Depths of Knowledge
HMS *Challenger* and the Reconfiguration of Modern Science

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ABSTRACT

In 1872 HMS *Challenger* set sail on a four-year circumnavigation of the globe with the aim of conducting the most complete and systematic exploration of the deep sea ever pursued. The goals were no less than to produce the most comprehensive knowledge of the world's oceans through temperature and depth measurements, chemical and physical analysis of the seawater, specimen collection and natural history observations. Touted as an emblematic success of Victorian science and continually identified as the beginning of modern oceanography, the *Challenger* expedition is a fundamental historical moment in the conception of the ocean as a scientific space.

This thesis considers the extent to which, and the ways in which, scholarly understanding of the expedition as the originator of modern oceanography has detached it from its historical origins. As a symbol of modern science the expedition has been decontextualised from the social, cultural, and political factors which informed the shape of the expedition and the resulting scientific knowledge. In historicising the expedition and the scientific knowledge which it produced I aim to explore the processes of scientific knowledge making in the modern era that contributed to such an effective and resilient decontextualisation as well as offer a revised historical narrative that re-contextualises the expedition within the histories of maritime exploration, natural history, Victorian science, and British colonialism.

DEDICATION

In memory of the two people I lost while writing this thesis, Gregory Zuroski and Ruby Yuan, and in honour of the two people I welcomed into the world, Felicity and Henry.

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This thesis is the result of many fortuitous moments in my life; oftentimes I found myself encountering the right people at the right time, people who came to be teachers, mentors, colleagues and friends. I am forever grateful for the education my parents provided me which in many ways started me on this long and unexpected journey. At Horace Mann my English teacher Deborah Stanford and my physics teacher Jeff Weitz, each, in their own way, taught me that there were stories to be found everywhere, especially in science.

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TABLE OF CONTENTS

INTRODUCTION

The *Challenger* Expedition

> The mission of the *Challenger* was then to traverse the great oceans and seas of the world, and at many points along her course to establish stations for scientific observations. We were to determine, whenever possible, the depth of the ocean. To ascertain the nature of the deposits taking place over the floor of the ocean. To procure specimens of sea water from various levels from the surface to the bottom, and to examine these chemically and physically. To ascertain the temperature of the ocean at various depths from surface to bottom. To catch, examine, and bring home the creatures that live in the surface and deep waters of the ocean and on the bed of the sea itself. To measure ocean currents. To take magnetical and meteorological observations daily. In short, to carry on whatever researches might throw light on the physical, chemical, and biological conditions of the deep sea, and, in addition, to examine the plants, animals, and geological structure of all oceanic islands and other little-frequented lands visited by the ship.[1]

These were the words of John Murray, one of the *Challenger* expedition naturalists, in a public lecture in Manchester, England one year after the end of the ship's circumnavigational voyage. At the time of HMS *Challenger*'s launch the expedition was touted as the most complete and systematic exploration of the deep sea ever pursued. As the above quotation reveals the goals were no less than to produce the most comprehensive knowledge of the world's oceans through measurements, specimen collection and observation. HMS *Challenger* sailed around the globe for nearly four years, from 1872 to 1876, and in that time took measurements at 348 individual stations in the ocean.[2] The results of the expedition

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[1] John Murray, 'The Cruise of the Challenger. (first lecture) Delivered in the Hulme Town Hall, Manchester, December 11th, 1877. By Mr. John Murray, F.R.S.E. Member of the Scientific Staff, H.M.S. Challenger', in *Science Lectures for the People Delivered in Manchester*, Manchester, 1866-1880, pp.105-106.

[2] Station Logs, 1872 – 1876, Murray Collection, MSS, Box 93, Natural History Museum Archives (NHM), London, UK.

were reported in various forms and concluded with the publication of a fifty-volume report nearly twenty years after the end of the expedition.[3]

The expedition's research made many important contributions to scientific discourse of the period. The expedition's scientific staff measured and catalogued oceanic depths around the globe. Combined with extensive collections of sediment and specimens this laid the foundation for a global map of the ocean floor. They collected numerous botanical and zoological specimens, among which dozens of new species were recorded for the first time. Other results from the expedition included depth and temperature measurements which furthered the understanding of ocean tides and currents, photographs and sketches of native populations encountered, and photographs of geological and oceanic formations, including some of the first photographs taken of Antarctic icebergs. Additionally, many of the technologies and techniques used to acquire data were developed and refined over the course of the expedition and laid the foundation for the ways in which the ocean was studied into the twentieth century.

