *The Voyage of the ‘Challenger,’* xiii.

<sup>551</sup> *Ibid.*, 114.

successful, will be creditable to us all.<sup>552</sup>

The new rhetoric of mutual respect and cooperation should not be taken as evidence that frictions had been eliminated. In fact, Matkin complained that the scientists were unwilling to share information about their work with others.<sup>553</sup> And a popular account of the *Challenger* cruise by one of its naval officers, W.J.J. Spry, describes the scientific party with a tone betraying a continued sense of his own caste, condescension toward the civilians, and determination to bend them to naval ways:

[T]he varied incidents at sea, all tend to rouse feelings and sensations [...] reserved alone for those whose business is on the great waters. To those constituting the scientific staff, the routine, especially of a man-of-war, was entirely different from that they had hitherto enjoyed on shore [...] At first, etiquette and usages of naval every-day life seemed particularly vexatious and annoying; but after awhile, [...] one and all perceived [...] the necessity of order.<sup>554</sup>

But there is little evidence that the dramatic episodes of conflict over space characteristic of earlier voyages (that could go so far as a captain's throwing collections overboard) continued into the late nineteenth century. A place for oceanography, and for those who pursued it, had been secured on *Challenger*.

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<sup>552</sup> Joseph Matkin, *At Sea with Scientifics*, 58.

<sup>553</sup> *Ibid.*, 41.

<sup>554</sup> W.J.J. Spry, *The Cruise of the Majesty's Ship 'Challenger.' Voyages Over Many Seas, Scenes in Many Lands*, (London: Sampson Low, Martson, Searle, & Rivington, 1877), 41.

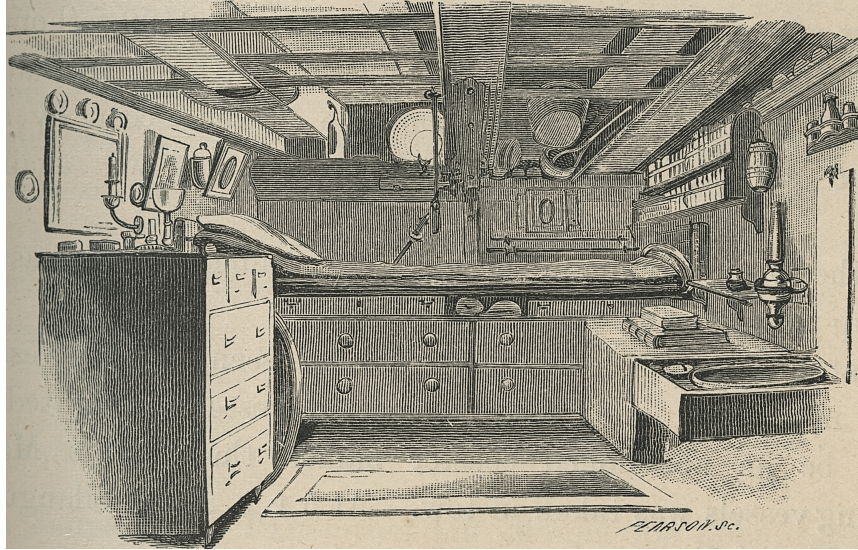


Fig. 6. The cabin of naturalist Henry Moseley aboard *Challenger*. Note the lack of scientific equipment.<sup>555</sup>



Fig. 7. The cabin of geologist Ferdinand Hochstetter aboard *Novara*, showing hammers, bottles, guns, and measuring implements.<sup>556</sup>

<sup>555</sup> T.H. Tizard, *Narrative of the Cruise of the H.M.S. Challenger with a General Account of the Scientific Results of the Expedition*, 645.

<sup>556</sup> Pencil sketch by expedition artist Joseph Selleny from the collection of the State Library of New South Wales. Original drawing is held by the State Library of New South Wales – DG\*6/1.

*A Laboratory for Social Experimentation:*

The confined spaces of the ship forced different types of workers, from disparate social and cultural backgrounds, into close contact with unfamiliar people and practices. It would take time for new relationships to become institutionalized and for specialized spaces to be appropriated for new practices. To return to the statements of Steward's Assistant Matkin, and Lieutenant Reynolds, there is an important difference between "microscopes" in an "analyzing room" and "interesting pieces of furniture hanging about [the scientifics'] beds & around their state rooms." Matkin was entering space consecrated to the expedition's mission, while Reynolds, visiting private apartments, was looking upon the "curiosities" possessed by their tenants. In his address to the Royal Society, President Hooker drew specific attention to the fact that *Challenger* did not have separate mess rooms. As Hooker explained: "the contrary practice [...] [of having a single mess on the *Challenger* expedition] has, as I am assured, been attended with the happiest results - and this notwithstanding the addition to the mess of that dreaded element, the philosophers."<sup>557</sup>

The fact that the naval officers and the scientists were now eating together, a modification of earlier practice, is cited as an "experience" [an experiment], whose "results" would hopefully dispel enduring "prejudices." As Chief Scientist Thomson wrote in the preface to his narrative, "the somewhat critical experiment of associating a party of civilians, holding to a certain extent an independent position, with the naval staff

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<sup>557</sup> Joseph Hooker, "Address of the President – Anniversary Meeting," 351. On a traditional naval vessel the captain dined alone in his stateroom. "[V]arious officers dine with the captain – but only when invited to do so, for the strictest form and etiquette is observed on board of a ship of war." Unknown author, "A Visit to the Iron-Cased Frigate 'Warrior,'" *The Exchange: A Home and Colonial Review of Commerce, Manufactures, and General Politics*, Vol. 1, (1862), 182.

of a man-of-war, has for once been successful.”<sup>558</sup> This critical experiment had been one of social organization, with the ship serving as laboratory.

There was already a long history of using the captive population of a ship’s crew for experimentation. Captain Cook, after returning from his first voyage around the world, was elected to the Royal Society and awarded the prestigious Copley Medal for testing antiscorbutics on his men during the course of the voyage and publicizing the results.<sup>559</sup> On the Austro-Hungarian *Novara* expedition (1857 -1859), one of the ship’s physicians, Eduard Schwarz, who spent his time ashore collecting human crania for ethnological purposes, also conducted experiments at sea on the crew to test his theories about the causes of night blindness. Schwarz compiled data on the health of the crew in a series of tables, translating these captive subjects into quantifiable scientific information.<sup>560</sup> Like the well-delineated space of a laboratory on land, the bounded world of a ship, isolating human subjects under military command, provided ideal conditions for controlled experimentation.

Research vessels also lent themselves to technological innovation. The first ship specifically built for oceanographic research, rather than modified to serve it, the U.S. Fish Commission steamer *Albatross* (1882-1921), was also the first U.S. government

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<sup>558</sup> Wyville Thomson, *The Voyage of the ‘Challenger,’* xvii.

<sup>559</sup> James Cook, “The Method Taken for Preserving the Health of the Crew of His Majesty’s Ship the Resolution During Her Late Voyage Round the World,” *Philosophical Transactions of the Royal Society*, (1776). See also R. Carmichael Tilghman, “President’s Address: Captain James Cook (1798 – 1779) Explorations and the Conquest of Scurvy,” *The American Clinical and Climatological Association*, (1981). For a history of the trials and errors associated with the treatment of scurvy among sailors, see John Naish, “The Health of Mariners: Vancouver’s Achievement,” *Enlightenment and Exploration in the North Pacific, 1741 – 1805*, ed. by Stephen W. Haycox, James Barnett, and Caedmon Liburn, (Anchorage: Cook Inlet Historical Society, 1997), 79 – 87.

<sup>560</sup> George Wolf, “Eduard Schwarz, A Neglected Pioneer in the History of Nutrition,” *Nutrition*, Vol. 13, No. 9, (1997), 845.

vessel to be equipped with electric lighting.<sup>561</sup> Electricity allowed scientists to extend their working hours and permitted them to process specimens gathered at night. Electric lighting even served as a lure for marine creatures.<sup>562</sup> By extending working hours and permitting scientists to gather specimens at night, electricity amplified the research vessel's extension of scientists' reach in time as well as in space.

*Landscape and Seascapes:*

Field scientists of the Victorian era favored landscapes and techniques that allowed them to reproduce some of the routines of laboratory work. Given the scientific authority of laboratories at the time, this is not surprising, Robert Kohler notes that biologists “tried to import laboratory methods to the field [and that] the most successful imports were generally the simplest – counting and tabulating.”<sup>563</sup> The ocean, as a relatively uniform field environment, had a number of attractive aspects from this perspective. Thus the scientists of *Challenger* came to prioritize what they termed “observing stations” at sea over land-based collecting. An observation station in the

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<sup>561</sup> George Shor, “The Development of Research Vessel Design,” *Oceanographic History: The Pacific and Beyond*, ed. by Keith Benson and Philip F. Rehbock, (Seattle: University of Washington Press, 2002), 46. See also Dean C. Allard, “The Origins and Early History of the Steamer Albatross, 1880 – 1887,” *Marine Fisheries Review*, Vol. 61, No. 4, (1999), 1 – 21. Edison lamps had already been used for marine research on the French research vessel *Talisman*. “Il était plus de huit heures lorsque le chalut rentrait à bord pour la quatrième fois; la nuit était faite, mais nous avions les lampes Edison pour suppléer au jour.” Léopold Folin, *Sous les Mers: Compagnes d'Explorations du 'Travailleur' et du 'Talisman,'* (Paris: Librairie J. B. Baillière et Fils, 1887), 276.

<sup>562</sup> Commander Z.L. Tanner of the *Albatross*, describes night collection by Edison lamp: “[A]n ordinary Edison 50- candle incandescent lamp, attached to a properly insulated cable, is lowered [...] 6 feet or more from the ship's side [...] Slow-moving forms which are floating on the surface collect in large numbers at the water line as the vessel sags slowly to leeward and more active species gather to feed upon them. As soon as the light is lowered, the latter gather around it, as moths about a candle, sometimes in great swarms, and it is then that the net reaps its richest harvests.” Z.L. Tanner, *Deep-sea Exploration: A General Description of the Steamer Albatross [...]*, 367.

<sup>563</sup> Kohler, “Place and Practice in Field Biology,” 192.

South Pacific could be used for measuring and sampling using the same techniques employed at a station in the North Atlantic. As Thomson wrote in the preface to his narrative, “we traversed a distance of 68,890 nautical miles, and at intervals as nearly uniform as possible, we established 362 observing stations.”<sup>564</sup> Samples of quantifiable data gathered from each of these “stations” could be compared using a uniform set of criteria. Thomson insisted that exploration of the conditions of the deep sea was the primary object of the expedition’s mission. “We dredged from time to time in shallow water in the most remote regions, [...] and collections of land animals and plants were likewise made on every available occasion; but I rather discouraged such work, which in our case could only be done imperfectly.”<sup>565</sup> The ocean was attractive to late nineteenth-century naturalists because it presented a more uniform research environment than was possible on land. At sea the position of each station could be marked as a single point on a chart, depth measured, a sediment core and water samples gathered, temperature taken at different depths, specimens collected with a dredge or trawl, specimens in the water column gathered by tow-net, atmospheric and meteorological conditions observed, and the direction and speed of water currents determined.

*The Ship as “Invisible Technician”:*

By establishing precedents for scientific practices of place and space, the *Challenger* expedition left a lasting impact on the way science would be conducted at sea. Laboratory space takes up much more room on modern research vessels than it did

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<sup>564</sup> Wyville Thomson, *The Voyage of the ‘Challenger,’* xvi.

<sup>565</sup> *Ibid.*, xvi.

on *Challenger*, and some vessels have become more laboratory than ship.<sup>566</sup> A stable instrument platform, unlike a moving vessel, allows sampling in an identical space over extended periods of time. Physical oceanographer Walter Munk has stated that the nineteenth century was “a century of undersampling.”<sup>567</sup> By this he meant that although oceanographic research vessels like the *Challenger* made consistent measurements at different “stations” as the ship crossed the ocean, differences between stations were interpreted as variations in space rather than in time; and observations at any one station could not be repeated, leading to an underestimation of the importance of seasonal changes in the ocean basin. Only at the end of the twentieth century, with the advent of satellite technology, did an era of “constant sampling” begin.

These developments in oceanographic technology reflect an enduring aim: to extend the reach of marine science in the field, while shortening the time between data collection and analysis. The expansion of human sensory immersion in the field has been accompanied by a reduction in the time needed for data collection. Anthropologist Stefan Helmreich writes, “the sensory trajectory through which the deep sea has been scientifically apprehended has travelled from the tactile, to the auditory, to the

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<sup>566</sup> The Floating Instrument Panel, or FLIP, built in 1962, is a good example. The Flip is towed to a “research station” and partly flooded, tilting the structure upright. This provides scientists with a stable platform, minimizing the effect of ocean movements that can interfere with instrumentation on conventional research vessels. Physical oceanographer Walter Munk recalls that FLIP was once used to substitute for the lack of a suitable island in a Pacific-wide study of wave formation in which all other observation sites were land-based. Walter Munk, “Affairs of the Sea,” *Annual Review of Earth and Planetary Sciences*, Vol. 8, (1980), 11. See also Elizabeth Noble Shor, *Scripps Institution of Oceanography: Probing the Oceans 1936 to 1976*, 102 – 105.

<sup>567</sup> Walter Munk, “Oceanography Before, and After, the Advent of Satellites,” *Satellites, Oceanography and Society*, ed. by David Halpern, (Amsterdam: Elsevier, 2000), 1 – 3.

visual[.]”<sup>568</sup> This expansion of human sensory immersion is reflected in a passage from an 1887 account of the voyages of the French *Travailleur* and *Talisman*, describing their dredges as “the hand of man descending to even the deepest depths.”<sup>569</sup> It is also reflected in American scientist Emily Nunn Whitman’s description in 1882 of the use of a diving suit for specimen collection at the Bay of Naples:

It is not only necessary that [marine animals] be taken [...] to aquarium and laboratory, it is important that the biologist visit them in their native homes and examine their surroundings. Encased in a heavy water-proof suit, [...] the biologist is let down [...] he can remain three hours and over walking about among the seaweeds and rocks [...] the minutest characteristics of a plant or animal can be distinctly observed. It is possible to make use of a lens, and one can seize with pincers the tiniest objects.<sup>570</sup>

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<sup>568</sup> Stefan Helmreich, *Alien Ocean: Anthropological Voyages in Microbial Seas*, (Berkeley: University of California Press, 2009), 35.

<sup>569</sup> “La drague est la main de l’homme descendant sur les fonds meme les plus profonds.” Marquis de Folin, *Sous Les Mers: Campagnes D’Explorations du ‘Travailleur’ et du ‘Talisman,’* xix. This nineteenth-century allusion to the technological extension of the human senses has been repeated in our century in an article on seafloor observatories: “The next great leap in our understanding of the earth-ocean system will require us to put our ‘eyes’ and ‘ears’ in the ocean [.]” John Collins, Robert Detrick, and Daniel Frye, “Seafloor to Surface Satellite to Shore: Moored Buoys Offer Potential for Continuous, Real-time Observations Anywhere in the Ocean,” *Oceanus Magazine*, (2000).

<sup>570</sup> Emily Nunn Whitman, “The Zoölogical Station at Naples,” *The Century Illustrated Monthly Magazine*, Vol. 32, (1882), 798.



Fig. 8. “The Diver at Work” – The Zoölogical Station at Naples.<sup>571</sup>

By allowing biologists to observe animals in their native environment, diving suits not only enhanced the scientists’ reach, but also reduced the time between observation and analysis.<sup>572</sup> Emphasis on the need to minimize such time is apparent in an account of work done on the Coast Survey Steamer *Blake*:

No attempt to analyze water specimens was ever made [...] Agassiz [...] decided that the proper facilities were not to be had on board the vessel. He suggested [...] that a properly furnished station be established on shore, convenient to some deep-sea basin, whence water specimens might be delivered [...] by quick runs of a steamer [...] With a station at the Tortugas, [...] the ‘Blake’ could deliver a

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<sup>571</sup> Ibid., 793.

<sup>572</sup> It should be noted, however, that in the late nineteenth century the use of diving suits for scientific research remained rare and was primarily restricted to shallow depths in conjunction with marine stations rather than deep-water vessels. Only in the 1950s with the invention of SCUBA equipment did diving become a commonly employed method for underwater research.

specimen from 2,000 fathoms within twelve hours[.]<sup>573</sup>

A similar means of expediting specimen collection and analysis was envisioned in 1885 by Anton Dohrn, director of the Naples Zoological station. In a description of the station's facilities, American naturalist Charles Edwards referred to Dohrn's blueprint for an ideal research vessel:

[A] floating laboratory [...] specially constructed [...] [with room for] six to ten investigators. Two laboratories [...] outfitted for a six months' voyage together with a library would furnish ideal conditions for work. With such a floating biological station unknown regions could be entered with all the resources of modern equipment [sic] [...] [T]he floating laboratory would be used, at first [...] with the Naples Station [...] depths would be searched [...] Small boats would be sent out to gather [specimens] [...] A portion of the catch would be examined [...] another part [...] [taken to] the Naples Station. [...] [The] vessel serves as dwelling house and laboratory from which would center all the activities of a marine station.<sup>574</sup>

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<sup>573</sup> Charles Sigsbee, *Deep-sea Sounding and Dredging: A Description and Discussion of the Methods and Appliances Used on Board the Coast and Geodetic Survey Steamer 'Blake,'* (Washington D.C.: Government Printing Office, 1880), 89 – 90.