The *Challenger* expedition is almost universally known as the beginning of modern oceanography. It is viewed as a success story and as an emblem of the significant contributions late-nineteenth-century British maritime expeditions have made to contemporary science.[4] As one scholar phrased it, "the *Challenger*

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[3] Charles Wyville Thomson, *Report of the Scientific Results of the Voyage of HMS Challenger during the years 1872 – 1876 under the Command of Captain George S. Nares, R.N., F.R.S. and Captain Frank Turle Thomson, R.N. Prepared under the Superintendence of the Late Sir C. Wyville Thomson, Knt., F.R.S., &c. Regius Professor of Natural History in the University of Edinburgh, Director of the Civilian Scientific Staff on Board and now John Murray, One of the Naturalists of the Expedition: Introduction to the Zoology Reports,* Her Majesty's Stationery Office, London, 1880.

[4] In the UK the *Challenger* expedition is a popular narrative well known by both scientists and the general public. As anecdotal evidence of its position in popular memory, the Natural History Museum in London recently developed the exhibition "The Deep Sea" which was centred on its collection of specimens gathered on the original expedition as

expedition had the same significance for the English Victorians as the Apollo moon landings had for Americans a century later".[5] The dominant narrative, one that has been moulded as much by popular memory as by scholarly accounts, emphasises the expedition's legacy as a successful episode in the attainment of oceanographic knowledge above historical factors; even broad historical narratives that include the Challenger episode tend to ignore its roots in nineteenth-century British imperial history. The popular legacy of the expedition has placed its historical significance firmly within oceanography. The contributions of this single expedition are seen as foundational to scientific knowledge of the ocean. This legacy however has overshadowed historical readings of the expedition as the epitome of modern science. Beyond its position within the history of oceanography, the *Challenger* expedition is an exemplar of modern science more broadly. The expedition demonstrates how notions of modern science promoted novelty and innovation in order to appear as revolutionary forms of knowing but were simultaneously predicated on long traditions of practice and knowledge. In this thesis I examine the expedition's role in early studies of the deep sea while also exploring the ways in which the *Challenger* narrative informs our theoretical understanding of modern science.

The *Challenger* expedition was originally coined the 'Scientific Circumnavigation Voyage' before the specific ship, HMS *Challenger* – already an active Naval screw corvette – was chosen for the expedition. Upon selection, the ship was renovated for scientific work. As Head Naturalist Charles Wyville Thomson remarked, "This is, I suppose, the first time in History that any Government has sent

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well as a multimedia presentation of the history of the Expedition and its legacy. Additionally, the Royal Society has a permanent display of photographs and drawings from the expedition in its newly renovated Library & Archives.

[5] William A. Berggren, "First Views of the Depths," *Science*, 302, 5647 (2003), p.989.

out an important and costly Expedition, under adequate scientific superintendence and with full appliances, with a purely scientific object".[6] The ship's crew of approximately 270 men was accompanied by a scientific staff of six who were employed solely for the purpose of scientific work. Led by Wyville Thomson, who had previously held the Regius Chair of Natural History at the University of Edinburgh, the staff also included naturalists Henry Nottidge Moseley, Rudolf von Willemöes Suhm, and John Murray; chemist J.Y. Buchanan; and secretary and artist J.J. Wild.[7]

The popular discourse surrounding the expedition portrays it first and foremost as a scientific expedition with limited connections to the naval or colonial projects of the period. In the prologue to the preliminary report on the *Challenger* voyage, Charles Wyville Thomson, the head naturalist of the expedition, asserted that:

> Captain Nares [the original Naval Captain of the *Challenger*] and Captain Thomson [Nares' replacement] both fully recognize that the expedition was intended for scientific purposes and I do not think that

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[6] Charles Wyville Thomson to Secretary of the Treasury, October 30, 1876 reproduced in *Minutes of the Meeting of the Council of the Royal Society,* December 7, 1876, Royal Society Archives (RS), London, UK.

[7] One of the most entertaining descriptions of the scientific staff was provided by Herbert Swire, a young sub-lieutenant on the expedition and a keen observer of the daily goings on of the ship: "First, then, as head of the civilian scientific staff, we have Professor Thomson, or rather Wyville Thomson. He gave up an appointment worth some £2,000 a year to join this ship, where he gets only half that sum, but will doubtless have the satisfaction of placing his name on the roll of fame with those of eminent scientific men who have gone before him. The Professor is a stoutish man, and has not yet got over his sea sickness, so I know little or nothing of him personally. Then there is Murray, naturalist I think, who is the sailor-like individual before mentioned [he had recently returned from a 'pleasure trip' on a North Sea whaler]; Buchanan, whose strong point in science I have not yet discovered, and who is the gentleman whose athletic feat I have described; von Suhm, a botanist and a Dane or German, and a decent sort of fellow to boot, and the youngest of the 'philosophers', as we call them; Wild, artist and Swiss, who is very dyspeptic and seldom is to be observed by the eye vulgarus; Moseley, naturalist, and chock-full of science, even unto bursting." See Herbert Swire, *The Voyage of the Challenger: A personal narrative of the historical circumnavigation of the globe in the years 1872 – 1876*, Golden Cockerel Press, London, 1938, p.11.

> in one single case the operations of the combined scientific staff were hampered in the least by avoidable service routine.[8]

The rhetorical delineation between the "scientific purposes" of the expedition and the routine work of running the ship contributes to the notion that this expedition was primarily scientific and distinct from earlier surveying expeditions. This type of language, and the artificial boundary between science and the Victorian empire it invokes, has been reproduced by historians who portray the expedition as an example of scientific innovation while also downplaying its historical context. Historians often highlight the on-board laboratory spaces and the scientific staff as legitimising evidence that the *Challenger* was engaged in a purely scientific endeavour, rather than one intertwined with the imperial practices typical of the Royal Navy.[9]

At the end of the expedition, the scientific staff returned to Britain to much acclaim. Many of the men were made members of the Royal Society with their participation on the voyage specifically cited.[10] The expedition propelled further deep-sea exploration and continued as a relevant source of oceanographic knowledge in the following decades. The published *Scientific Reports*, completed in 1895, were distributed across the globe and were often taken aboard international scientific maritime expeditions as reference material.[11]

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[8] Charles Wyville Thomson, *The Voyage of the Challenger: The Atlantic; a preliminary account of the general results of the exploring voyage of HMS Challenger during the year 1873 and the early part of the year 1876, Harper & Brothers, New York, 1878,* p.xii.

[9] See Richard Corfield, *The Silent Landscape: The Scientific Voyage of HMS Challenger*, The Joseph Henry Press, Washington, DC, 2003; and Anne-Flore Laloë, 'Where is *Bathybius haeckelii*? The Ship as Scientific Instrument and a Space of Science', in Don Leggett and Richard Dunn, eds., *Re-inventing the Ship: Science, Technology and the Maritime World, 1800 – 1918*, Routledge, London and New York, 2012, pp.113-130.

[10] Certificates of a Candidate for Election, John Young Buchanan, 1887, EC/1887/03, and John Murray, 1896, EC/1896/13, RS, London, UK.

[11] John Murray, *Report of the Scientific Results of the Voyage of HMS Challenger during the years 1872 – 1876 under the Command of Captain George S. Nares, R.N., F.R.S. and Captain Frank Turle Thomson, R.N. Prepared under the Superintendence of the Late Sir*

The *Challenger* expedition took place in a distinct historical moment at the cusp of a modern era. In numerous ways the expedition reflects the destabilisation and uncertainty that surrounded the social, cultural and scientific foundations of the period. Norms and logic which had underpinned dominant epistemologies since the classical era were disrupted, leaving anxieties and providing new possibilities for social order and knowledge production. The transformation of the foundation of order, to use Michel Foucault's terminology, created entirely new conditions of possibility. I locate the *Challenger* expedition in the moment of transition, where the foundations of order of the classical period had not yet been fully rejected, and where new order was in the process of being established. The historical legacy of the *Challenger* highlights the active contribution that the expedition made to this process of reconfiguration which characterises the transition to the modern era.