<sup>574</sup> Charles Lincoln Edwards, "The Zoological Station at Naples," *The Popular Science Monthly*, Vol. 77, (September 1910), 221 - 223. See also the description of the survey ship *Carnegie* (1909 – 1929) by Acting Director of the Department of Terrestrial Magnetism of the Carnegie Institution, John Fleming: "the scientific program [...] computed values [...] forwarded from port to port in such a form that they could be immediately utilized by workers ashore, and by the hydrographic offices of the world." John Fleming, "Forward," *The Last Cruise of the Carnegie*, J. Harland Paul, (Baltimore: The Williams & Wilkins Company, 1932), xvi. The impetus to extend reach and reduce time propelled the development of the "man-in-the-sea" programs throughout the 1960s and 70s. By permitting long-duration "saturation dives" without the need for decompression, underwater habitation structures extended the range of field observation. As Helen Rozwadowski recounts, in 1963 "the Oceanic Institute of Hawaii tested a pilot underwater structure at a depth of 30 feet off Manana Island with the intention of constructing a permanent undersea laboratory that would serve as a 'base camp' for stepwise explorations of adjacent depths [.]" Helen Rozwadowski, "Engineering, Imagination, and Industry: Scripps Island and Dreams for Ocean Science in the 1960s," *The Machine in Neptune's Garden: Historical Perspectives on Technology and the Marine Environment*, ed. by Helen Rozwadowski and David Van Keuren, (USA: Science History Publications, 2004), 372.

In Dorhn's view, such a vessel would be an extension of the marine station, a hybrid space serving as a platform for collecting specimens, a laboratory for experiment, and base for observation in the field.

Oceanographers have continued to use research vessels as hybrid workspaces into the twenty first century. This multiple-usage of shipboard space is described in the preface to a scientific text entitled *Experimental Biology at Sea*:

For some the ship is a floating laboratory, enabling experiments to be carried out on freshly collected material. For others the ship is a mobile instrument platform and for a few the ordinary research ship is used in conjunction with other, more highly specialized vehicles [...] The distinction between these two categories is not absolute and much work uses a research ship both as a laboratory and as an instrumented vehicle.<sup>575</sup>

In the course of the last decade, sensor buoys (Argo Floats), remotely operated vehicles (ROVs), and autonomous underwater vehicles (AUVs) have been used to gather data and transfer it nearly instantaneously to laboratories on land via satellite. The entire ocean, crisscrossed by sensors, has come to be reconceived as a "natural laboratory" or "laboratory system."<sup>576</sup> The introductory paragraph of the website for the recently

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<sup>575</sup> A.G. Macdonald and I.G. Priede, *Experimental Biology at Sea*, ed. by A.G. Macdonald and I.G. Priede, (London: Academic Press, 1983), vii.

<sup>576</sup> "[T]he U.S. National Science Foundation [...] is on the verge of investing [...] in the construction [...] of an innovative infrastructure known as the Ocean Observatories Initiative (OOI) [...] [T]his initiative will [...] implement electro-optically cabled observing systems in the northeast Pacific Ocean [...] [I]nteractive, distributed sensor networks [...] will create a large-aperture 'natural laboratory' for conducting a wide range of long-term innovative experiments within the ocean volume using real-time control over the entire 'laboratory' system." Roger Barga and John Delaney, "A 2020 Vision for Ocean Science," *Earth and the Environment*, (2009), 32. Since the publication of the Barga and Delaney article several ocean observatory systems have become operational. Canada led the way with the completion of the first array of the Victoria Experimental Network Under the Sea (VENUS) in 2006. This was followed by the launch of the North-East Pacific Time-series Undersea Networked Experiments (NEPTUNE) in 2009. Judith Lavoie, "Undersea Observatory Reveals What's in the

launched National Oceanic and Atmospheric Administration vessel, *Okeanus Explorer*, insists that the ship “is *not* a research vessel.”<sup>577</sup> The first ship to be equipped with a permanent ROV, *Okeanus* can transmit data (including images and high-definition video), via high-speed Internet to scientists and their publics (anyone with an internet connection) anywhere in the world: a feat referred to as “telepresence.”

Two important changes have taken place: technological advances have extended the field of scientific observation far beyond the bounds attained by earlier research vessels, and the term “laboratory”, attractive to marine scientists for its connotations of authority and control, has been re-defined to include *observational* as well as experimental science. As University of Washington oceanographer John Delany recently observed: “there will be massive amounts of data flowing ashore, all available to anyone who has any interest in using it. This is going to be much more powerful than having a single ship in a single location[.]”<sup>578</sup> In a New York Times article of 2007, Delaney described the potential of remote observatories even more succinctly: “[...] we’re going to turn Juan de Fuca Plate into a national laboratory.”<sup>579</sup> But if the Juan de Fuca Plate, or an entire ocean, can be considered a ‘laboratory,’ the word has changed in meaning, the space of observation and analysis engulfing the field. In this new ocean-laboratory oceanographers can now

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Ocean off the Coast of Vancouver Island,” *Times Colonist*, (24 August 2013). In the United States, the Washington regional node of the U.S. Oceans Observatory Initiative (OOI), led by Delaney, finished laying their first submarine cable in 2011. The Argo Floats program, established in 2000, achieved its goal of deploying 3000 floats in 2007. At the time of writing, there are 3552 floats deployed with the target of maintaining a 3° X 3° array. See also Robert Fricke, “Down to the Sea in Robots,” *Technology Review*, Vol. 97, No. 7, (1994), 46-55.

<sup>577</sup> “NOAA Ship *Okeanos Explorer*.” [Accessed online 29 April 2011], <http://www.moc.noaa.gov/oe/>.

<sup>578</sup> John Delaney, “Wiring an Interactive Ocean,” TED Talk, (July 2010).

<sup>579</sup> William Yardley, “‘Bringing the Ocean to the World,’ in High-Def,” *The New York Times*, (4 September 2007).

present their work as “experiments.”<sup>580</sup>

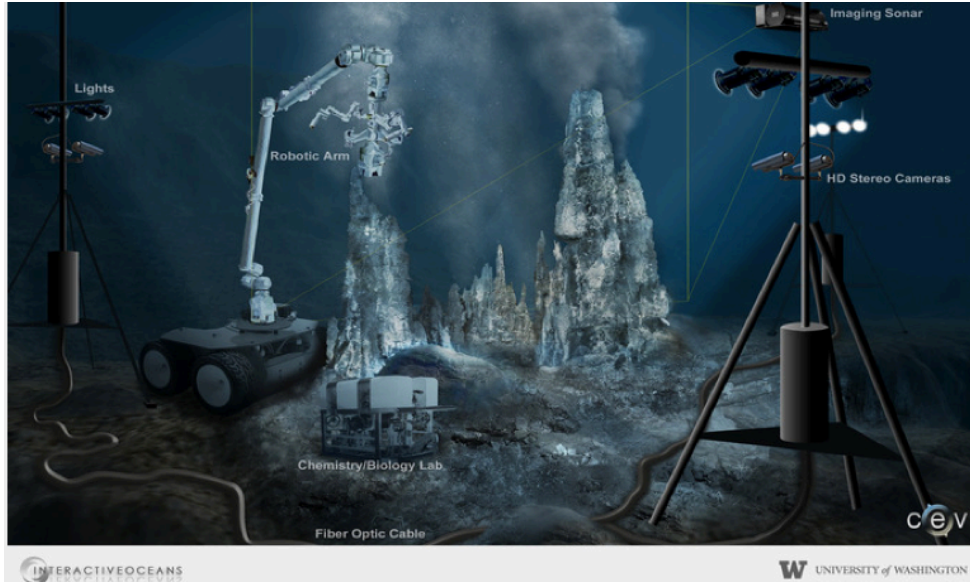


Fig. 9. “Conceptual view of future seafloor laboratory.”<sup>581</sup>

As oceanography changes, the model of the ship as laboratory pioneered by the *Challenger* expedition is no longer fully adequate. Perhaps, to adapt Steven Shapin’s concept, the model of the ship’s place in some contemporary oceanographic research is already that of “invisible technician.” Research vessels continue to serve as scientific instruments by deploying remote sensors, yet the ships themselves – supply vessels to a system of sensors embedded in the ocean - are no longer primary collectors or producers of scientific knowledge. To quote the president of Ocean Networks Canada, Martin Taylor: “The strength of our observatories is they are able to provide data without

<sup>580</sup> The term “experiment” is frequently found in modern oceanographic project titles. A few examples are the Mid-Oceans Dynamics Experiment (MODE), the Tasmania Internal Tide Experiment (T-Tide), and the North-East Pacific Time-Series Underwater Networked Experiments (NEPTUNE).

<sup>581</sup> Conceptual View of Future Seafloor Laboratory, OOI Regional Scale Nodes Program and Center for Environmental Visualization, University of Washington. [Accessed online 15 April 2013].

<http://www.interactiveoceans.washington.edu/file/Conceptual+View+of+Future+Seafloor+Laboratory>.

[scientists] going out in ships, but we need ships to service and maintain them.”<sup>582</sup>

*Conclusion:*

In this chapter I have examined three models for understanding the work of oceanographic vessels. I have attempted to throw light on the history of fieldwork at sea, on the development of shipboard laboratory space, and on the social relations of science production. I have focused on changes in the allocation, design, and control of shipboard space. The process by which science and scientists found a place on expedition vessels had a literal physical dimension; and the evolution of the physical spaces in which naturalists worked, from cabins to laboratories, helped confer authority to a new ocean science. This history teaches us not to approach field science as a simple series of expedition events or set of technological advances, but as a process in which changing treatments of workspace reveal evolving social practices and shifting interests.

In casting eighteenth-century vessels as scientific instruments, Richard Sorrenson began a story I have sought to continue. Oceanography provides a model of “laboratory space” that moved into the field, expanded to include new forms of observation and activity, and eventually engulfed the field. Changes in research vessel usage accrued gradually over time, and earlier usages persist alongside later innovations. For some, the research vessel remains a floating laboratory, for others it has become an observation platform, or even an invisible, yet essential, “technician” servicing a “natural laboratory system” expanded to encompass the entire ocean.

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<sup>582</sup> Judith Lavoie, “Retired Coast Guard Boat to Become Floating Lab,” *Times Colonist*, (19 January 2011).

## Epilogue:

### The End of Oceanographic Fieldwork?

*“If we regard an expedition as a scientific experiment, then we must propose to answer certain specific questions, and the strategy of exploration, the disposition of ships and buoys, and so on, must be designed with a view to obtaining quantitative, statistically significant answers to these questions.”*

- Henry Stommel, oceanographer, Harvard University, (1963).<sup>583</sup>

*“Now we can cut the tether – the one that binds our questioning intellect to vulnerable human flesh. Through telepresence, a mind detaches itself from the body’s restrictions and enters the abyss with ease, and with lightening-quick fiber optic nerves.”*

- Robert Ballard, oceanographer, University of Rhode Island, (2000).<sup>584</sup>

*“[W]e are going to have a constant presence beneath the surface [...] We’re going to catch the ocean storms, the harmful algae blooms, we’re going to understand the air/sea interaction.”*

- Jack Barth, oceanographer, Oregon State University, (2011).<sup>585</sup>

*“What we’re doing is bringing the ocean to the world.”*

- John Delaney, oceanographer, University of Washington, (2007).<sup>586</sup>

While working on this dissertation I have been fortunate to have regular contact with oceanography faculty and graduate students. From them I have been made acutely aware of the rapid rate of change in contemporary oceanography. In turn, reflecting on current shifts in oceanographic field practices has informed my analysis of the history of oceanography. An oceanographer nearing retirement today has witnessed multiple major methodological changes over the course of their career. Three examples include: the widespread use of submersibles, the invention of remote sensing technology and, most

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<sup>583</sup> Henry Stommel, “Varieties of Oceanographic Experience,” *Science*, Vol. 139, (1963), 572.

<sup>584</sup> Robert Ballard, *The Eternal Darkness: A Personal History of Deep-Sea Exploration*, (Princeton: Princeton University Press, 2000), 311.

<sup>585</sup> Quoted in Lori Tobias, “Largest ocean science project in United States launches soon off Oregon coast,” *The Oregonian*, (19 October 2011).

<sup>586</sup> Quoted in William Yardley, “‘Bringing the Ocean to the World,’ in High-Def.”

recently, the genomics revolution. These technological innovations have provided paradigm-shifting information about marine ecosystems. For instance, within the last fifty years, oceanographers have acquired a better understanding of microbial evolution and ecology through gene sequencing, have formed a much clearer picture of marine animal migration thanks to electronic tagging, and have discovered entirely new marine ecosystems – deep sea hydrothermal vent communities – with the help of manned submersibles. Much oceanographic fieldwork has shifted from exploration of an unknown frontier to the monitoring, observation, and testing of established models.<sup>587</sup> But, while methodological approaches to the study of the oceans are changing, the oceans themselves are also rapidly being transformed.<sup>588</sup>

In 1957, Scripps director Roger Revelle famously wrote:

Human beings are now carrying out a large-scale experiment of a kind that could not have happened in the past nor be reproduced in the future. Within a few centuries we are returning to the atmosphere and oceans the concentrated organic carbon stored in sedimentary rocks over hundreds of millions of years. This experiment, if adequately documented, may yield far-reaching insight into the processes determining weather and climate.<sup>589</sup>

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<sup>587</sup> Scientists working in certain branches of oceanographic work would debate this statement; exploration remains an important component of field research in the deep-sea. Nevertheless, it is important to recall that the mythos of an “endless frontier” at sea has long served as a means for justifying marine research. See, Helen Rozwadowski, “Arthur C. Clarke and the Limitations of the Ocean as a Frontier,” 578 – 602. See also Erik Dücker’s analysis of the accelerated pace of habitat discovery in Erik Dücker, *News From an Inaccessible World: The History and Present Challenges of Deep-sea Biology*, Doctoral Dissertation, Radboud University, NL, (2014), 146 – 147.

<sup>588</sup> Naomi Oreskes, “Scaling Up Our Vision,” *Isis*, Vol. 105, No. 2, (June 2014), 383.

<sup>589</sup> Roger Revelle and Hans Seuss, “Carbon Dioxide Exchange Between the Atmosphere and Ocean and the Question of an Increase in Atmospheric CO<sub>2</sub> during the Past Decades,” *Tellus*, Vol. 9, (1957), 19 – 20. Revelle, who “liked great geophysical experiments,” was less worried about the implications of global climate change and more concerned with establishing a program for systematic monitoring. See Joshua Howe, *Behind the Curve: Science and the Politics of Global Warming*, (Seattle: University of Washington Press, 2014), 19.

Humanity has done little to slow the progress of this “experiment” with the oceans since that time. In recent years, mounting scientific evidence has confirmed predictions that climate change and overfishing are transforming the world’s oceans at an unprecedented rate. In a 2009 interview with the BBC, marine biologist Carol Turley of the Plymouth Marine Laboratory, speaking on the threat of ocean acidification, warned that this “rate of change in the oceans hasn’t been seen since the dinosaurs.” “One thing is certain,” she added “it is not a very wise experiment to be making.”<sup>590</sup> The oceans are changing as a result of human interference, and the scientific approach to the study of the oceans must adapt as well.

In the bay of Naples, near the island of Ischia, naturally occurring volcanic seeps release bubbles of CO<sub>2</sub> into the water column. This results in localized high concentrations of carbonic acid, making the area extremely inhospitable to organisms with calcareous shells. In marked contrast to nearby ecosystems, sea grass flourishes in the CO<sub>2</sub> rich environment.<sup>591</sup> A similar location has been identified off the coast of Papua New Guinea.<sup>592</sup> These sites are of particular interest to marine scientists, not just because they are exemplary of local environmental conditions, but also because they offer a glimpse of future conditions in the oceans as a whole. As climate change has refocused scientific attention to global systems, oceanographic fieldwork may be shifting

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<sup>590</sup> Roger Harrabin, “‘Coral lab’ Offers Acidity Insight,” *BBC News*, (11 March 2009). [Accessed online 23 September 2014].

<http://news.bbc.co.uk/2/hi/science/nature/7936137.stm>.

<sup>591</sup> Richard Black, “Natural Lab Shows Sea’s Acid Path,” *BBC News*, (8 June 2008). [Accessed online 23 September 2014].

<http://news.bbc.co.uk/2/hi/science/nature/7437862.stm>.

<sup>592</sup> Roger Harrabin, “How Climate Change Will Acidify the Oceans,” *BBC News*, (26 March 2014). [Access online 23 September 2014]. <http://www.bbc.com/news/magazine-26746039>.

increasingly from a science of localized observation and analysis to one of global systems prediction.

A good example of this shift in methodology is GEOTRACES, an international collaborative study of marine biogeochemical cycles of trace elements and their isotopes. A decade-long program formally launched in 2010, GEOTRACES has the participation of over thirty countries and is now one of the most important funding source for chemical oceanographic research. As laid out on the program's science plan, its primary aim is to "identify processes and quantity fluxes that control the distributions of key elements and isotopes in the ocean, and to establish the sensitivity of these distributions to changing environmental conditions." This information, the report claims, will offer "unique insights into the future consequences of global change."<sup>593</sup>

As a result of this re-orientation to future global-scale changes in the marine environment, some scientists have shifted their attention to the study of marine ecosystem manipulation - experimentation on a grand scale.<sup>594</sup> Algal plankton, minuscule single-celled organisms found in large concentrations in the oceans, account for approximately 50% of the photosynthesis on earth. As plankton photosynthesize, like any terrestrial plant, they remove carbon dioxide from the atmosphere and release oxygen. It is estimated that 99.9% percent of the carbon dioxide that has been incorporated by biological organisms over geologic time is buried in marine sediments. When plankton

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<sup>593</sup> Scientific Committee on Oceanic Research, International Council for Science, *GEOTRACES, An International Study of the Marine Biogeochemical Cycles of Trace Elements and Their Isotopes, Science Plan*, (Plymouth: The Clyvedon Press Ltd, 2006), 1.