So what were the major effects of this modern decontextualisation? Firstly, there was a transformation of the temporal. From almost immediately after the conclusion of the expedition in 1876, the practices became detached from their historical moment. There was a steady stream of publications around the findings of the expedition through to the final contributions to the *Scientific Reports*. Although firmly grounded in Victorian scientific practice, the *Challenger* findings have not dated the same as other types of scientific practices and knowledge of the era. Natural history, ethnology, and even some surveying techniques were quickly considered out-dated and non-modern science by the twentieth century. However, the science of the expedition, which was constituted by these categories, did not suffer the same fate.

C. Wyville Thomson, Knt., F.R.S., &c. Regius Professor of Natural History in the University of Edinburgh, Director of the Civilian Scientific Staff on Board and now John Murray, One of the Naturalists of the Expedition: A Summary of the Scientific Results: Historical Introduction, Her Majesty's Stationery Office, London, 1885.

Additionally, the expedition came to be seen as a novel configuration, one distinct from the long tradition of naval and scientific expeditions that had gone before it. Despite hundreds of years of naval expeditions, including many that had specific scientific missions, the *Challenger* came to hold a unique place in maritime history. The route of the expedition, and the imperial mission to traverse the entire globe in a circumnavigation, established the guidelines and standards for the science of oceanography. The tradition of maritime circumnavigations came out of an imperial power dynamic developed over several centuries, beginning with Christopher Columbus in the fifteenth century.

While the dominant rhetoric around the Challenger expedition emphasised its novelty, the pursuit was not entirely new, not even for the participants themselves. HMS *Challenger* was conceived and funded after the success of separate expeditions on HMS *Lightning* and HMS *Porcupine* in the late 1860s that conducted deep-sea sounding and dredging in the Atlantic Ocean. Challenger head naturalist Wyville Thomson participated in these earlier missions ahead of being selected for the circumnavigation.

The conclusion of the expedition marked the beginning of a new period of inquiry, research and publication which would carry the work of the *Challenger* into the twentieth century. Over the course of the expedition, preserved specimens were shipped back to the University of Edinburgh where it was agreed between Wyville Thomson and the Lords Commissioners of the Admiralty they would be held until the conclusion of the voyage. These were overseen by Professor William Turner until Wyville Thomson's return, when the vast collection was completed with the remainder of specimens brought back aboard HMS *Challenger*.[12] Soon after, however, conflict arose between Wyville Thomson, who desired to keep the entire collection with him in Edinburgh, and representatives of the government, who argued the entire collection should be transferred to the natural history department of the British Museum (now known as the Natural History Museum) as items of national significance. Correspondence shows that this debate soon became acrimonious and caused considerable damage to Wyville Thomson's reputation amongst many of his funders and collaborators.[13] It was finally agreed that Wyville Thomson would retain the majority of the collection in Edinburgh in order to complete the *Scientific Reports* under the auspices of the newly established Challenger Office.[14] Eventually John Murray, who took over leadership at the Challenger Office when Wyville Thomson passed away, transferred the specimens to the Museum, which has retained them to this day.

Research and writing relating to the expedition carried on much longer than anticipated. Correspondence reflects ongoing challenges in coordinating the completion of the vast collection of *Scientific Reports*. By 1882 it was decided that

[12] T.H. Tizard, H.N. Moseley, J.Y. Buchanan, and J. Murray, *Report of the Scientific Results of the Voyage of HMS Challenger during the years 1872 – 1876 under the Command of Captain George S. Nares, R.N., F.R.S. and Captain Frank Turle Thomson, R.N. Prepared under the Superintendence of the Late Sir C. Wyville Thomson, Knt., F.R.S., &c. Regius Professor of Natural History in the University of Edinburgh, Director of the Civilian Scientific Staff on Board and now John Murray, One of the Naturalists of the Expedition: Narrative of the Cruise of HMS Challenger with a General Account of the Scientific Results of the Expedition, Parts I and II,* Her Majesty's Stationery Office, London, 1885, p.946.

[13] Unconfirmed meeting minutes of the Council of the Royal Society, 26 October 1876, JDH/1/14/2/221, RS, London, UK; and [no author], *Correspondence Concerning the Specimens and Collections made by the 'Challenger' Expedition*, Taylor & Francis, London, 1877.

[14] The Challenger Office was established for the purpose of organising and disseminating the vast amounts of material collected during the expedition, and it remained open at least through to the end of the nineteenth century and the final publication of the *Scientific Reports*. It is unclear when the Challenger Office was closed, but it appears to have been inactive since the 1910s.

Thomson would focus on writing the *Narrative* while responsibility for coordinating the *Scientific Reports* would be handed over to Murray. While this was attributed primarily to Wyville Thomson's failing health, it appears that it was also partly motivated by the Government representatives' ongoing frustrations with Wyville Thomson and his perceived inability to finish the work in a timely manner.[15] Upon Wyville Thomson's death in March of 1882 responsibility for all *Challenger*-related publications and researches fell to Murray.

The task of sorting through the research notes and physical collections became such a significant undertaking that Wyville Thomson decided, in conjunction with the Royal Society, to delegate the work of writing up the individual reports to experts in each area. Divided up by species, the notes and specimens were distributed out to the top naturalists, who in turn took months or years to work through the material in order to write up the report. Contributors included eminent members of the global scientific community including William Turner, Ernst Haeckel, Alexander Agassiz, and William Carpenter. Publication of the *Scientific Reports* and other related materials began soon after; however, the full collection was not completed until 1895.

The *Narrative* was published and bound in several volumes and copies were gifted to hundreds of scientific institutions around the world. This work, along with the preliminary reports, personal narratives, scientific reports and other additional materials were used as reference materials by early oceanographers well into the twentieth century. Wyville Thomson suggested, "Since the return of the *Challenger*, the work of the Expedition has been largely intermixed with all subsequent abysmal researches carried out by British and foreign expeditions, these being, in many respects, supplementary or limited to special regions of the ocean, none of them

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[15] [no author], *Correspondence Concerning Specimens.*

partaking of the world-wide and general character of the *Challenger* explorations."[16][17]

Due in part to the central role the *Challenger* holds within contemporary oceanography, including continuities of knowledge and practice, as well as its place in popular British memory, the expedition's historical legacy has been moulded by public accounts in addition to scholastic ones. Often these popular histories frame the *Challenger* through a present-centred lens. Typically these accounts present the ocean as an ontological constant primed for scientific investigation. Their history of oceanography therefore is a progressive narrative beginning with the *Challenger* and

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[16] John Murray, *Report of the Scientific Results of the Voyage of HMS Challenger during the years 1872 – 1876 under the Command of Captain George S. Nares, R.N., F.R.S. and Captain Frank Turle Thomson, R.N. Prepared under the Superintendence of the Late Sir C. Wyville Thomson, Knt., F.R.S., &c. Regius Professor of Natural History in the University of Edinburgh, Director of the Civilian Scientific Staff on Board and now John Murray, One of the Naturalists of the Expedition: A Summary of the Scientific Results: Historical Introduction,* Her Majesty's Stationery Office, London, 1885, p.104.

[17] The prolific nature of the expedition participants, and in a sense of the expedition itself, is a defining part of its historical legacy. The circulation of reports, images, and collected specimens promoted the success of the expedition and embedded its research and findings into scientific discussions at the turn of the century. The end of the circumnavigation also marked the beginning of a regenerating existence for HMS *Challenger*, one that is continually re-found in the archives. I am merely the latest of many historians to have worked with *Challenger* manuscript materials. The circuitous and sometimes uncharted lives of these archival items since the late 19th century means that almost no two historians have pursued to the same path in finding them. The archival materials are scattered across institutions and libraries throughout the UK. The Natural History Museum in London houses the actual faunal specimens collected during the expedition along with manuscript materials relating to the collection. Manuscript documents relating to the naval operations of the expedition can be found in multiple places including the Royal Geographical Society which houses the collections of three of the naval officers: Pelham Aldrich, Balfour, Andrew Francis, and RA Richards; the National Maritime Museum, and the National Archives. Materials are also located in the British Library and the archives of the University of Edinburgh, which housed the Challenger Office until it went dark some time in the early twentieth century. In these present locations one can see hints of the debates over ownership in which expedition participants and government representatives were engaged at the conclusion of the expedition. Given their impressive size and grandiose delivery, the official Challenger Reports have been preserved and retained by many of the educational institutions which first received them in 1895. I personally have examined individual copies in institutions as far reaching as the University of Auckland, the British Library and Cornell University. This thesis has taken form by tracing the paths of these various materials. I have attempted to make apparent the ways in which historical narratives are contingent on a material legacy and how the ongoing lives of these objects extends the temporal boundaries of an historical event.