<sup>594</sup> Though, as James Fleming has shown, climate manipulation schemes have been around for a long time. James Fleming, *Fixing the Sky: The Checkered History of Weather and Climate Control*, (New York: Columbia University Press, 2010).

die off, the remaining organic material – “marine snow” – sinks in the water column, trapping carbon dioxide in the depths of the ocean. This process is what climate scientists refer to as a “climate sink”<sup>595</sup> and some have speculated that plankton blooms should be artificially induced in order to mitigate climate change.

Since 1993 at least twelve ocean experiments were carried out in order to artificially trigger plankton blooms.<sup>596</sup> Iron serves as an important nutrient for algae thus marine scientists hypothesized that simply adding iron dust to the marine environment could trigger large-scale plankton blooms. As marine biochemist John Martin, former director of the Moss Landing Marine Laboratory, famously quipped: “give me half a tanker of iron, and I’ll give you an ice age.”<sup>597</sup> But, as another marine geochemist later acknowledged, “[in the past] we were trying to answer the question, ‘how does the world work?’ – not ‘how do we make the world work for us?’”<sup>598</sup> In recent years the scientific consensus has shifted to regard iron seeding as too risky and unpredictable a procedure to offer a viable solution to climate change.<sup>599</sup> Geoengineering of the world’s oceans seems to be off the table, at least for now. Nevertheless, as the oceans have become more accessible to scientists, and as marine resources are exploited to an ever-greater extent,

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<sup>595</sup> The meaning is literal since plankton takes in carbon dioxide then sinks as marine snow, trapping the carbon dioxide in deep-sea sediments.

<sup>596</sup> For one example, see Boyd et al., “A mesoscale phytoplankton bloom in the polar Southern Ocean stimulated by iron fertilization,” *Nature*, Vol. 407, (12 October 2000), 695 – 702.

<sup>597</sup> Hugh Powell, “Fertilizing the Ocean with Iron: Should we add iron to the sea to help reduce greenhouse gases in the air?” *Oceanus Magazine*, Vol. 46, No. 1, (January 2008).

<sup>598</sup> Quoted in *Ibid*.

<sup>599</sup> It has been argued that blooms deplete oxygen at depth as bacteria decompose the plankton, consuming oxygen and releasing carbon dioxide back into the ocean. The addition of dissolved carbon dioxide into the water column then contributes to ocean acidification as carbon dioxide bonds with water molecules to form carbonic acid.

many more people, states, and institutions will have the ability to dramatically shape the oceans' future.

As I was writing this dissertation, the largest iron seeding experiment ever conducted took place in the northeastern Pacific. Two hundred thousand pounds of iron sulphate were dumped off the coast of British Columbia under the direction of an “entrepreneur” and self-described “plant ecologist” named Russ George. George has consistently argued that his “perfect experiment” produced valuable data in the form of “thousands and thousands of biological samples.”<sup>600</sup> However, the reaction from the scientific community was far from positive. Russ’ experiment was condemned as “unscientific,” “irresponsible,” and in violation of two UN conventions for the protection of the marine environment.<sup>601</sup> Though previous government-funded studies had conducted similar iron seeding “experiments” at sea, George’s venture was a for-profit, non-peer reviewed project, conducted by someone without academic credentials.

It is easy to dismiss George’s iron-seeding experiment as an aberration from the scientific norm; however, the controversy surrounding this event suggests an issue of increasing concern for marine scientific policy. It may be that future oceanographers, unlike their predecessors, will be less concerned with encouraging widespread collaborative observation and experimentation at sea, and more concerned with overseeing and restricting what is deemed acceptable scientific practice in the marine environment. As the number of people working in a scientific discipline increases and as

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<sup>600</sup> David Biello, “Pacific Ocean Hacker Speaks Out: Is Russ George a ‘rogue geoengineer,’ salmon savior or something else?” *Scientific American*, (24 October 2012).

<sup>601</sup> See, Martin Lukacs, “World’s biggest geoengineering experiment ‘violates’ UN rules: Controversial US businessman’s fertilization off west coast of Canada contravenes two UN conventions,” *The Guardian*, (15 October 2012); and Henry Fountain, “A Rogue Climate Experiment Outrages Scientists,” *New York Times*, (18 October 2012).

experimental procedures are standardized, increased restriction and regulation is an expected result. The scientific response to the 2012 “rogue” iron seeding “experiment” can be interpreted a sign of oceanography’s maturity as an established scientific discipline.

The oceans, once an inhospitable and inaccessible terrain, are now increasingly accessible and, as a result, increasingly overexploited. What does this mean for the future of the ocean as a natural environment, as a field site for scientific research? As I discussed in chapters four and five, the increased exploitation of marine resources in the nineteenth century – particularly of marine fisheries – led to the formation of collaborative international scientific programs, ICES foremost among them. The most crucial difference between the present period and the late nineteenth century is the extent of human environmental interference. In addition to the ever-increasing scale of marine fisheries exploitation, the oceans are now fields for oil and mineral extraction, expanding telecommunication infrastructure, and increasing shipping traffic. While fisheries management concerns gave form to the marine sciences of the nineteenth and twentieth centuries, climate change will, in all likelihood, be the primary shaper of the marine sciences (and indeed of all field sciences) in the twenty-first century. Fear of environmental degradation then, has been a primary motivation for scientific research over the course of the history of marine science. Perhaps, then the only difference between nineteenth-century fisheries concerns and fears about contemporary climate change is the scale of the problem.

Oceanography’s gradual transformation into a global-systems-science mirrors broader social, political, and economic concerns with “global” climate change. In turn,

the concern over global environmental marine degradation has rekindled scientific interest in international scientific collaboration. For instance, citing marine pollution as a “clearly international” problem, oceanographers Henry Stommel and E. D. Goldberg appealed in a 1969 editorial in *Science* for “an international laboratory, equipped on a scale commensurate to global problems[.]” Projects were necessarily being scaled up, they argued, and expeditions proposed for the proceeding decade would require: “twenty-five hydrographic survey ships, forty oceanographic and fishery research vessels, ten fishing vessels, for systematic resource surveys, eight weather ships, an aircraft carrier with two escort ships, three deep-sea drilling vessels and five drilling barges, as well as some submarines including one nuclear power.”<sup>602</sup> But Stommel also argued that oceanography, faced by the urgency of climate change, required “sharp focus for an enhanced emergency research effort,” which he described as running in parallel with the procedures of wartime science.<sup>603</sup> By the late twentieth century, internationalism could thus be re-framed as a buttress against a new external threat: global climate change.

*Policing the Oceans:*

There are two important differences between the present period and the late nineteenth century. Today, large-scale active intervention in the marine environment – the intentional creation of artificial conditions – is technologically more feasible than in the past, and secondly, the oceans are increasing jurisdictionally controlled spaces.<sup>604</sup> As

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<sup>602</sup> Henry Stommel and E.D. Goldberg, “Oceanography: An International Laboratory,” *Science*, Vol. 165, (1969), 751.

<sup>603</sup> Henry Stommel, “Statement about Priorities for Greenhouse Research,” [Unpublished editorial written in 1990], *Collected Works of Henry Stommel*, ed. by Nelson G. Hogg and Rui Xin Huang, Vol. 1, (Boston: American Meteorological Society, 1995), I-221.

<sup>604</sup> I recognize that fisheries can be considered a form of active intervention in the marine environment, and certainly past marine ecosystems have been rapidly transformed by

I write this conclusion, President Obama is set to announce the creation of the largest marine preserve in human history. The Pacific Remote Islands Marine National Monument will cover 490,000 square miles, the equivalent of three times the area of the state of California. No marine preserve of this size has ever existed before. Ironically, the 200-mile limit economic exclusion zone is a product of marine resource exploitation, a process which began with President Truman's 1945 proclamation: "Policy of the United States with Respect to the Natural Resources of the Subsoil and Sea Bed of the Continental Shelf." Other countries quickly followed the example of the United States, eager to lay claim to the resources within their own territorial jurisdiction. The modern 200-mile Economic Exclusive Zone (EEZ) territorial limit, which lays claim to resources available in the water column, is a product of the 1982 UN Convention of the Law of the Sea (UNCLOS). Only the high seas remain outside of jurisdictional control. But, as it become increasingly evident that the fate of the our planet, and the fate of humanity, is tied to the welfare of the world's oceans, even the high seas may soon require extra-territorial policing.<sup>605</sup>

For much of the history of oceanography, the high seas were a territorial no-man's land. The extraterritoriality of the marine environment shaped the work of oceanographers; it allowed them to promote their science to their state sponsors as a means of extending state power into an international space, or as a means for States to

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overexploitation. However, while we can acknowledge the existence of nineteenth century proposals for climate modification, climatic geoengineering has only truly been feasible since the mid twentieth century. See David W. Keith, "Geoengineering the Climate: History and Prospect," *Annual Review of Energy and the Environment*, Vol. 25, (2000), 250.

<sup>605</sup> Unknown author, "The Tragedy of the High Seas: New management is needed for the planet's most important common resource," *The Economist*, (22 February 2014).

gain prestige on an international stage. As I have also traced in this dissertation, the extraterritorial marine environment has long served as a space where scientific cooperation and international peace initiatives can be performed.

*The Wired Ocean:*

The history of oceanography is also the story of the continuing expansion of control over the marine environment. I showed how this occurred on the microscale in my description of French marine stations in Chapter Three and my discussion of research vessel design in Chapter Five. Marine stations and research vessels began a process of scientifically domesticating the ocean and modern ocean observing systems are the logical successors to these efforts.

Every year the international telecommunication giant TeleGeography produces a map. Resembling a city subway system diagram, the “Submarine Cable Map,” as its name suggests, provides a global representation of the fiber-optic cable routes that crisscross the world’s oceans. As of March 2014 there are 263 cable routes – 22 more are soon to be installed. Fiber-optic cables now support 99% of all global information communication. Though satellite communication has been feasible since the 1960s, costs remain prohibitive (satellite communication is also more easily intercepted and thus less secure). In contrast, the cost of installing fiber optic cables on the seabed has become ever more affordable.<sup>606</sup> When compared to the truly massive scale of the telecommunications cable infrastructure already in place on the ocean’s seabed, the national science foundation funded fiber-optic observatory network off the coast of

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<sup>606</sup> See Ryan W. Neal, “Underwater Internet Cables: ‘Submarine Cable Map’ Shows How the World Gets Online,” *International Business Times*, (5 March 2014). [Accessed online 25 September 2014]. <http://www.ibtimes.com/underwater-internet-cables-submarine-cable-map-shows-how-world-gets-online-1559604>

western Washington, set to go into full operations in 2015, is miniscule. Granted, the objectives of the Ocean Observatories Initiative, *in situ* observation and analysis, are arguably much more complex tasks than simple data transmission.

Nevertheless, this comparison highlights one of the important shifts now occurring in the marine environment. The exploration of even the most remote area of the ocean is no longer the exclusive terrain of marine scientists. Private companies, seeking profit from marine resource exploitation (fisheries, mining, off-shore oil), negotiate with state powers for access to large swaths of the marine environment and marine “science” has become a focal point of these negotiations. One of the priorities identified by the “World Ocean Council” – an “ocean business community” formed in 2008 – is to promote “improved ocean science,” because “increased, improved, and better coordinated ocean science is important to industry operations in the marine environment, to help ensure the business environment is as predictable as possible.”<sup>607</sup>

*Oceanography – A State of Mind?:*

It is easy to imagine that recent technological advances in remote sensing and telepresence are transforming marine scientists once again into “arm-chair naturalists” – able, like some of their late eighteenth-century predecessors, such as the professors of the Paris Museum of Natural History, to carry out their analysis from the comfort of their offices while others (now, robots, technicians, or graduate students) do the laborious work of data collection in the field. With this development in mind, I asked a marine geologist working at the University of Washington to what extent recent advances in

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<sup>607</sup> Quoted in Stacy Alaimo, “Feminist Science Studies and Ecocriticism: Aesthetics and Entanglement in the Deep Sea,” *The Oxford Handbook of Ecocriticism*, ed. by Greg Garrard, (Oxford: Oxford University Press, 2014), 192.

oceanographic technology have transformed the logistics planning of oceanographic expeditions. His response indicates a perception of the marine environment in which the mediation of technology has been effaced:

We're better than we were thirty years ago, but you're never as good as you want to be. You want to go down there, and instead of hauling big rocks back, you want to get down there and make *in situ* measurements. You want to measure: 'what is the permeability of that rock?' 'What is the porosity of those sediments?' 'What is the chemistry of that fragile coating over there, while it's there, before I have to take it up?' [...] We're better than we were, but we're not where we want to be.<sup>608</sup>

I was reminded of the words of Elizabeth Noble Shor, marine biologist and historian of the Scripps Institution of Oceanography, who wrote in 1978, "Oceanography is not so much a science as a state of mind."<sup>609</sup> For contemporary marine scientists, the ability to imagine the extension of the human senses into an inhospitable environment of the sea has remained an important facet of oceanographic work. This suggests an important continuity between contemporary scientists and the field collectors of the early nineteenth century. For instance, we can interpret the lyrics of Edward Forbes' humorous 'Dredging Song,' as evidence of Forbes' ability to imagine the actions of his instrument –

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<sup>608</sup> Interview with Dr. Paul Johnson, University of Washington, 29 May 2013. This exchange is reminiscent of what Chandra Mukerji describes as the "normalization" of deep-sea submersible research. She argues that scientists "employ framing devices to mediate between themselves and the deep sea so they can do their work in a routine manner, without being unduly awed or anxious about being at the bottom of the ocean in a tiny sphere." Chandra Mukerji, *A Fragile Power: Scientists and the State*, (Princeton: Princeton University Press, 1989), 72. However, none of the oceanographers I have spoken to expressed anxieties about the nature of their work; if anything, danger and discomfort was an appealing feature of marine research.

<sup>609</sup> Elizabeth Noble Shor, *Scripps Institution of Oceanography: Probing the Oceans, 1936 to 1976*, 3.

the dredge – in an inaccessible terrain.<sup>610</sup> While the early field collectors probed the depths with nets and dredges, contemporary marine scientist employ robots, submersibles, and fiber optic cables but the role of imagination, part of the mental process required for remote sensing, has remained a constant. If we compare how naturalists have *perceived* the field over time, rather than how their technological abilities have changed, how different are these two groups of naturalists from one another?

As Robert Kohler has argued, the division between laboratory and field is best conceived as a “boundary,” rather than as a “border.” Nevertheless, he distinguished between laboratory biology and field biology as each having “distinct modes of knowledge production” and “distinct political economies.” The characteristic feature of the “lab-field border,” he argued, was the “motion” of biologists back and forth from one space to the other.<sup>611</sup> Moving back and forth between laboratory and field is increasingly less of a requirement for present-day oceanographers. And, while many of the oceanographers alive today became interested in oceanography *precisely because* they wanted to go to sea, future oceanographers may well be drawn to the marine sciences by other motivations that do not require moving between lab and field. Oceanographers of the future might, for instance, be drawn to the field of oceanography because of a love for computer programming rather than for ships.

Until the time at which field data collection becomes entirely automated (which, despite recent technological advances, remains a future possibility), travel to the field will

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<sup>610</sup> The lyrics of the dredging song can be found in George Wilson and Archibald Geikie, *Memoir of Edward Forbes, Late Regius Professor of Natural History in the University of Edinburgh*, (London: Macmillan and Co., 1861), 247.

<sup>611</sup> Robert Kohler, *Landscapes and Labscapes: Exploring the Lab-Field Border in Biology*, 18 – 19.

become increasingly the task of technicians (and/or graduate student). These fieldworkers may be motivated by a love of being in the field but their status (and thus the status of their contribution to scientific knowledge) will still fall below that of the increasingly sedentary principle investigators. Nevertheless, *generating* scientific knowledge about the oceans still requires the movement of scientists across the lab / field boundary. Thus, in our present time, Kohler's model still applies to oceanography, though it may not in the near future.

*"The Machine in Neptune's Garden":*

As I have shown, and as many other historians of oceanography have argued, scientists' perceptions of the field are mediated, both by the technology used to probe that environment, and by the social and political environment they have been forced to navigate in order to promote and carry out their work.<sup>612</sup> Hence, perceptions of the marine environment have continually evolved as oceanographic field practices have changed. Perceptions of the marine environment held by oceanographers nearing retirement today were shaped by the experience of using modern research vessels and the postwar environment of cooperation with the navy. Yet, it is important to remember that both machines and scientists enter the field, but do not necessarily do so at the same time, or for the same purpose. The point is easily made that not all ships are scientific research vessels. But, once *in* the field, scientists do adopt available technologies for scientific purposes. Hence, the ship is co-opted to become a scientific instrument or a mobile laboratory. To give a more contemporary example and illustrate how this principle can be

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<sup>612</sup> See, for instance, Keith Benson, Helen Rozwadowski, and David van Keuren, "Introduction," *The Machine in Neptune's Garden: Historical Perspectives on Technology and the Marine Environment*, xiii – xvi.

widely applied, an emeritus professor of biological oceanography in an interview explained to me how the first satellite chlorophyll observations were made in the Arabian Sea in the late 1970s:

There happened to be a physical study, by ships, of the Somali current, which is a very strange, very interesting current, and two guys, physical [oceanography] types, were placed in Mombassa, which is at the southern end of the Somali current – Kenya – and were sitting there and had nothing to do, and just saw this satellite coming over [...] Before, the Satellite was an experimental machine, nobody really worried about it; [they just] let it run. And so, these guys, who [went to] Miami, where the satellite community was at that time, they said: ‘well, if you have half an hour, we need six minutes really for crossing the Arabian Sea, and that is a cloud free region, why not then let the satellite henceforth work over the Arabian sea for six minutes every time [it] went [over].’<sup>613</sup>

Thus, a satellite that was not built and launched in order to take chlorophyll measurements in the Arabian Sea, was co-opted by oceanographers – already in the field – for their own observation purposes.