covering over a hundred years of exploration of the sea that has continually revealed more information. This type of whiggish history is considered out dated in the history of science, but is still popular in science writing and science journalism.[18]

Previous academic scholarship on the *Challenger* expedition primarily focuses on two aspects: the distinction of the ship as a scientific space and the role of the expedition within the field of oceanography. There are also other common themes found in narrative accounts including the collaboration between the Admiralty and the Royal Society, the natural history of the deep sea, and the social order on board the ship between the naval crew and the scientific staff. Overall, scholars have typically chosen to focus on the materiality and physical spaces of the ship, which leads to detailed accounts of the practices and social order of the *Challenger* ship but often excludes broader cultural and social context for the expedition and its scientific results.

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[18] Richard Corfield, The Silent Landscape: The Scientific Voyage of HMS Challenger, The Joseph Henry Press, Washington, DC, 2003.
Science writer Richard Corfield published perhaps the most well-known history of the Challenger, The Silent Landscape, in 2003. Corfield approaches the Challenger with a present-centred lens on the scientific practices of the expedition. He introduces his book as, "the science of the Challenger expedition updated, focusing not just on what the expedition did find but what it *would have found* if it had on board someone with a knowledge of early twenty-first-century biology, physics, and chemistry." (emphasis author's own) Corfield depends primarily on the published narrative accounts of the expedition from members of both naval and scientific staff. Corfield's book is structured around the chronological account of the four years at sea, which is then infused with discussions of later scientific events which he believes are tied to the work that took place during the time of the Challenger.
Throughout his book Corfield contributes contemporary scientific views on various discoveries and observations that were made during the original Challenger expedition. However in almost all cases he explains the technological and scientific improvements and advancements that provide for the revised knowledge, rather than contextualising the shift in knowledge claims. This prevents him from writing a history that demonstrates the tenacity of certain aspects of the expedition, or why certain types of scientific knowledge from the late nineteenth century still hold authority as scientific knowledge over one hundred years later.

Helen Rozwadowski's book *Fathoming the Ocean* is arguably the most relevant text that covers the expedition in any detail, and it is upon this that my work builds. Rozwadowski's history traces the study of the deep sea over the course of the nineteenth century, primarily focusing on British and American exploration and the *Challenger* is a central example recurring throughout the book. This text has made significant contributions to the history of oceanography and engages with the history of science and environmental history. It directly responds to a history of oceanography that has typically positioned the *Challenger* as the start of a Kuhnian revolution and emphasised the emergence of a modern science distinct from earlier practices. While Rozwadowski acknowledges the chronological evolution of the field that previous scholars have established, identifying the development of modern oceanography from the mid-nineteenth century onward, she anchors various aspects of nineteenth-century oceanographic practices to technologies and knowledge claims from a prior period. Rather than emphasising the novelty of modern oceanography, she identifies the epistemological origins of the deep sea in factors such as fictional voyage narratives, natural history practices and hydrography technologies, all of which have much longer histories pre-dating the nineteenth century. In doing this, she specifically pushes back against the emphasis on novelty and innovation as attributes of the *Challenger* expedition that is evident in other histories:

> The *Challenger* expedition has been remembered as a landmark national accomplishment and the genesis of the science of oceanography. Although its fifty-volume report arguably serves as the intellectual foundation of the field, the expedition itself represented the culmination of midcentury questions, practices, and traditions of ocean investigation. It was novel only in its huge scale.[19]

[19] Helen Rozwadowski, *Fathoming the Ocean: The Discovery and Exploration of the Deep Sea*, Belknap Press, Cambridge, MA, 2005, p.168.

Rozwadowski situates the *Challenger* within a much longer history of oceanic exploration and investigation of the deep sea. She also uses the expedition to highlight the continuities that deep-sea exploration had to an earlier era of maritime voyages and exploration. Particular attention is paid to the technologies and techniques used for trawling, dredging and sounding which are similar to current methods and often identified as originating from the *Challenger*. Rozwadowski draws on earlier expeditions, including the immediate predecessors HMS *Porcupine* and HMS *Lightning*, to highlight the ways in which the *Challenger* was part of a longer history of experimenting and developing successful techniques for deep-sea research.