In the conclusion of my final chapter I suggested that ships, once the mobile laboratories of scientists temporarily entering the marine environment, should in our present time be considered more akin to “invisible technicians,” tending the non-ship based instrumentation used to generate scientific data. But, what happens in an increasingly “wired” ocean, where scientists have panoptic powers of observation? For one, the technological boundary between the natural and the unnatural world begins to blur. We see this already in the use of satellite tracked electronically tagged marine creatures. Marine animal tracking provides data about the creatures tagged, but *also* about

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<sup>613</sup> Interview with Dr. Karl Banse, University of Washington, 6 December 2012.

the environment the animals traverse.<sup>614</sup> As Jeffery Polovina, a NOAA marine biologist who studies loggerhead turtles, recently explained:

We look out on the ocean and see this homogenous expanse. But animals see it very differently, and that's why it's useful to send fleets of animals out with tags on them. By combining tag data with oceanographic data, we get to see how animals perceive the ocean, and that provides some amazing insights. [...] We tagged about 400 loggerheads, and we found that quite a number of them spend years [...] in the open ocean far from shore, migrating back and forth along a well-defined oceanographic front. That front separates a nutrient-rich mass of water to the north from nutrient-poor waters to the south, and the turtles were moving back and forth across that boundary. People had studied these regions before, but until the turtles showed us that it was important, no one had paid attention to the boundary between them, which stretches most of the way across the Pacific Ocean. So they showed us an important feature of the ocean that we didn't know was out there.<sup>615</sup>

And, while man-made technology is gradually being fused with nature for the improvement of remote sensing, better understanding of the marine environment is also shaping the development of technology used to probe the oceans, sometimes mimicking nature. One example is “Cyro,” a robotic jellyfish designed to imitate *Cyanea capillata*, commonly known as the “lion mane” jellyfish. This robot, created at Virginia Tech with funding provided by the Office of Naval Research and the Undersea Warfare Center, is projected by its designers as eventually being able to “patrol the oceans,” where it could

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<sup>614</sup> George Boehlert, et al., “Autonomous Pinniped Environmental Samplers: Using Instrumented Animals as Oceanographic Data Collectors,” *Journal of Atmospheric and Oceanic Technology*, Vol. 18, (2001), 1882 - 1893.

<sup>615</sup> Rich Press, “Satellite Tags Reveal How Animals See the Ocean: An interview with NOAA Fisheries scientists Jeffrey Polovina,” NOAA Fisheries, [Accessed online 3 October 2014]

[http://www.nmfs.noaa.gov/stories/2014/09/how\\_animals\\_see\\_the\\_ocean.html](http://www.nmfs.noaa.gov/stories/2014/09/how_animals_see_the_ocean.html)

then also study aquatic life, map ocean floors, and monitor ocean currents.<sup>616</sup> Naval funding, however, suggests alternative, more militaristic, purposes.

Without entering the realm of future speculation, however, we can explore the nature of the contemporary laboratory / field divide by asking what at first appears to be a very straightforward question: where does the data go? It turns out, that in contemporary oceanography (and indeed for many contemporary scientific disciplines), laboratory and field are joined by a third space, the Internet. There are numerous computer databases across the globe where oceanographic data is stored, depending on the type of information collected. In the United States, for instance, physical and chemical oceanographic data is stored by the National Oceanographic Data Center (NODC), a branch of the National Oceans and Atmospheric Association; in contrast, much of the genetic sequencing data collected at sea is deposited with the National Center for Biotechnology Information (NCBI), a branch of the National Institute of Health. At first glance, these databases – products of the computing revolution – appear to be the “centers of calculation” of the digital age.<sup>617</sup> But, unlike eighteenth-century centers of calculation, these databases have had the effect of making oceanographic data available to a much larger community of scientists, destabilizing oceanographers’ monopoly over oceanographic data.<sup>618</sup> Thus, the gulf between data producers and data users is ever

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<sup>616</sup> Alex A. Vallanueva, et. al., “Biomimetic autonomous robot inspired by the *Cynea capillata* (Cyro),” *Bioinspiration & Biomimetics*, Vol. 8, No. 4, (29 October 2013).

<sup>617</sup> Bruno Latour, *Science in Action: How to Follow Scientists and Engineers Through Society*, 220.

<sup>618</sup> This falls within what Erik Conway describes as “a significant unexamined development in the history of recent science.” Erik Conway, “Drowning in Data: Satellite Oceanography and Information Overload in the Earth Sciences,” *Historical Studies in the Physical and Biological Sciences*, Vol. 37, No. 1, (September 2006), 129.

widening.<sup>619</sup> In the world of contemporary oceanography, scientific analysis is no longer centralized in any single location. One can argue that databases are accumulators of data, but their locality is unimportant since they can be accessed from anywhere. This is what Michael Nielsen has referred to as “networked science,” signaling “the emergence of a new pattern of discovery.”<sup>620</sup>

The famous American oceanographer Henry Bigelow described oceanography in 1931 as a “mother science, the branches of which, though necessarily attacked by different disciplines, are intertwined too closely to be torn apart.” Furthermore, he said of future changes in oceanography that “to list all the problems that await the oceanographer will never be possible so long as science lives, for new ones will constantly unfold, as the boundaries of knowledge are rolled back.”<sup>621</sup> These statements remain true for the oceanographers of the present. As the technology of observation improves, the oceans, in their vast scale, will continue to confront oceanographers with new scientific problems. Exploration confronts the unknown, and much of the ocean depths are yet to be explored. We cannot foresee what discoveries will be made. However, as the oceans are complex dynamic systems, we can predict that they will remain terrains for interdisciplinary scientific study. Field oceanography is not about to end, at least not in the near future.

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<sup>619</sup> Ibid., 150. See also the discussion of data collection during the IGY in Jacob Hamblin, “Seeing the Oceans in the Shadow of Bergen Values,” *Isis*, Vol. 105, No. 2, (June 2014), 360 – 361. In the 1950s, American oceanographers were critical of Soviet oceanographers’ practice of publishing large data sets without analysis.

<sup>620</sup> Michael Nielsen, *Reinventing Discovery: The New Era of Networked Science*, (Princeton: Princeton University Press, 2012), 106.

<sup>621</sup> Henry Bigelow, *Oceanography: Its Scope, Problems, and Economic Importance*, (Boston: Houghton Mifflin Company, 1931), 4, 11.

## References cited:

- Adler, Antony, "A Letter From Japan: Internationalism and Pacific Oceanography," *Bulletin of the Pacific Circle*, (April 2014), 3 – 6.
- Adler, Antony, "From the Pacific to the Patent Office: The U.S. Exploring Expedition and the Origins of America's First National Museum," *The Journal of the History of Collections*, Vol. 23, No.1, (2011), 49 – 74.
- Alaimo, Stacy, "Feminist Science Studies and Ecocriticism: Aesthetics and Entanglement in the Deep Sea," *The Oxford Handbook of Ecocriticism*, ed. Greg Garrard, (Oxford: Oxford University Press, 2014), 188 – 204.
- Alexander, Jennifer Karns, *The Mantra of Efficiency: From the Waterwheel to Social Control*, (Baltimore: Johns Hopkins University Press, 2008).
- Allard, Dean C., "The Origins and Early History of the Steamer Albatross, 1880 – 1887," *Marine Fisheries Review*, Vol. 61, No. 4, (1999), 1 – 21.
- Allen, G. E., "Pan-Pacific Scientific Research Work," *Pan-Pacific Union Bulletin*, No. 61 (November 1924), 3 – 4.
- Anspacher, Carolyn, "Pacific House Popular," *San Francisco Chronicle, Exposition Extra*, (20 February 1939).
- Armytage, W.H.G., "The Jardin du Roi: Seedbed Of Science," *The British Medical Journal*, Vol. 2, No. 5207, (22 Oct. 1960).
- Audouin, Jean Victor, and Milne – Edwards, Henri, "Résumé des recherches sur les animaux sans vertèbres, faites aux îles Chausey," *Annales des Sciences Naturelles*, Vol 15, (September 1828), 5 – 19.
- Babin, Gustave, "Le peintre de la vie sous-marine M. Mathurin Méheut," *L'Illustration*, (20 December 1913), 506 – 511.
- Ballard, Robert, *The Eternal Darkness: A Personal History of Deep-Sea Exploration*, (Princeton: Princeton University Press, 2000).
- Balzac, Honoré de, *Z. Marcas*, (1840). E-book, Trans. by Clara Bell. [Accessed online, 4 November 2014.] <http://www.gutenberg.org/files/1841/1841-h/1841-h.htm>
- Barga, Roger, and Delaney, John, "A 2020 Vision for Ocean Science," *The Fourth Paradigm: Data-Intensive Scientific Discovery*, eds. Tony Hey, Stewart Tansley, and Kristin Tolle, (Seattle: Microsoft Research, 2009).

- Barriety, Louis, "Océanographie du golfe de Gascogne: un précurseur: le marquis Léopold de Folin," *Comptes rendus du 94e congrès national des sociétés savants*, Vol. 1, (Paris: Bibliothèque Nationale, 1969), 131 – 140.
- Battaglia, Pietro, Ammendolia, Giovanni, Romeo, Teresa, and Andaloro, Franco, "Finding of *Eretmophorus kleinenbergi* (Moridae) in the central Mediterranean Sea 93 years after its previous record, with a first description of sagittae and fresh coloration," *Marine Biodiversity Records*, Vol. 5, (2012).
- Baulny, Olivier, "L'Oeuvre Américaine d'Alcide Dorbigny," *Cahiers des Amériques Latines*, No. 5, (1970).
- Beaglehole, J. C., *The Life of Captain James Cook*, (Palo Alto: Stanford University Press, 1974).
- Beneden, Édouard van, "Compte rendu sommaire des recherches entreprises à la Station biologique d'Ostende pendant les mois d'été 1883," *Bulletins de l'Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique*, Vol. 7, (Bruxelles, 1883), 458 – 483.
- Benson, Keith, "Summer Camp, Seaside Station, and Marine Laboratory: Marine Biology and its Institutional Identity," *Historical Studies in the Physical and Biological Sciences*, Vol. 32, No. 1, [Second Laboratory History Conference], (2001).
- Benson, Keith, Rozwadowski, Helen, and van Keuren, David K., "Introduction," *The Machine in Neptune's Garden: Historical Perspectives on Technology and the Marine Environment*, ed. Helen Rozwadowski and David K. van Keuren, (Sagamore Beach, MA: Watson Publishing International, 2004).
- Bernard, Augustin, "Océanographie. Généralités," *Annales de Géographie*, Vol. 1, Issue 2, (1892), 199 – 217.
- Biello, David, "Pacific Ocean Hacker Speaks Out: Is Russ George a 'rogue geoengineer,' salmon savior or something else?" *Scientific American*, (24 October 2012).
- Bigelow, Henry, *Oceanography: Its Scope, Problems, and Economic Importance*, (Boston: Houghton Mifflin Company, 1931).
- Bissell, John H., "The Canadian and American Fisheries of the Great Lakes," *Biennial Report of the State Board of Fish Commissioners*, Vol. 8, (Lansing: Darius D. Thorp, State Printer and Binder, 1888).
- Black, Richard, "Natural Lab Shows Sea's Acid Path," *BBC News*, (8 June 2008). [Accessed online 23 September 2014].  
<http://news.bbc.co.uk/2/hi/science/nature/7437862.stm>

- Boehlert, George W., et al., “Autonomous Pinniped Environmental Samplers: Using Instrumented Animals as Oceanographic Data Collectors,” *Journal of Atmospheric and Oceanic Technology*, Vol. 18, (2001), 1882 – 1893.
- Boitard, Pierre, and Janin, Jules, *Le Jardin des Plantes*, (Paris: J.J. DuRochet et Editeurs, 1842).
- Bolster, Jeffrey, *The Mortal Sea: Fishing the Atlantic in the Age of Sail*, (Cambridge: Harvard University Press, 2012).
- Bonneuil, Christophe, “Le Muséum National d’Histoire Naturelle et l’Expansion Coloniale de la Troisième République (1870-1914),” *Revue Française d’Histoire d’Outre-mer*, Vol. 86, No. 322 – 323, (1999), 143 – 169.
- Bonneuil, Christophe, “The Manufacture of Species: Kew Gardens, the Empire, and the Standardization of Taxonomic Practices in Late Nineteenth-Century Botany,” *Instruments, Travel, and Science: Itineraries of Precision from the Seventeenth to the twentieth Century*, ed. Marie-Noëlle Bourguet, Christian Licoppe and H. Otto Sibum, (New York: Routledge, 2002).
- Bont, Raf de, “Between the Laboratory and the Deep Blue Sea: Space Issues in the Marine Stations of Naples and Wimereux,” *Social Studies of Science*, Vol. 39, No. 2 (April 2009).
- Bourdon, Isidore, *Illustres Médecins et Naturalistes des Temps Modernes*, (Paris: Comptoir des Imprimeurs-Unis, 1844).
- Bourée, Henry, *L’océanographie vulgarisée: de la surface aux abîmes*, (Paris: Librairie Ch. Delagrave, 1912).
- Boutan, Louis, *La photographie sous-marine et les progrès de la photographie*, (Paris: Librairie C. Reinwald, 1900).
- Boutan, Louis, *La photographie sous-marine et les progrès de la photographie*, (Paris: Librairie C. Reinwald, 1900).
- Boyd, Philip, et al., “A mesoscale phytoplankton bloom in the polar Southern Ocean stimulated by iron fertilization,” *Nature*, Vol. 407, (12 October 2000), 695 – 702.
- Boyle, Robert, *Relations About the Bottom of the Sea*, (1672).
- Brøgger, Waldemar Christopher, and Rolfsen, Nordahl, *Fridtjof Nansen, 1861 – 1893*, trans. by William Archer, (London: Longmans, Green, and Co., 1896).

- Bryan, William Alanson, "The Pacific Scientific Institution: An Address by William Alanson Bryan," *Pacific Institution Publications*, Special Series, No. 2, (Chicago: 1908).
- Buckland, Frank, *The Natural History of British Fishes; Their Structure, Economic Uses, and Capture by Net and Rod*, (London: The Gresham Press, 1881).
- Burgess, Geoffrey, "Frank Buckland and the Buckland Foundation," *British Marine Science and Meteorology: The History of their Development and Application to Marine Fishing Problems, Buckland Occasional Papers: No 2*, (1996).
- Burgess, Geoffrey, *The Eccentric Ark: The Curious World of Frank Buckland*, (New York: The Horizon Press, 1967).
- Burkhardt, Richard Jr., "Naturalists' Practices and Nature's Empire," *Pacific Science*, No. 4, Vol. 55, (2001), 327 – 341.
- Bush, Vannevar, *Science the Endless Frontier: A Report to the President*, (Washington D.C.: National Science Foundation, 1990). [First published July 1945].
- Caird, James, Huxley, Thomas Henry, and Lefevre, George Shaw, "Sea Fisheries. Report of the Commissioners appointed to inquire into the Sea Fisheries of the United Kingdom," *Annals of British Legislation: Being a Digest of the Parliamentary Blue Books*, ed. Leone Levi, Vol. 3, (London: Smith, Elder and Co., 1866), 184 – 214.
- Callon, Michel, "Some Elements of a Sociology of Translation: Domestication of the Scallops and the Fishermen of St. Briec Bay," *The Science Studies Reader*, ed. Mario Biagioli, (New York: Routledge, 1999), 67 – 83.
- Campino, Gualtiero, "The Paradox of Monaco. How Late Prince Had Fairly to Force Constitution on His Reluctant People," *The New York Times*, (2 July 1922).
- Carpenter, Patricia F., and Totah, Pail, *The San Francisco Fair: Treasure Island 1939 – 1940*, eds. Patricia F. Carpenter and Pail Totah, (San Francisco: Scottwall Associates, 1989).
- Carpine-Lancre, Jacqueline, "'...une trace de mes anciens sillage.' Albert Ier de Monaco et la mer," *Monaco port des Princes*, ed. by André Z. Labarrère, (Monaco: Yacht Club de Monaco, 1996), 44 – 71.
- Carpine-Lancre, Jacqueline, *Albert Ier Prince de Monaco: des oeuvres de science, de lumière et de paix*, (Monaco: Palais de S. A. S. Le Prince, 1998).