As suggested by her title, Rozwadowski examines the ocean as an epistemological construct that evolved out of nineteenth-century thinking. She argues that the ocean as a concept within the British imagination emerged as Britons ventured further and further away from the shore. In this way the ocean conceptually expanded through a growing number of encounters. Prior to popular seafaring in the nineteenth century, the majority of Britons would encounter the ocean only as the shore; and in this sense the ocean only existed as a linear boundary. As more and more Britons began to experience the ocean at sea, the ocean evolved from a shallow watery wall, to an expansive open waterway.[20] Rozwadowski identifies a similar process regarding the depths of the sea. Just as the geographical expanse of the ocean grew so too did the depths of the ocean as natural historians and maritime explorers focused on the vertical dimensions of the sea.

Building on Rozwadowski's comprehensive narrative of the origins of modern oceanography, my thesis demonstrates the ways in which oceanography exemplifies the generation of modern science more broadly. While it may seem at first ambitious

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[20] Rozwadowski, *Fathoming the Ocean*, p.9.

to focus on a single maritime expedition in order to theorise on modern science, this thesis demonstrates how singular historical events, like the Challenger expedition, came to be known as a signifier of an epistemological sea change. In exploring the historical contributions that the expedition made to early studies of the deep sea, I also examine the ways in which that knowledge-making process constituted modernity.

The Ship as Heterotopia

> Brothels and colonies are two extreme types of heterotopia, and if we think, after all, that the boat is a floating piece of space, a place without a place, that exists by itself, that is closed in on itself and at the same time is given over to the infinity of the sea and that, from port to port, from tack to tack, from brothel to brothel, it goes as far as the colonies in search of the most precious treasures they conceal in their gardens you will understand why the boat has not only been for our civilization, from the sixteenth century until the present, the great instrument of economic development (I have not been speaking of that today), but has been simultaneously the greatest reserve of the imagination. The ship is the heterotopia par excellence. In civilizations without boats, dreams dry up, espionage takes the place of adventure, and the police take the place of pirates.[21]

In *Of Other Spaces* Michel Foucault outlines his general thoughts on heterotopias: physical places which embody and contain multiple spaces simultaneously. Famously Foucault argued that ships were heterotopias *par excellence*. A heterotopia “is capable of juxtaposing in a single real place several spaces, several sites that are in themselves incompatible”.[22] This thesis follows in a long tradition of history of science which aims to contextualise the complex configurations of a historical moment in order to understand the construction of scientific knowledge. The HMS *Challenger* expedition laid the foundation for

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[21] Michel Foucault, ‘Of Other Spaces’, *Diacritics*, 16, 1 (1986), pp. 27.
[22] Foucault, ‘Of Other Spaces’, p.23.

modern oceanographic knowledge that has underpinned much of twentieth and twenty-first-century deep-sea research. Heterotopia as a mode of analysis allows for new understandings of the multiple dimensions of the *Challenger* expedition, which elevates an understanding of the material constraints of the expedition alongside the scientific epistemology and historical narratives.

What makes this narrative unique, and a story worth telling, is that the expedition and the ship itself became a link between disparate activities. As Foucault offers, "Structuralism, or at least that which is grouped under this slightly too general name, is the effort to establish, between elements that could have been connected on a temporal axis, an ensemble of relations that makes them appear as juxtaposed, set off against one another, implicated by each other – that makes them appear, in short, as a sort of configuration."[23] By analysing HMS *Challenger* as a heterotopia, I aim to demonstrate that the foundations of modern oceanography were laid by a diverse and expansive set of scientific practices of the nineteenth century. Oceanography was not a discipline as such when HMS *Challenger* set sail in 1872. However over the course of the expedition, these practices were reconfigured thereby constituting the modern science of oceanography.