- Carpine-Lancre, Jacqueline, "Honorer la science: Le Prince Albert Ier de Monaco, le Muséum de Paris et Lamark," *Bulletin du Musée Anthropologique et Préhistorique de Monaco*, No. 51, (2011), 155 – 172.
- Carpine-Lancre, Jacqueline, "La première campagne océanographique du Prince Albert de Monaco (juillet – août 1885)," *Acta geographica*, 3<sup>rd</sup> Series, No. 63, (1985), 1 – 12.
- Carpine-Lancre, Jacqueline, "Le Prince Albert Ier de Monaco et la Science," *Archives de l'Institut de Paléontologie Humaine, Mémoire*, Vol. 39, (2008), 13 – 26.
- Carpine-Lancre, Jacqueline, "Les Expéditions Océanographiques Françaises du XIXe Siècle," *Actes du XIIIe Congrès International d'Histoires des Sciences, Paris, 1968*, (Paris: Librairie Scientifique et Technique Albert Blanchard, 1971), 61 – 65.
- Carpine-Lancre, Jacqueline, "Prince, océanographe et 'cinématographe': Albert Ier de Monaco," *1895*, No. 18, (September 1995), 84 – 95.
- Carpine-Lancre, Jacqueline, "The Origin and Early History of 'La Carte Générale Bathymétrique des Océans,'" *The History of GEBCO 1903 – 2003*, (Netherlands: Lemmer, 2003).
- Carpine-Lancre, Jacqueline, "The Plan for an International Oceanographic Congress," *Oceanography: The Past*, eds. M. Sears and D. Merriman, (New York: Springer-Verlag, 1980), 157 – 167.
- Carpine-Lancre, Jacqueline, *Albert I Prince of Monaco (1848 - 1922)*, (Monaco: Editions EGC, 1998).
- Carpine-Lancre, Jacqueline, *Albert I<sup>er</sup>, Prince de Monaco. Des oeuvres de science, de lumière et de paix. 150<sup>e</sup> Anniversaire de sa Naissance*, (Monaco, Palais de SAS le Prince, 1998).
- Carpine-Lancre, Jacqueline, and Barr, William, "The Arctic cruises of Prince Albert I of Monaco," *Polar Record*, Vol. 44, Issue 1, (January 2008), 1 – 14.
- Carpine-Lancre, Jacqueline, and Fouilleron, Thomas. Speech delivered by and on the occasion of the centenary of the Oceanographic Institute, 21 June 2011. [Private communication, Jacqueline Carpine-Lancre].
- Carpine-Lancre, Jacqueline, and McConnell, Anita, "Prince Albert and J. Y. Buchanan: Mediterranean Investigations," *History of Oceanography*, No. 22, (January 2011), 24 – 31.

- Carpine-Lancre, Jacqueline, and Mills, Eric, “The Oceanographic Museum of Monaco,” *Ocean Frontiers, Explorations by Oceanographers on Five Continents*, ed. E. M. Borgese, (New York: H. N. Abrams, 1992), 120 – 135.
- Carpine, Christian, “Les navires océanographiques dont les noms ont été choisis par S.A.S. le Prince Albert 1<sup>er</sup> pour figurer sur la façade du Musée océanographique de Monaco,” *Bull. Inst. océanogr. Monaco*, No. 2 (Congr. Int. Hist. Océanogr. 1, 1968), 627 – 638.
- Carpine, Christian, *La pratique de l’océanographie au temps du Prince Albert Ier*, (Monaco: Musée Océanographique, 2002).
- Cary, R. W., *The Naval History of Treasure Island*, (Treasure Island, California: U.S. Naval Training and Distribution Center, 1946).
- Chamisso, Adelbert Von, *A Voyage Around the World with the Romanzov Exploring Expedition in the Years 1815 – 1818 in the Brig Rurik, Captain Otto Kotzebue*, trans. and ed. Henry Kratz, (Honolulu: University of Hawaii Press, 1986).
- Chaplin, Joyce E., “Knowing the Ocean: Benjamin Franklin and the Circulation of Atlantic Knowledge,” *Science and Empire in the Atlantic World*, ed. James Delbourgo and Nicholas Dew, (New York: Routledge, 2008), 73 – 96.
- Charnock, H., “H.M.S. Challenger and the Development of Marine Science,” *The Journal of Navigation*, Vol. 26, No. 1, (1973), 1 – 12.
- Clarke, Arthur C., *The Deep Range*, (New York: Bantam Books, 1957).
- Clausen, Roy Elwood, “The Sixth Pacific Science Congress,” *Science*, Vol. 90, No. 2342, (17 November 1939), 449 – 456.
- Cligny, Adolphe, “L’océanographie et les pêches maritimes,” *La Revue du Mois*, Vol. 2, (1906), 208 – 230.
- Collini, Silvia, *Les instructions scientifiques pour les voyageurs: XVIIe-XIXe siècle*, (Paris: l’Harmattan, 2005).
- Collins, John, Detrick Robert, and Frye, Daniel, “Seafloor to Surface Satellite to Shore: Moored Buoys Offer Potential for Continuous, Real-time Observations Anywhere in the Ocean,” *Oceanus Magazine*, Vol. 42, No. 1, (2000).
- Conway, Erik, “Drowning in Data: Satellite Oceanography and Information Overload in the Earth Sciences,” *Historical Studies in the Physical and Biological Sciences*, Vol. 37, No. 1, (September 2006), 127 – 151.

- Cook, James, “The Method Taken for Preserving the Health of the Crew of His Majesty’s Ship the Resolution During Her Late Voyage Round the World,” *Philosophical Transactions of the Royal Society of London*, (1776), 402 – 406.
- Coste, Victor, “De l’observation et de l’expérience en physiologie,” *Journal de l’anatomie et de la physiologie normales et Pathologiques de l’homme et des animaux*, Vol. 6, (1869), 650 – 660.
- Coste, Victor, “Pisciculture – L’établissement de concarneau,” *Magasin Pittoresque*, Vol. 37, (1869).
- Coste, Victor, “Rapport a sa majesté l’empereur sur les huitrières artificielles créées dans la baie de Saint-Brieuc,” *Voyage d’exploration sur les côtes de France et d’Italie*, (Paris: Imprimerie Impériale, 1855).
- Coste, Victor, *Voyage d’exploration sur les côtes de France et d’Italie*, (Paris: Imprimerie Impériale, 1861).
- Crosland, Maurice, *Science Under Control: The French Academy of Sciences 1785 – 1914*, (New York: Cambridge University Press, 1992).
- Cunliffe-Owen, F., “Prince of Monaco the First Reigning Sovereign of Europe to Visit the United States,” *The Sun*, (10 August 1913).
- Daly, R. A., “Problems of the Pacific Islands,” *The American Journal of Science*, Vol. 41, (February 1916), 153 – 186.
- Darwin, Charles, *The Beagle Letters*, ed. Frederick Burkhardt, (Cambridge: Cambridge University Press, 2008).
- Darwin, Charles, *The Life and Letters of Charles Darwin Including an Autobiographical Chapter*, ed. Francis Darwin, Vol. 3, (London: John Murray, 1887).
- Daubenton, Louis Jean-Marie, ““Sur les Voyages et les Theories des Naturalistes,’ Quinzieme Séance (2 Ventose) Histoire Nature,” *Séances Des Écoles Normales, Recueillies par des Stenographes, et Revues par les Professeurs. Nouvelles Edition*, Vol. 2, (Paris: A L’imprimerie du Cercle-Social, 1800).
- Davies, William Lewis, *Wolf-Hunting and Wild Sport in Lower Brittany*, (London: Chapman and Hall, 1875).
- Day, Deborah, and Mills, Eric, “Charles Atwood Kofoid and the Biological Stations of Europe,” *Places, People, Tools: Oceanography in the Mediterranean and Beyond. Proceedings of the Eight International Congress for the History of Oceanography*, (Naples: Stazione Zoologica Anton Dohrn, 2013).

- Deacon, Margaret, *Scientists and the Sea 1650 – 1900: A Study of Marine Science*, (London Ashgate Publishing, Ltd., 1997).
- Debaz, Josquin, “Une histoire de la station de biology marine de Roscoff (1872 – 1914),” [unpublished manuscript].
- Debaz, Josquin, *Les stations françaises de biologie marine et leurs périodiques entre 1872 et 1914*, [Doctoral Thesis], École des Hautes Études en Sciences Sociales, Centre Alexandre Koyré, (7 July 2005).
- Dehérain, Pierre Paul, “Bulletin du Muséum d’Histoire Naturelle” *La Nature: Revue des Sciences et de Leurs Applications Aux Arts et a l’Industrie, Journal Hebdomadaire Illustré*, ed. Gaston Tissandier, Vol. 23, (Paris: Libraire de l’Académie de Médecine, 1895).
- Delbourgo, James and Dew, Nicholas, “Introduction: The Far Side of the Ocean,” *Science and Empire in the Atlantic World*, eds. James Delbourgo and Nicholas Dew (New York: Routledge, 2008).
- Delisle, Fernand, “L’Enseignement Spécial pour les Voyageurs organisé par le Muséum,” *Association Française pour l’Avancement des Sciences Fusionnée avec l’Association Scientifique de France Compte Rendu de la 22e Session, Second Partie Notes et Extraits*, (Paris: Au Secrétariat de L’Association, 1894).
- Di Gregorio, Mario A. *From Here to Eternity: Ernst Haeckel and Scientific Faith*, (Göttingen: Vandenhoeck & Ruprecht, 2005).
- Dorhn, Anton, “The Zoological Station at Naples,” *Nature*, Vol. 43, (19 March 1891), 465 – 466.
- Droessler, Earl, “Interview with Dr. Roger Revelle, La Jolla, CA, 3 February 1989,” *American Institute of Physics*. [Accessed online 11 November 2014], <http://www.aip.org/history/ohilist/5051.html>.
- Dubois, Xavier, *La révolution sardinière: pêcheurs et conserveurs en Bretagne Sud au XIXe siècle*, (Rennes: Presses universitaires de Rennes, 2004).
- Dücker, Erik, *News From an Inaccessible World: The History and Present Challenges of Deep-sea Biology*, Doctoral Dissertation Radboud University, NL, (2014).
- Dupin, Le Baron Charles, *Forces Productives et Commerciales de la France*, Vol 1, No. 55, (Paris: Bachelier, Libraire, Successeur de Mme V. Courcier, Quai des Augustins, 1827).
- Edwards, Charles Lincoln, “The Zoological Station at Naples,” *The Popular Science Monthly*, Vol. 77, (September 1910), 209 – 225.

- Ehrenberg, R. E., Wolter, J. A., and Burroughs, C. A., "Surveying and Charting the Pacific Basin," *Magnificent Voyagers: U.S. Exploring Expedition, 1838 – 1842*, ed. Herman J. Viola and Carolyn Margolis, (Washington D.C.: Smithsonian Institution Press, 1985), 164 – 187.
- Eigan, Edward, "The Place of Distribution: Episodes in the Architecture of Experiment," *Architecture and the Sciences: Exchanging Metaphors*, eds. Antoine Picon and Alessandra Ponte, (Princeton: Princeton Architectural Press, 2003).
- Eigen, Edward A., *Between Stations and Habitations: The Architecture of French Science at the Shore, 1830 – 1900*, [Doctoral Dissertation], MIT Department of Architecture, (2000).
- Elkin, A. P., "Pacific Science Association: It's History and Role in International Cooperation," *Bernice P. Bishop Museum Special Publication No. 48*, (Hawaii: Bishop Museum Press, 1961).
- Ellis, Erik, "Dixy Lee Ray, Marine Biology, and Public Understanding of Science in the United States (1930 – 1970)," Doctoral Dissertation, (Oregon State University, 2005).
- Eyriès, Jean Baptiste Benoît, *Nouvelles Annales Des Voyages, de la Geographie et de L'Histoire*, Vol. 5, (Paris: Librairie de Fide Fils, 1820).
- Faideau, Ferdinand, "Le prince Albert de Monaco," *La Science Illustrée*, Vol. 17, No. 424, (1896).
- Faideau, Ferdinand, "Le Yacht 'Princess Alice,'" *La Science Illustrée*, Vol. 17, No. 434, (1896).
- Fallows, E. Huntington, "Fisheries," *The New Werner Twentieth Century Edition of the Encyclopaedia Britannica*, (Akron, OH: The Werner Company, 1907).
- Farber, Paul, *Finding Order in Nature: The Naturalist Tradition from Linnaeus to E. O. Wilson*, (Baltimore: Johns Hopkins University Press, 2000).
- Filhol, H., *Conseils aux Voyageurs Naturalistes: publication consécutive aux leçons Faites au Muséum d'Histoire Naturelle en 1893*, (Paris: Imprimerie Nationale, 1893).
- Findlay, John, *Magic Lands: Western Cityscapes an American Culture After 1940*, (Berkeley: University of California Press, 1992).

- Fisher, Jean Louis, “L’aspect social et politique des relations épistolaires entre quelques savants français et la Station zoologique de Naples de 1878 à 1912,” *Revue d’histoire des sciences*, Tome 33, No. 3, (1980), 225 – 251.
- Fleming, James, *Fixing the Sky: The Checkered History of Weather and Climate Control*, (New York: Columbia University Press, 2010).
- Fleming, James, *Meteorology in America, 1800 – 1870*, (Baltimore: Johns Hopkins University Press, 1990).
- Fleming, John, “Forward,” *The Last Cruise of the Carnegie*, J. Harland Paul, (Baltimore: The Williams & Wilkins Company, 1932).
- Folin, Léopold, *Sous les Mers: Compagnes d’Explorations du ‘Travailleur’ et du ‘Talisman,’* (Paris: Librairie J. B. Baillière et Fils, 1887).
- Forbes, Edward, *The Natural History of the European Seas*, (London: John Van Voorst, Paternoster Row, 1859).
- Forster, Johann Reinhold, *Observations Made During a Voyage Round the World*, eds. Nicholas Thomas, Harriet Guest, and Michael Dettelbach, (Honolulu: University of Hawaii Press, 1996).
- Fountain, Henry, “A Rogue Climate Experiment Outrages Scientists,” *New York Times*, (18 October 2012).
- Fraser, Charles McLean, “Oceanography: Marine Zoology,” *The Scientific Monthly*, Vol. 44, No. 1, (January 1937), 62 – 66.
- Freidel, Frank, *Franklin D. Roosevelt: The Apprenticeship*, (Boston: Little, Brown and Company, 1952).
- Fricke, Robert, “Down to the Sea in Robots,” *Technology Review*, Vol. 97, No. 7, (1994).
- Fuchs, Eckhardt, “The Politics of the Republic of Learning: Internationalism Scientific Congresses in Europe, the Pacific Rim, and Latin America,” *Across Cultural Borders: Historiography in Global Perspective*, eds. Eckhardt Fuchs and Benedikt Stuchtey, (Maryland: Rowman & Littlefield Publishers Inc., 2002), 205 – 244.
- Galison, Peter, *Einstein’s Clocks, Poincaré’s Maps: Empires of Time*, (New York: W. W. Norton & Company, 2003).
- Gillispie, Charles Couston, *Science and Polity in France: The End of the Old Regime*, (Princeton: Princeton University Press, 2004).

- Girard, Jules, “L’océanographie à l’Exposition maritime de Bordeaux,” *La Géographie: Bulletin de la Société de Géographie*, Vol. 16, (1907), 111 – 113.
- Glémarec, Michel, *Qu’est-ce que la biologie marine? De la biologie marine à l’océanographie biologique*, (Paris: Vuibert, 2010).
- Goetzmann, William, *Exploration and Empire: The Explorer and the Scientist in the Winning of the American West*, (New York: Viking Press, 1986).
- Green, W. S., “The Sea Fisheries of Ireland,” *Ireland: Industrial and Agricultural*, (Dublin: Browne and Nolan, Limited, 1902).
- Greene, Mott, “Oceanography’s Double Life,” *Earth Sciences History*, Vol. 12, No. 1, (1993), 48 – 53.
- Gregory, Herbert H., “Address,” *Fifth Pacific Science Congress Proceedings*, Vol. 1, (Vancouver: Pacific Science Association, 1933), 130 – 132.
- Grimaldi, Albert, “A New Ship for the Study of the Sea,” *Proceedings of the Royal Society of Edinburgh*, Vol. 18, (November 1890 to July 1891), 295 – 302.
- Grimaldi, Albert, “Croisière dans les régions arctiques,” *La Grande Revue*, Vol. 14, (1900).
- Grimaldi, Albert, “Discours à l’Assemblée générale de la Société des amis du Muséum d’histoire naturelle,” *Journal de Monaco*, Vol. 56, No. 2881, (1913).
- Grimaldi, Albert, “Discours à l’inauguration de l’Institut de paléontologie humaine,” *Journal de Monaco*, Vol. 63, No. 3283, (1920).
- Grimaldi, Albert, “Discours de S.A.S. le Prince de Monaco,” *Discours prononcés à l’occasion des fêtes d’inauguration du Musée océanographique de Monaco, 29 mars 1910*, (Paris: Imprimerie Draegar, 1910), 5 – 11.
- Grimaldi, Albert, *La carrière d’un navigateur*, [2<sup>nd</sup> edition], (Monaco: Imprimerie de Monaco, 1905).
- Groeben, Christiane, “Tourists in Science: 19<sup>th</sup> Century Research Trips to the Mediterranean,” *Proceedings of the California Academy of Sciences – Fourth Series*, Vol. 59, Supplement I, No. 9, (September 2008), 139 – 154.
- Groeben, Christiane, ed., *Charles Darwin 1809 – 1882, Anton Dohrn 1840 – 1909: Correspondence*, (Naples: Naples Zoological Station, 1982), 26.
- Groeben, Christiane, ed., *Correspondence: Karl Ernst von Baer – Anton Dohrn*, (Philadelphia: The American Philosophical Society, 1993).

- Gulliver, Katrina, "Finding the Pacific World," *Journal of World History*, Vol. 22, No. 1, (March 2011), 83 – 100.
- Hamblin, Jacob Darwin, *Oceanographers and the Cold War: Disciples of Marine Science* (Seattle: University of Washington Press, 2005).
- Hamblin, Jacob, "Seeing the Oceans in the Shadow of Bergen Values," *Isis*, Vol. 105, No. 2, (June 2014), 352 – 363.
- Hamy Ernest, *Bulletin de la Société d'Anthropologie de Paris, 3ème série*, Vol. 5, (1882).
- Hannaway, Owen, "Laboratory Design and the Aim of Science: Andreas Libavius versus Tycho Brahe," *Isis*, Vol. 77, No. 4, (December 1986), 585 – 610.
- Harmer, Sidney F., "On the Embryology of the Ectoprocta," *Studies from the Morphological Laboratory in the University of Cambridge*, Vol. 5, (London: C. J. Clay and Sons, Cambridge University Press, 1892), 1 – 15.
- Harrabin, Roger, "'Coral lab' Offers Acidity Insight," *BBC News*, (11 March 2009). [Accessed online 23 September 2014].  
<http://news.bbc.co.uk/2/hi/science/nature/7936137.stm>.
- Harrabin, Roger, "How Climate Change Will Acidify the Oceans," *BBC News*, (26 March 2014). [Access online 23 September 2014].  
<http://www.bbc.com/news/magazine-26746039>.
- Harvey, W. H., *The Sea-Side Book: Being an Introduction to the Natural History of the British Coasts*, (London: John Van Voorst, Paternoster Row, 1849).
- Headrick, Daniel R., *The Tools of Empire: Technology and European Imperialism in the Nineteenth Century* (New York: Oxford University Press, 1981).
- Heggie, Vanessa, "Why Isn't Exploration a Science?" *Isis*, Vol. 105, No. 2, (June 2014), 319.
- Heidbrink, Ingo, "Creating a Demand: The Marketing Activities of the German Fishing Industry, c. 1880 – 1990," *The North Atlantic Fisheries: Supply, Marketing, and Consumption, 1560 – 1990*, eds. David Starkey and James Candow, (Hull, UK: North Atlantic Fisheries History Association, 2006).
- Helmreich, Stefan, *Alien Ocean: Anthropological Voyages in Microbial Seas*, (Berkeley: University of California Press, 2009).
- Henry Stommel, "Statement about Priorities for Greenhouse Research," [Unpublished editorial written in 1990], *Collected Works of Henry Stommel*, eds. Nelson G.

- Hogg and Rui Xin Huang, Vol. 1, (Boston: American Meteorological Society, 1995), I-221 – I-223.
- Henson, Pamela M., “The Smithsonian Goes to War: the Increase and Diffusion of Scientific Knowledge in the Pacific,” *Science and the Pacific War: Science and Survival in the Pacific, 1939 – 1945*, ed. Roy Macleod, (Dordrecht: Kluwer Academic Publishers, 2000), 27 – 50.
- Herdman, William A., *Founders of Oceanography and Their Work: An Introduction to the Science of the Sea*, (London: Edward Arnold & Co., 1923).
- Heuss, Theodor, *Anton Dohrn: A Life for Science*, trans. by Liselotte Dieckman, (Berlin: Springer-Verlag, 1991).
- Hilprecht, Hermann Vollrat, *Explorations in Bible Lands During the 19<sup>th</sup> Century*, (Philadelphia: A. J. Holman and Company, 1903).
- Hjort, Johan, and Murray, John, *The Depths of the Ocean: A General Account of the Modern Science of Oceanography Based Largely on the Scientific Researches of the Norwegian Steamer Michael Sars in the North Atlantic*, (London: Macmillan and Co., 1912).
- Hooker, Joseph D., “Address of the President – Anniversary Meeting,” *Proceedings of the Royal Society of London*, Vol. 25, No. 175, (1876), 339 – 362.
- Howard, Rio, “The Founding of the Jardin des Plantes in Paris,” *Proceedings of the 2<sup>nd</sup> meeting of the Western Society for French History*, Nov 21 – 23, (1974).
- Howe, Joshua, *Behind the Curve: Science and the Politics of Global Warming*, (Seattle: University of Washington Press, 2014).
- Hubbard, Jennifer, *A Science on the Scales: The Rise of Canadian Atlantic Fisheries Biology, 1898 -1939*, (Toronto: University of Toronto Press, 2006).
- Huxley, Thomas Henry, “Inaugural Address, Fisheries Exposition, London (1883),” *The Fisheries Exhibition Literature (1885), Scientific Memoirs V*. [Accessed online] <http://aleph0.clarku.edu/huxley/SM5/fish.html>.
- Huxley, Thomas Henry, “Science at Sea,” *Westminster Review*, Vol. 5, (January 1854).
- Ibáñez, Vicente Blasco, *Mare Nostrum*, Trans. by Charlotte Brewster Jordan, (New York: A. L. Burt Company, 1919).
- Ibáñez, Vicente Blasco, *The Enemies of Women*, Trans. Irving Brown, (New York: E. P. Dutton & Co, 1918).

- Inizan, Christelle , “L’institut océanographique de Paris,” *In Situ*, (23 November 2011). [Accessed online 23 July 2014]. <http://insitu.revues.org/865#text>.
- Jack, Homer A., “Biological Field Stations of the World,” *Chronica Botanica*, Vol. 9, No. 1, (Waltham, Mass.: Chronica Botanica, 1945).
- James, Jack, and Weller, Earle, *Treasure Island, “The Magic City,” 1939 – 1940. The Story of the Golden Gate International Exposition*, (San Francisco: Pisani Printing and Publishing Company, 1941).
- Jardine, Nicholas, *Cultures of Natural History*, (Cambridge: Cambridge University Press, 1996).
- Johnstone, Kenneth, *The Aquatic Explorers: A History of the Fisheries Research Board of Canada*, (Toronto: University of Toronto Press, 1977).
- Jonas, Ray, *Industry and Politics in Rural France: Peasants of the Isère 1870 – 1914*, (Ithaca: Cornell University Press, 1994).
- Joubin, Louis, “Discours de M. Louis Joubin,” *Travaux de la Station Biologique de Roscoff*, 5 (Paris: Les Presses Universitaires de France, 1926), 1 – 30.
- Joubin, Louis, “Le Laboratoire Zoologique de Roscoff,” *La Nature*, No. 601, (1885), 344 – 347.
- Joubin, Louis, “The Deep Sea Explorations of the Prince of Monaco,” *The International Quarterly*, Vol. 10, (1905), 374 – 390.
- Jullien, Marc-Antoine, Jullien, Auguste, and Carnot, Hippolyte, *Revue Encyclopédique, ou Analyse Raisonnée des Productions les Plus Remarquables dans la Littérature, les Sciences et les Arts, par une Réunion de Membres de l’Institut, et d’Autres Hommes de Lettres*, Vol. 2, (Paris: Au Bureau de la Revue Encyclopédique, chez Baudouin Frères, 1819).
- Keith, David W., “Geoengineering the Climate: History and Prospect,” *Annual Review of Energy and the Environment*, Vol. 25, (2000), 245 – 284.
- Kingsland, Sharon E., “The Role of Place in the History of Ecology,” *The Ecology of Place: Contributions of Place-Based Research to Ecological Understanding*, eds. Ian Billick and Mary V. Price, (Chicago: University of Chicago Press, 2010).
- Kingston, Ralph, “A Not So Pacific Voyage: The ‘Floating Laboratory’ of Nicholas Baudin,” *Endeavour*, Vol. 31, No. 4, (2007), 145 – 151.
- Knappen, Theodore M., “The Sinews of War: California Fish Industry Has Been Stimulated to Undreamed-Of Proportions,” *New York Tribune*, (10 August 1917).

- Koerner, Lisbet, "Carl Linneaus in His Time and Place," *Cultures of Natural History*, eds. Nicholas Jardine, James Secord, and Emma Spary, (Cambridge: Cambridge University Press).
- Kofoed, Charles, "The Biological Stations of Europe," *Bulletin of the United States Bureau of Education*, No. 4, (1910).
- Kohler, Robert E, and Kuklick, Henrika, eds. "Science in the Field," *Osiris*, Vol. 11, (1996).
- Kohler, Robert, "History of Field Science: Trends and Prospects," *Knowing Global Environments: New Historical Perspectives on the Field Sciences*, ed. Jeremy Vetter, (New Brunswick: Rutgers University Press, 2011), 212 – 240.
- Kohler, Robert, "Place and Practice in Field Biology," *History of Science*, Vol. 40, (2002), 189 – 210.
- Kohler, Robert, *Landscapes and Labscapes: Exploring the Lab-field Border in Biology*, (Chicago: University of Chicago Press, 2002).
- Kuisel, Richard F., *Capitalism and the State in Modern France: Renovation and economic Management in the Twentieth Century*, (Cambridge: Cambridge University Press, 1981).
- Kunzig, Robert, *Mapping the Deep: the Extraordinary Story of Ocean Science*, (New York: Norton, 2000).
- Kury, Lorelay, *Civiliser la Nature: Histoire Naturelle et Voyage (France, fin du XVIIIe siècle – début du XIXe siècle)* [doctoral thesis], École des Hautes Études en Sciences Sociales, (1995).
- Lacaze-Duthiers, Henri, "A propos de la station des choetoptères et des myxicoles sur les plages de Roscoff et de Saint-Pol-De-Léon, cotes de Bretagne (finistère)," *Archives de Zoologie Expérimentale et Générale: Notes et Revue*, Vol. 1, (1872), xvii – xxiv.
- Lacaze-Duthiers, Henri, "Avertissement," *Archives de zoologie expérimentale et générale*, Vol. 1, (1872).
- Lacaze-Duthiers, Henri, "Le monde de la mer et ses laboratoires," *Revue Scientifique*, Vol. 42, No. 6, Series 3, (11 August 1888), 162 – 173.
- Lacaze-Duthiers, Henri, "Les Laboratoires de Roscoff et de Banyuls," *Revue Scientifique*, Quatrième Série, Vol. 3, (Paris: Bureau des Revues, 1895).

- Lacaze-Duthiers, Henri, “Les Laboratoires Maritimes de Roscoff et de Banyuls en 1891,” *Archives de Zoologie Expérimentale et Générale*, Series 2, Vol. 9, (1891), 255 – 363.
- Lacaze-Duthiers, Henri, “Les progrès de la station zoologique de Roscoff et la création du laboratoire Arago à Banyuls-sur-mer,” *Archives de Zoologie Expérimentale et Générale*, Vol. 9, (1881), 543 – 598.
- Lacaze-Duthiers, Henri, “A propos de la station des choetoptères et des myxicoles sur les plages de Roscoff et de Saint-Pol-De-Léon, cotes de Bretagne (finistère),” *Archives de zoologie expérimentale et générale, Notes et Revues*, Vol. 1, (1872), x – xiii.
- Lacaze-Duthiers, Henri, “Zoologie – Note accompagnant la presentation du 3e volume des ‘Archives de Zoologie expérimentale,’” *Comptes Rendus des Séances de L’Académie des Sciences*, (26 April 1875), 1056 – 1059.
- Lacaze-Duthiers, Henri, “Zoologie. – Les laboratoires maritimes de Banyuls-sur-Mer et de Roscoff,” *Comptes Rendus Hebdomadaires des Séances de L’Académie des Sciences*, Vol. 93, (Paris: Gauthier-Villars, 1881).
- Lacaze-Duthiers, Henri, *Notice sur les travaux scientifiques de M. F. – J. – Henri de Lacaze-Duthiers présentée a l’appui de sa candidature à l’académie des sciences*, (Paris: Institut de France, 1862).
- Lacaze-Duthiers, Henri, *Rapport sur l’École pratique des hautes études 1877 – 1878, 1878 – 1879*, (Paris: Imprimerie nationale, 1879).
- Lacoin, P., “Rapport a L’Empereur sur l’exposition internationale de Pêche et d’Aquiculture d’arcachon,” (Paris: Typographie E. Panckoucke, 1867).
- LaFrenière, Gilbert F., *The Decline of Nature: Environmental History and the Western Worldview*, (Palo Alto, CA: Academica Press, 2008).
- Laissus, Yves, “Les Voyageurs Naturalistes du Jardin du Roi et du Museum d’Histoire Naturelle: Essai de Portrait –Robot,” *Revue d’Histoire des Sciences*, No. 3, Vol. 34, (1981), 259 – 317.
- Laloë, Ann-Flore, “Where is *Bathybius haeckelii*? The Ship as Scientific Instrument and a Space of Science,” *Re-inventing the Ship: Science, Technology, and the Maritime World, 1800 – 1918*, eds. Don Leggett and Richard Dunn, (Surrey, England: Ashgate, 2012), 113 – 130.
- Lankester, E. Ray, “An American Sea-Side Laboratory,” *Nature*, Vol. 21, Issue 543, (25 March 1880), 497 – 499.

- Lankester, E. Ray, "Anton Dohrn," *Nature*, Vol. 81, (7 October 1909), 429 – 431.
- Lankester, E. Ray, *The Scientific Results of the Exhibition*, (London: William Clowes and Sons, Ltd., 1883).
- Lankester, Ray E., "Summary of Zoological Observations made at Naples in the winter of 1871 – 72," *The Annals and Magazine of Natural History*, Series 4, Vol.11, No. 62, (1873), 81 – 97.
- Latour, Bruno, *Reassembling the Social: An Introduction to Actor-Network-Theory*, (Oxford: Oxford University Press, 2005).
- Latour, Bruno, *Science in Action: How to Follow Scientists and Engineers Through Society*, (Cambridge: Harvard University Press, 1987).
- Laubier, Lucien, "Le role du prince Albert 1er de Monaco," *Compte rendu des entretiens Science et Ethique 2002*. [Accessed online 14 August 2014], [http://www.science-ethique.org/site\\_ES/programme.php?internum=829&PHPSESSID=094f66e39aea9d1b37a18d9a20ae7bb](http://www.science-ethique.org/site_ES/programme.php?internum=829&PHPSESSID=094f66e39aea9d1b37a18d9a20ae7bb).
- Lavoie, Judith, "Retired Coast Guard Boat to Become Floating Lab," *Times Colonist*, (19 January 2011).
- Lavoie, Judith, "Undersea Observatory Reveals What's in the Ocean off the Coast of Vancouver Island," *Times Colonist*, (24 August 2013).
- Lenz, Walter, "The Aspirations of Alfred Merz, George Wüst, and Albert Defant: From Berlin to Pacific Oceanography," *Oceanographic History: The Pacific and Beyond*, eds. Keith Benson and Philip Rehbock, (Seattle: University of Washington Press, 2002), 118 – 123.
- Lenz, Walter, "The Museum für Meereskunde in Berlin," *History of Oceanography*, No. 18, (September 2006).
- Levasseur, Olivier, "La culture des mers en France au XIXe siècle," *Observation des écosystèmes marin et terrestre de la Côte d'Opale: du naturalisme à l'écologie*, ed. François G. Schmitt, (Paris: Union des océanographes de France, 2011).
- Lewis, Meriwether, and Clark, William, *The Journals of Lewis and Clark*, ed. Frank Bergon, (New York: Penguin Books, 1989).
- Limoges, Camille, "The Development of the Muséum d'Histoire Naturelle," *The Organization of Science and Technology in France 1808 – 1914*, eds. Robert Fox and George Weisz, (Cambridge: Cambridge University Press, 1980).

- Lukacs, Martin, “World’s biggest geoengineering experiment ‘violates’ UN rules: Controversial US businessman’s fertilization off west coast of Canada contravenes two UN conventions,” *The Guardian*, (15 October 2012).
- Macdonald, A.G., and Priede, I.G., *Experimental Biology at Sea*, eds. A.G. Macdonald and I.G. Priede, (London: Academic Press, 1983).
- MacLoed, Roy, and Rehbock, Philip, “Developing a Sense of the Pacific: the 1923 Pan-Pacific Science Congress in Australia,” *Pacific Science*, Vol. 54, No. 3, (2000), 209 – 225.
- MacLoed, Roy, and Rehbock, Philip, “Preface,” *Darwin’s Laboratory: Evolutionary Theory and Natural History in the Pacific*, (Honolulu: University of Hawaii Press, 1994), ix – x.
- Magnuson, Warren G., “Magnuson Preview: Century 21 Science Pavilion To Be ‘Jewel Box’ Of Wonder,” *Seattle Post-Intelligence*, (5 March 1961).
- Maienschein, Jane, “History of American Marine Laboratories: Why Do Research At the Seashore?,” *American Zoologist*, Vol. 28, No. 1, (1988).
- Matkin, Joseph, *At Sea with Scientifics: The Challenger Letters of Joseph Matkin*, ed. Philip F. Rehbock, (Honolulu: University of Hawaii Press, 1992).
- Maury, Matthew Fontaine (anonymous), “Scraps from the Lucky Bag,” *The Southern Literary Messenger*, (April, 1840), 238.
- Maury, Matthew Fontaine, *The Physical Geography of the Sea*, [19<sup>th</sup> ed.] (London: Thomas Nelson and Sons, 1883).
- Mazzarelli, G., “Gli animali abissali e le correnti sottomarine dello Stretto di Messina,” *Rivista Mensile di Pesca e Idrobiologia*, Vol. 11, (1909), 177 – 218.
- McConnell, Anita, *No Sea Too Deep: The History of Oceanographic Instruments*, (Bristol: Adam Hilger Ltd., 1982).
- McEwen, George, “The Distribution of Temperature and Salinities, and the Circulation in the North Pacific Ocean,” *Bulletin of the Scripps Institution for Biological Research of the University of California*, No. 9, (15 December 1919), 58 – 64.
- McIntosh, Robert P., *The Background of Ecology: Concept and Theory*, (Cambridge: University of Cambridge, 1985).
- Méheut, Mathurin, *Étude de la mer: faune et flore de la manche et de l’océan*, (Paris: Librairie Centrale des Beaux-arts, 1913).

- Michelet, Jules, *La Mer*, (Paris: Librairie de I. Hachette et Co., 1861).
- Mikhailov, N. N., Vyazilov, E. D., Lomonov, V. I., Studyonov, N. S., and Shaimardanov, M. Z., “Russian Marine Expeditionary Investigations of the World Ocean,” *International Ocean Atlas and Information Series*, Vol. 5, (Obninsk – Silver Spring: National Oceanic and Atmospheric Administration, 2002).
- Mills, Eric, “Editorial – Rediscovering the Prince of Monaco,” *History of Oceanography*, No. 11, (September 1999).
- Mills, Eric, “Problems of Deep-Sea Biology: An Historical Approach,” *Deep-Sea Biology*, ed. Gilbert T. Rowe, (Cambridge: Harvard University Press, 2005), 1 – 79.
- Mills, Eric, “The Historian of Science and Oceanography After Twenty Years,” *Earth Sciences History*, Vol. 12, No. 1, (1993), 5 – 18.
- Mills, Eric, “The History of Oceanography: Introduction,” *Earth Science History*, Vol. 12, No. 1, (1993), 1.
- Mills, Eric, “The Oceanography of the Pacific: George F. McEwen, H. U. Sverdrup and the Origin of Physical Oceanography on the West Coast of North America,” *Annals of Science*, Vol. 48, (1991), 241 – 266.
- Mills, Eric, “Useful in Many Capacities. An Early Career in American Physical Oceanography,” *Historical Studies in the Physical and Biological Sciences*, Vol. 20, No. 2, (1990), 265 – 311.
- Mills, Eric, “What is the History of Oceanography?,” *History of Oceanography*, No. 2, (July 1990), 2 – 3.
- Mills, Eric, *Biological Oceanography: An Early History, 1870 – 1960*, (Toronto: University of Toronto Press, 2012).
- Mills, Eric, *The Fluid Envelope of our Planet: How the Study of Ocean Currents Became a Science*, (University of Toronto Press, 2009).
- Milne-Edwards, Alphonse, “Observations sur l’existence de divers mollusques et zoophytes a de très grandes profondeurs dans la mer Méditerranée,” *Annales des Sciences Naturelle, zoologie*, Vol. 4, No. 15, (1861), 149 – 157.
- Montabré, Maurice, “Les Découvertes d’un Garçon de Laboratoire,” *Je Sais Tout*, (15 February 1922).
- Moore, Sarah J., *Empire on Display: San Francisco’s Panama-Pacific International Exposition of 1915*, (Norman: University of Oklahoma Press, 2013).

- Morcos, Selim A., "Marine Sciences in Egypt," *Places, People, Tools: Oceanography in the Mediterranean and Beyond, Proceedings of the Eight International Congress for the History of Oceanography*, ed. Christiane Groeben, (Naples: Giannini Editore, 2013).
- Mukerji, Chandra, *A Fragile Power: Scientists and the State*, (Princeton: Princeton University Press, 1989).
- Munk, Walter, "Affairs of the Sea," *Annual Review of Earth and Planetary Sciences*, Vol. 8, (1980), 1 – 17.
- Munk, Walter, "Glimpses of Oceanography in the Postwar Period," *Oceanography*, Vol. 21, No. 3, (September 2008), 14 – 21.
- Munk, Walter, "Oceanography Before, and After, the Advent of Satellites," *Satellites, Oceanography and Society*, ed. David Halpern, (Amsterdam: Elsevier, 2000), 1 – 3.
- Murray, John, "Alexander Agassiz: His Life and Scientific Work," *Bulletin of the Museum of Comparative Zoology*, Vol. 54, No. 3, (Cambridge: Museum of Comparative Zoology, 1911), 139 – 158.
- Musselman, Elizabeth Green, "Science as a Landed Activity: Scientifics and Seamen aboard the U.S. Exploring Expedition," *Surveying the Record: North American Exploration to 1900*, ed. Edward L. Carter, (Philadelphia: American Philosophical Society, 1999), 77 – 102.
- Naish, John, "The Health of Mariners: Vancouver's Achievement," *Enlightenment and Exploration in the North Pacific, 1741 – 1805*, eds. Stephen W. Haycox, James Barnett, and Caedmon Liburn, (Anchorage: Cook Inlet Historical Society, 1997), 79 – 87.
- Neal, Ryan W., "Underwater Internet Cables: 'Submarine Cable Map' Shows How the World Gets Online," *International Business Times*, (5 March 2014). [Accessed online 25 September 2014]. <http://www.ibtimes.com/underwater-internet-cables-submarine-cable-map-shows-how-world-gets-online-1559604>.
- Nielsen, Michael, *Reinventing Discovery: The New Era of Networked Science*, (Princeton: Princeton University Press, 2012).
- Nierenberg, William, "Athelstan Spilhaus," *Proceedings of the American Philosophical Society*, Vol. 144, No. 3, (September 2000).
- Nyhart, Lynn K., *Modern Nature: The Rise of the Biological Perspective in Germany*, (Chicago: Chicago University Press, 2009).

- Odum, Eugene P., "The Mesocosm," *BioScience*, Vol. 34, No. 9, (October, 1984), 558 – 562.
- Oppenheimer, Jane M., "Introduction," *Von Baer – Dohrn Correspondence*, ed. Christiane Groeben, Vol. 83, Part 3, (Philadelphia: The American Philosophical Society, 1993).
- Oreskes, Naomi, "A Context of Motivation: US Navy Oceanographic Research and the Discovery of Hydrothermal Vents," *Social Studies of Science*, Vol. 33, No. 5, (October, 2003), 697 – 742.
- Oreskes, Naomi, "Scaling Up Our Vision," *Isis*, Vol. 105, No. 2, (June 2014), 379 – 391.
- Organ, Michael, "'Osterreich in Australien': Ferdinand von Hochstetter and the Austrian Novara Scientific Expedition 1858 -9," *Historical Records of Australian Science*, Vol. 12, No. 1, (1998), 1 – 13.
- Ortega, Casimiro Gomez, *Instruccion Sobre el Modo Mas Seguro y Económico de Transportar Plantas Vivas Por Mar y Terra a los Paises Mas Distantes*, (Madrid: Por D. Joachin Ibarra Impresor de Cámara de S. M., 1779).
- Osborn, Michael A., *Nature the Exotic, and the Science of French Colonialism*, (Bloomington: Indiana University Press, 1994).
- Outram, Dorinda, "New Spaces in Natural History," *Cultures of Natural History*, eds. Nicholas Jardine, James Secord, and Emma Spary, (Cambridge: Cambridge University Press, 1996).
- Parville, Henri de, "Henri de Lacaze-Duthiers," *La Nature*, No. 1471, (3 August 1901), 159 – 160.
- Patterson, Carolyn Bennett, "Seattle Fair Looks to the 21<sup>st</sup> Century," *National Geographic*, Vol. 122, No. 3, (September 1962), 402 – 427.
- Paul, Harry W., *From Knowledge to Power: The Rise of the Science Empire in France 1860-1939*, (London: Cambridge University Press, 1985).
- Pavé, Marc, *La pêche côtière en France (1715-1850): approche sociale et environnementale*, (Paris: L'Harmattan, 2013).
- Pérard, M. J., and Maire, M., *Congrès International d'Aquiculture et de Pêche Tenue à Paris du 14 au 19 Septembre 1900. Procès – Verbaux Sommaires*, (Paris: Imprimerie Nationale, 1900).

- Pérez, Charles, “Études diverses – l’Exposition internationale d’Océanographie et des Pêches maritimes de Marseille,” *Revue Scientifique (Revue Rose)*, Vol. 7, No. 7, (16 February 1907).
- Perrier, Edmond, “Le laboratoire maritime de Muséum d’Histoire Naturelle de Tatihou,” *La Nature*, No. 794, (18 August 1888).
- Pettersson, Otto, “Förslag till en världsomfattande internationell havsforskningsexpedition,” *Ymer*, No. 1, (1924), 36 – 44.
- Pillsbury, John Elliott, “The Grandest and Most Mighty Terrestrial Phenomenon: The Gulf Stream,” *National Geographic Magazine*, Vol. 23, No. 7, (1912), 767- 778.
- Plée, Auguste and Plée, François, *Herborisations artificielles aux environs de Paris*, (Paris: Printed by the authors, 1811).
- Poesch, Jessie, *Titian Ramsay Peale and his Journals of the Wilkes Expedition 1799 – 1885*, (Philadelphia: American Philosophical Society, 1961).
- Pouchet, Georges, “La mission de Laponie,” *La Nature*, Vol. 10, No. 444, (3 December 1881), 40 – 41.
- Powell, Hugh, “Fertilizing the Ocean with Iron: Should we add iron to the sea to help reduce greenhouse gases in the air?” *Oceanus Magazine*, Vol. 46, No. 1, (January 2008).
- Press, Rich, “Satellite Tags Reveal How Animals See the Ocean: An interview with NOAA Fisheries scientists Jeffrey Polovina,” NOAA Fisheries, [Accessed online 3 October 2014]  
[http://www.nmfs.noaa.gov/stories/2014/09/how\\_animals\\_see\\_the\\_ocean.html](http://www.nmfs.noaa.gov/stories/2014/09/how_animals_see_the_ocean.html).
- Pruvot, G., “Contribution à la topographie et à la faune du golfe du lion,” *Annales de l’Université de Grenoble*, Vol. 7, No. 4 (1895).
- Pyeson, Lewis and Sheets-Pyeson, Susan, *Servants of Nature: A History of Scientific Institutions, Enterprises, and Sensibilities*, (New York: W.W. Norton & Company, 1999).
- Rainger, Ronald, “Science at the Crossroads: The Navy, Bikini Atoll, and American Oceanography in the 1940s,” *Historical Studies in the Physical and Biological Sciences*, Vol. 30, No. 2, (2000), 350 – 355.
- Raj, Kapil, *Relocating Modern Science: Circulation and the Construction of Knowledge in South Asia and Europe, 1650 – 1900*, (New York: Palgrave Macmillan, 2007).

- Rankine, W. J. Macquorn, *A Memoir of John Elder Engineer and Shipbuilder*, (Edinburgh: William Blackwood and Sons, 1871).
- Rehbock, Philip, "Organizing Pacific Science: Local and International Origins of the Pacific Science Association," *Pacific Science*, Vol. 45, No. 2, (1991), 107 – 122.
- Rehbock, Philip, "The Early Dredgers: 'Naturalizing' in British Seas, 1830 -1850," *Journal of the History of Biology*, Vol. 12, No. 2, (1979), 293 – 368.
- Rehbock, Philip, "The Early Dredgers: "Naturalizing" in British Seas, 1830 - 1850," *Journal of the History of Biology*, Vol. 12, No. 2, (1979).
- Reidy, Michael, *Tides of History: Ocean Science and Her Majesty's Navy*, (Chicago: University of Chicago Press, 2008).
- Revelle, Roger, and Seuss, Hans, "Carbon Dioxide Exchange Between the Atmosphere and Ocean and the Question of an Increase in Atmospheric CO<sub>2</sub> during the Past Decades," *Tellus*, Vol. 9, (1957), 18 – 27.
- Reynolds, William, *The Private Journal of William Reynolds: The United States Exploring Expedition, 1838 – 1842*, eds. Nathaniel Philbrick and Thomas Philbrick, (New York: Penguin Press, 2004).
- Richard, Jules, "The Oceanographic Museum of Monaco" [Translated from *Transactions of the International Geographical Congress*, Berlin, 1899], *The Museums Journal*, Vol. 2, No. 3, (September 1902), 77 – 78.
- Richard, Jules, *L'Océanographie*, (Paris: Vuibert & Nony Éditeurs, 1907).
- Richard, Jules, *Les campagnes scientifiques de S.A.S. le Prince Albert Ier de Monaco*, (Monaco: Imprimerie de Monaco, 1900).
- Roberts, Callum, *The Unnatural History of the Sea*, (Washington D.C.: Island Press, 2007).
- Roosevelt, Franklin D., "Fireside Chat on Progress of the War," *Public Papers of the Presidents of the United States: F. D. Roosevelt, 1942*, Vol. 11, (Best Books, 1950), 105 – 117.
- Rozwadowski, Helen, "'Small World' Forging a Scientific Maritime Culture for Oceanography," *Isis*, Vol. 87, No. 3, (1996), 409 – 429.
- Rozwadowski, Helen, "Arthur C. Clarke and the Limitations of the Ocean as a Frontier," *Environmental History*, Vol. 17, No. 3, (2012), 578 – 602.

- Rozwadowski, Helen, "Engineering, Imagination, and Industry: Scripps Island and Dreams for Ocean Science in the 1960s," *The Machine in Neptune's Garden: Historical Perspectives on Technology and the Marine Environment*, eds. Helen Rozwadowski and David Van Keuren, (USA: Science History Publications, 2004).
- Rozwadowski, Helen, "Internationalism, Environmental Necessity, and National Interest: Marine Science and Other Sciences," *Minerva*, 42, (2004), 127 – 149.
- Rozwadowski, Helen, "Oceans: Fusing the History of Science and Technology with Environmental History," *A Companion to American Environmental History*, ed. Douglas Cazaux Sackman, (Malden, MA: Wiley-Blackwell, 2010).
- Rozwadowski, Helen, *Fathoming the Ocean: The Discovery and Exploration of the Deep Sea*, (Cambridge: Harvard University Press, 2005).
- Rozwadowski, Helen, *The Sea Knows No Boundaries: A Century of Marine Science Under ICES*, (Seattle: University of Washington Press, 2002).
- Rydell, Robert, *World of Fairs: The Century-of-Progress Expositions*, (Chicago: University of Chicago Press, 1993).
- Sand, René, "Les Laboratoires Maritimes de Zoologie," *Revue de l'Université de Bruxelles*, Vol. 3, (1898), 23 – 235.
- Scherzer, Karl, *Narrative of the Circumnavigation of the Globe by the Austrian Frigate Novara, Undertaken by Order of the Imperial Government, in the Years 1857, 1858, & 1859, [...]*, Vol. 1, (London: Saunders, Otley, and Co., 1863).
- Scheuering, Rachel White, *Shapers of the Great Debate: A Biographical Dictionary*, (Westport, CT: Greenwood Press, 2004).
- Schlee, Susan, *The Edge of An Unfamiliar World: A History of Oceanography*, (New York: E. P. Dutton & Co., 1973).
- Schlesinger, Stephen, *Act of Creation: The Founding of the United Nations*, (Boulder, CO: Westview Press, 2003).
- Schmidt, Benjamin, "Accumulating the World: Collecting and Commodifying 'Globalism' in Early Modern Europe," *Centers and Cycles of Accumulation in and Around the Netherlands in the Early Modern Period*, ed. Lissa Roberts, (Berlin: LIT Verlag Münster, 2011).
- Shapin, Steven, "The House of Experiment in Seventeenth-Century England," *Isis*, Vol. 79, (1988), 373 – 404.

- Shapin, Steven, "The Invisible Technician," *American Scientist*, Vol. 77, No. 6, (1989), 554 - 563.
- Shapin, Steven, *A Social History of Truth: Civility and Science in Seventeenth-Century England*, (Chicago: Chicago University Press, 1994).
- Shapin, Steven, and Schaffer, Simon, *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life*, (Princeton: Princeton University Press, 1985).
- Shor, Elizabeth Noble, *Scripps Institution of Oceanography: Probing the Oceans 1936 to 1976*, (San Diego: Tofua Press, 1978).
- Shor, George, "The Development of Research Vessel Design," *Oceanographic History: The Pacific and Beyond*, eds. Keith Benson and Philip F. Rehbock, (Seattle: University of Washington Press, 2002), 45 – 52.
- Sigsbee, Charles, *Deep-sea Sounding and Dredging: A Description and Discussion of the Methods and Appliances Used on Board the Coast and Geodetic Survey Steamer 'Blake,'* (Washington D.C.: Government Printing Office, 1880).
- Sims, David W., and Southward, Alan J., "Dwindling fish numbers already of concern in 1883," *Nature*, Vol. 439, No. 9, (February 2006).
- Skallerup, Harry, *Books Ashore & Afloat: A History of Books, Libraries, and Reading Among Seamen During the Age of Sail*, (Hamden, Connecticut: Archon Books, 1974).
- Smed, Jens, "Abortive Plans for a World-Wide Oceanographic Expedition," *History of Oceanography*, No. 12, (September 2000), 10 – 14.
- Smed, Jens, "Physical Oceanography in Scandinavia," *Earth-Science Reviews: International Magazine for Geo-Scientists*, Vol. 3, (1967), A119 – A121.
- Smed, Jens, "The Accession of France Into ICES," *History of Oceanography*, No. 21, (September 2009), 9 – 17.
- Smith, Adolphe, *Monaco and Monte Carlo*, (London, Grant Richards Ltd., 1912).
- Smith, Tim, *Scaling Fisheries: The Science of Measuring the Effects of Fishing, 1855 – 1955*, (Cambridge: Cambridge University Press, 1994).
- Sorrenson, Richard, "The Ship as Scientific Instrument in the Eighteenth Century," *Osiris*, Vol. 11, No. 2, (1996), 221 – 236.
- Southward, A.J., "The Marine Biological Association and Fishery Research, 1884 – 1924: Scientific and Political Conflicts that Changed the Course of Marine

- Science in the United Kingdom,” *British Marine Science and Meteorology: The History of their Development and Application to Marine Fishing Problems*, *Buckland Occasional Papers: No 2*, (1996).
- Spary, Emma C., *Utopia’s Garden: French Natural History from the Old Regime to Revolution*, (Chicago: University of Chicago Press, 2000).
- Spencer, Larry T., “Four Men and an Albatross: The Growth of American Oceanography, 1882 – 1921,” *Oceanographic History: The Pacific and Beyond*, ed. Keith Benson and Philip Rehbock, (Seattle: University of Washington Press, 2002), 288 – 297.
- Spiess, F., *The Meteor Expedition: Scientific Results of the German Atlantic Expedition, 1925 – 1927*, Trans. by William J. Emery, (New York: Amerind Publishing Co., 1985).
- Spilhaus, Athelstan, “Oceanography: A Wet and Wondrous Journey,” *Bulletin of the Atomic Scientists: Journal of Science and Public Affairs*, (December 1964), 11 – 15.
- Spilhaus, Athelstan, *U.S. Science Exhibit Seattle World’s Fair: Final Report*, (Washington, D.C.: U.S. Department of Commerce, 1963).
- Sponsel, Alistair, “An Amphibious Being: Why Darwin’s Theories Depended Upon His Practical Experience in Maritime Surveying,” [unpublished manuscript, presented at history of oceanography workshop, *Place and Practice: Doing Science on and in the Ocean 1800 – 2012*, Halifax, Nova Scotia, June 14 – 17, 2014].
- Spry, W.J.J., *The Cruise of the Majesty’s Ship ‘Challenger.’ Voyages Over Many Seas, Scenes in Many Lands*, (London: Sampson Low, Martson, Searle, & Rivington, 1877).
- Stagl, Justin, *A History of Curiosity: The Theory of Travel, 1550 – 1800*, (Amsterdam: Harwood Academic Publishers, 1995).
- Stanton, William, *The Great United States Exploring Expedition*, (Berkeley: University of California Press, 1975).
- Steinbeck, John, “Let’s Go After the Neglected Treasures Beneath the Seas: A Plea for Equal Effort on ‘Inner Space’ Exploration,” *Popular Science*, (September 1966), 84 – 87.
- Stevenson, Robert Louis, “Records of a Family of Engineers,” *Letters and Miscellanies of Robert Louis Stevenson*, (New York: Charles Scribner’s Sons, 1896).
- Stewart, Robert, “Introduction to Physical Oceanography,” [Accessed online 17 Nov. 2014], [http://oceanworld.tamu.edu/resources/ocng\\_textbook/contents.html](http://oceanworld.tamu.edu/resources/ocng_textbook/contents.html).

- Stommel, Henry, "Statement about Priorities for Greenhouse Research," [Unpublished editorial written in 1990], Collected Works of Henry Stommel, eds. Nelson G. Hogg and Rui Xin Huang, Vol. 1, (Boston: American Meteorological Society, 1995), I-221.
- Stommel, Henry, "Varieties of Oceanographic Experience," *Science*, Vol. 139, (1963), 572 – 576.
- Stommel, Henry, and Goldberg, E.D., "Oceanography: An International Laboratory," *Science*, Vol. 165, (1969), 751 – 752.
- Stott, Rebecca, *Darwin and the Barnacle: The Story of One Tiny Creature and History's Most Spectacular Scientific Breakthrough*, (New York: W. W. Norton & Company, 2003).
- Tanner, Z.L., *Deep-sea Exploration: A General Description of the Steamer Albatross [...]*, (Washington D. C.: Government Printing Office, 1897).
- Tharp, Marie, "Connect the Dots: Mapping the Seafloor and Discovering the Mid-ocean Ridge," *Lamont-Doherty Earth Observatory of Columbia: Twelve Perspectives on the First Fifty Years 1949 – 1999*, ed. Laurence Lippsett. [Accessed online 26 June 2014].  
<http://www.whoi.edu/sbl/liteSite.do?litesiteid=9092&articleId=13407>.
- Théodoridès, Jean, "Les débuts de la biologie marine en France: Jean-Victor Audouin et Henri-Milne Edwards, 1826 – 1829," *Bulletin de l'Institut Océanographique de Monaco*, numéro spécial 2, Vol. 2, (1968), 417 – 437.
- Thésée, Françoise, *Auguste Plée 1786 – 1825 Un Voyageur Naturaliste: Ses Traveaux et Ses Tribulations aux Antilles, au Canada, en Colombie*, (Paris: Editions Caribéennes, 1989).
- Thomson, Charles Wyville, *The Depths of the Sea: An Account of the General Results of the Dredging Cruises of H.M.S. 'Porcupine' and 'Lightening' During the Summers of 1868, 1869, and 1870 [...]*, (London: Macmillan & Co., 1873).
- Thomson, Charles Wyville, *The Voyage of the 'Challenger': The Atlantic: A Preliminary Account of the General Results of the Exploring Voyage of the H.M.S. 'Challenger' [...]*, (New York: Harper, 1878).
- Thoreau, Henry David, *Cape Cod*, (Boston: Ticknor and Fields, 1865).
- Thoulet, Julien, "Un des fondateurs de l'océanographie – Marsigli," *Revue Scientifique*, No 26, Vol. 8, (25 December 1897), 801 – 805.

- Thoulet, Julien, *A Voyage to Newfoundland*, trans. and ed. Scott Jamieson, (Montreal & Kingston: McGill-Queen's University Press, 2005).
- Thoulet, Julien, *L'Océan: ses lois et ses problèmes*, (Paris: Librairie Hachette, 1904).
- Thurstan, Ruth, Hawkins, Julie, Roberts, Callum, "Origins of the bottom trawling controversy in the British Isles: 19<sup>th</sup> century witness testimonies reveal evidence of early fishery declines," *Fish and Fisheries*, Vol. 15, Issue 3, (2013), 506 – 522.
- Tilghman, R. Carmichael, "President's Address: Captain James Cook (1798 – 1779) Explorations and the Conquest of Scurvy," *The American Clinical and Climatological Association*, (1981).
- Tilley, Helen, *Africa as a Living Laboratory: Empire, Development, and the Problem of Scientific Knowledge, 1870 – 1950* (Chicago: University of Chicago Press, 2011).
- Tizard, T.H., *Narrative of the Cruise of the H.M.S. Challenger with a General Account of the Scientific Results of the Expedition*, (London: Her Majesty's Stationary Office, 1885).
- Tjossem, Sara, *The Journey to PICES: Scientific Cooperation in the North Pacific*, (Fairbanks: University of Alaska, Alaska Sea Grant Program, 2005).
- Tobias, Lori, "Largest ocean science project in United States launches soon off Oregon coast," *The Oregonian*, (19 October 2011).
- Unknown author, "A Royalty Worth A Struggle. That of Monaco Means a Fat Income to the Grimaldi Who Wins It," *The San Francisco Chronicle*, (5 July 1922).
- Unknown author, "A Visit to the Iron-Cased Frigate 'Warrior,'" *The Exchange: A Home and Colonial Review of Commerce, Manufactures, and General Politics*, Vol. 1, (1862), 182.
- Unknown author, "Address of R.A. Falla," *Seventh Pacific Science Congress Proceedings*, Vol. 1, (Wellington, NZ: R.E. Owen, Government Printer, 1952).
- Unknown author, *Annuaire Statistique de la France*, (Paris: Imprimerie Nationale, 1882).
- Unknown author, "Art: The Road to Xanadu," *Time Magazine*, (18 January 1963).
- Unknown author, "Astronautical and Aeronautical Events of 1962: Report of the National Aeronautics and Space Administration to the Committee on Science and Astronautics U.S. House of Representatives Eighty – Eight Congress First Session," (Washington, D.C.: U.S. Government Printing Office, 1963).

- Unknown author, "Count Castellane Scores Prince Albert of Monaco," *San Francisco Chronicle*, (5 July 1899).
- Unknown author, "Editorial," *New-York Tribune*, (10 June 1898).
- Unknown author, "Encrinites," *The Manchester Guardian*, (24 December 1869).
- Unknown author, "Exposition internationale de pêche et d'aquiculture à Arcachon, en juillet 1886. Formulaire de questions," *Bulletin de la Société Impériale Zoologique d'Acclimatation*, Series 2, Vol. 3, (Paris: Victor Masson et Fils, 1866), 182 – 188.
- Unknown author, "French Sardine Crisis – Brittany Fishermen Making Small Catches – The Probable Causes," *The Montreal Gazette*, (22 Feb. 1908).
- Unknown author, "Généralités – L'inauguration du Musée Océanographique de Monaco," *Annales de Géographie*, Vol. 19, Issue 106, (1910), 374 – 375.
- Unknown author, *GEOTRACES, An International Study of the Marine Biogeochemical Cycles of Trace Elements and Their Isotopes, Science Plan*, (Plymouth: The Clyvedon Press Ltd, 2006).
- Unknown author, "Japan Opened. Satisfactory Result of Commodore Perry's Visit [...]," *New York Times*, (13 June 1854).
- Unknown author, "L'établissement de con carneau," *Magasin Pittoresque*, Vol. 37, (1869), 300 – 302.
- Unknown author, "MC-46: Athelstan Frederick Spilhaus papers," *Woods Hole Oceanographic Institution Data Library and Archives*, [Accessed online, 11 November 2014], <http://dla.whoi.edu/manuscripts/node/196143>.
- Unknown author, "More Reform in Monaco; Prince Albert Surrenders Control of the Government Finances," *The New York Times*, (16 October 1910).
- Unknown author, "Océanographie. Généralités," *Annales de Géographie*, Vol. 1, Issue 2, (1892), 199 – 217.
- Unknown author, "Ocean Frontier," *Time*, Vol. 74, Issue 1, (6 July 1959), 46.
- Unknown author, "Prince of Monaco an Autocrat," *The Washington Post*, (24 October 1910).
- Unknown author, "Prince of Monaco Sees City After Forty-Five Years and Explains Musical Mystery of the Sea," *New York Herald*, (11 September 1913).

- Unknown author, "Probable Population of the World at the End of 1884," *The Record Almanac 1885*, (Philadelphia: Philadelphia Record, 1885).
- Unknown author, "Progress of a French Zoological Station," *The Times*, (3 March 1881).
- Unknown author, "Public Sessions," *Sixth Pacific Congress Proceedings*, Vol. 1, (Berkeley: University of California Press, 1940), 49.
- Unknown author, "Punch's Sentiments," *Punch Magazine*, 7 (1844).
- Unknown author, "Resolutions Adopted at the Fourth Pacific Science Congress," *Fifth Pacific Science Congress Proceedings*, Vol. 1, (Vancouver: Pacific Science Association, 1933), 250.
- Unknown author, "Scientific Notes and News," *Science*, Vol. 33, No. 841, (10 February 1911), 214.
- Unknown author, "The Challenger Her Challenge," *Punch Magazine*, Vol. 63, (1872), 255.
- Unknown author, "The Exposition of Arcachon and its Object," *Fraser's Magazine*, (September 1866), 297 – 308.
- Unknown author, "The Oceanographical Museum at Monaco," *Nature*, No. 2111, Vol. 83, (14 April 1910), 191 – 193.
- Unknown author, "The Political Mission to the East," *Ainsworth's Magazine, A Miscellany of Romance, General Literature, & Art*, ed. William Harrison Ainsworth, Vol. 6, (London: John Mortimer, Publisher, 1846).
- Unknown author, "The Prince of Monaco," *The Brooklyn Daily Eagle*, (27 June 1922).
- Unknown author, "The Scientist Who Ruled Monte Carlo," *The Literary Digest*, Vol. 74, No. 3, (15 July 1922), 38 – 41.
- Unknown author, "The Toilers of the Sea," *Natural Science: A Monthly Review of Scientific Progress*, Vol. 5, No. 33, (November, 1894), 323 – 325.
- Unknown author, "The Tragedy of the High Seas: New management is needed for the planet's most important common resource," *The Economist*, (22 February 2014).
- Unknown author, "Transportation of Live Fish," *New York Tribune*, (12 July 1908).
- Unknown author, "Veteran Prince Thinks It's Fun to Discuss Science With American Savants," *Times Herald*, (21 April 1921).

- Unknown author, "Wonders of Deep Shown in Paris," *San Francisco Chronicle*, (16 March 1913).
- Unknown author, (A Lady Correspondent), "Feminism and Fashion in Paris. A Quaint Exhibition.," *The Observer*, (7 December 1913).
- Unknown author, *An International Study of the Marine Biogeochemical Cycles of Trace Elements and Their Isotopes*, Science Plan, (Plymouth: The Clyvedon Press Ltd, 2006).
- Unknown author, "Art: The Road to Xanadu," *Time Magazine*, (18 January 1963).
- Unknown author, *Commercial Relations of the United States with Foreign Countries During the Years 1882 and 1883. Annual Reports from the Consuls of the United States on the Commerce, Manufactures, Industries, etc., of Their Several Districts for the Above Year*, Vol. 1, (Washington D.C.: Government Printing Office, 1884).
- Vallanueva, Alex A., et. al., "Biomimetic autonomous robot inspired by the *Cynea capillata* (Cyro)," *Bioinspiration & Biomimetics*, Vol. 8, No. 4, (29 October 2013).
- Vallaux, Camille, "Nécrologie – Julien-Olivier Thoulet (1843-1936)," *Annales de Géographie*, Vol. 45, Issue 254, (1936), 217 – 218.
- Vattemare, Alexander, *Movement of the International Literary Exchanges, Between France and North America, From January, 1845, to May, 1846, with Instructions for Collecting, Preparing, and Forwarding Objects of Natural History Written by the Professors of the Museum of Natural History at Paris. And Instructions Relative to Anthropology and Zoology, by M. Isidore Geoffroy St. – Hilaire, (Both series translated by an American Lady)*, (Paris: Printed by Paul Dupont, 1846).
- Vaughan, Thomas Wayland, *International Aspects of Oceanography: Oceanographic Data and Provisions for Oceanographic Research*, (Washington D.C.: National Academy of Sciences, 1937).
- Vetter, Jeremy, ed., *Knowing Global Environments: New Historical Perspectives on the Field Sciences*, (New Jersey: Rutgers University Press, 2011).
- Wadewitz, Lissa, *The Nature of Borders: Salmon, Boundaries, and Bandits on the Salish Sea*, (Seattle: University of Washington Press, 2012).
- Weber, Eugen, *Peasants into Frenchmen: The Modernization of Rural France 1870 - 1914*, (Palo Alto: Stanford University Press, 1976).

- Weill, R., “La station biologique d’Arcachon 1867-1968.” [Accessed online] [http://www.sauvonslemuseeaquarium.org/wordpress/wp-content/uploads/2009/10/museeaquarium03-1\\_weill.pdf](http://www.sauvonslemuseeaquarium.org/wordpress/wp-content/uploads/2009/10/museeaquarium03-1_weill.pdf).
- Weir, Gary E., “Fashioning Naval Oceanography: Columbus O’Donnell Iselin and American Preparation for War, 1940 – 1941,” *The Machine in Neptune’s Garden: Historical Perspectives on Technology and the Marine Environment*, eds. Helen Rozwadowski and David K. van Keuren, (U.S.A.: Science History Publications, 2004), 65 – 91.
- Weir, Gary, “The American Sound Surveillance System: Using the Ocean to Hunt Soviet Submarines, 1950 – 1961,” *International Journal of Naval History*, Vol. 5, No. 2, (August 2006).
- Weir, Gary, *An Ocean In Common: American Naval Officers, Scientists, and the Ocean Environment*, (College Station: Texas A&M University Press, 2001).
- Weitze, Marc – Denis, “Science Centers: Examples from the U.S. and from Germany,” *Proceedings of a Conference held in Pognana sul Lario, Italy, June 1 – 6, 2003*, (Munich: Deutsches Museum, 2004), 1 – 8.
- Wenk, Edward, *The Politics of the Ocean*, (Seattle: University of Washington Press, 1972).
- White, Richard, “From Wilderness to Hybrid Landscape,” *A Companion to American Environmental History*, ed. by Douglas Cazaux Sackman, (Malden, MA: Wiley-Blackwell, 2010).
- Whitman, Emily Nunn, “The Zoölogical Station at Naples,” *The Century Illustrated Monthly Magazine*, Vol. 32, (1882).
- Wilkes, Charles, *Narrative of the United States Exploring Expedition During the Years 1838, 1839, 1840, 1841, 1842*, Vol. 1, (Philadelphia: Lea & Blanchard, 1845).
- Williams, Glyn, *Naturalists at Sea: Scientific Travelers from Dampier to Darwin*, (New Haven: Yale University Press, 2013).
- Williams, Kathleen Broome, “From Civilian Planktonologist to Navy Oceanographer: Mary Sears in World War II,” *The Machine in Neptune’s Garden: Historical Perspectives on Technology and the Marine Environment*, eds. Helen Rozwadowski and David K. van Keuren, (Sagamore Beach, Mass.: Science History Publications, 2004), 243 – 272.
- Wilson, George, and Geikie, Archibald, *Memoir of Edward Forbes, Late Regius Professor of Natural History in the University of Edinburgh*, (London: Macmillan and Co., 1861).

- Wolf, George, "Eduard Schwarz, A Neglected Pioneer in the History of Nutrition," *Nutrition*, Vol. 13, No. 9, (1997), 844 – 846.
- Wood, Henry, "Fisheries of the United Kingdom," *Sea Fisheries: Their Investigation in the United Kingdom*, ed. Michael Graham, (London: Edward Arnold Ltd., 1956).
- Wüst, Georg, "The Major Deep-Sea Expeditions and Research Vessels 1873 – 1960," *Progress in Oceanography*, Vol. 2, (1964), 1 - 52.
- Yardley, William, "'Bringing the Ocean to the World,' in High-Def," *The New York Times*, (4 September 2007).
- Youtz, Philip N., *Proposal for a Permanent Pacific House*, [Unpublished document in the San Francisco Public Library Special Collections], Golden Gate International Exposition folder.