How does one define the boundaries of a historical project? One possibility is to use the physical space of the ship and the temporal organisation of its circumnavigation as the defining boundaries. However, this can exclude activities and practices which contribute to the expedition as a historical event. How do we consider the activities of expedition participants once they disembarked from the ship into colonial lands? What about the histories and experience of the expedition's scientific staff both before and after the voyage? How does one understand the construction of

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[23] Foucault, 'Of Other Spaces', p.22.

knowledge if we don't follow the extensive process of research and publication from expedition findings that continued into the twentieth century? Viewing the ship as heterotopia allows us to see the bounds of the ship and the bounds of the expedition as flexible and oft-changing phenomena. In effect, the physical boundaries of the ship transform at sea and on land. The ship at sea and the ship in port are a single heterotopia with differing bounds; but taken together we can begin to see the diverse set of practices and interactions which contributed to the expedition's knowledge making. Similarly, the temporal bounds of the expedition expand and contract depending on which aspects we choose to examine. The voyage, which can be defined as a discrete historical moment, transforms into a broader history when considering the vast network of experiences, practices, and knowledges which contributed to it. Accommodating the fluid and ambiguous boundaries of this historical moment produces the thesis that follows; it reconnects disparate activities and events and their seemingly incongruous forms into a coherent narrative.

This thesis considers the extent to which scholarly understandings of the HMS *Challenger* expedition as the originator of modern oceanography have detached it from its historical origins. As a symbol of modern science the expedition has been decontextualised from the social, cultural and political factors which informed the shape of the expedition and the knowledge it produced. Historicising the expedition reveals the processes of scientific-knowledge making in the modern era that contributed to such an effective and resilient decontextualisation. Recovering this history reveals that the history of the ocean is also a story of the science of the ocean. Understanding the *Challenger* expedition as the origins of modern oceanography is to explore the interconnection between science and history that forms our current understanding of the ocean.

Chapter Overview

Chapter 1: "Cosmopolitan Nature: Circumnavigations, Natural History, and the debate over Natural Selection" situates the expedition within the broader context of nineteenth-century natural history. Focusing on a contentious exchange between Wyville Thomson and an aged Charles Darwin, this chapter examines the expedition's contribution to, and agitation of, contemporary debates around the theory of evolution and the mechanics of natural selection. By contextualising this debate as well as the expedition within a history of nineteenth-century scientific voyages and the rise of Humboldtian science, it demonstrates that the ocean came to be seen as a new frontier for the exploration of evolutionary theory in natural history.

Chapter 2: "Situating the Local in a Global Expedition" focuses on HMS *Challenger*'s time in and around New Zealand in order to examine how local interactions and experiences contributed to the expedition. The scientific staff constructed a coherent narrative of their circumnavigation, and they used this positioning to support universal knowledge claims about the ocean, the deep sea, and the natural world. However this global expedition was a mosaic of local interactions and location-specific activities that included numerous invisible participants, local accommodations, and culturally specific practices. This close reading of the time spent in New Zealand reveals the nature of these component parts in order to better understand what constitutes a scientific circumnavigation.

Chapter 3: "The Superior Advantages of HMS *Challenger*" explores the role of the expedition in connection with Thomas Huxley's late nineteenth-century discovery, and consequent revocation, of the protoplasm *Bathybius haeckelii*. This chapter proposes that the ship itself facilitated new temporal and spatial relationships between specimen collection and examination. HMS *Challenger* transformed into a moving centre of calculation through its scientific reconfigurations, thereby allowing for observation and analysis at the immediate place and time of collection, regardless of the distance from a metropolitan centre. Whereas Huxley's initial discovery followed a typical pattern of scientific practice, where specimens would be collected, preserved and then brought back to the metropolitan laboratory for observation and analysis, the eventual refutation occurred because collection and analysis could occur at the same time and place, even in the middle of the Pacific Ocean. I argue that the *Bathybius* episode highlights how HMS *Challenger*, as a moving centre of calculation, reconfigured peripheral localities as spaces in which authoritative scientific observation and analysis could occur, thereby revolutionising their role in late nineteenth-century scientific knowledge production.

Chapter 4: "'What we get and how we got it': Science and Imagery on the *Challenger* Expedition" engages with the visual imagery made during the expedition. Despite the fact that the expedition participants produced a large and diverse collection of images they very rarely attempted to visually depict the underwater environment. This chapter examines the challenges of imagining the deep sea and highlights how the scientific staff, inspired by a Humboldtian approach to natural history and focused on large amounts of numerical data, constructed tables and graphs which became the dominant visual representation. This chapter also explores the continuing fascination and apparently contradictory presence of mermaids, as a representation of the fantastical aspects of the deep sea, in *Challenger* materials. I suggest that given the paucity of scientific imagery, these artistic visual renderings remained, even to the extent that they worked in concert alongside the *Challenge*r's scientific data of the ocean.

Chapter 5: “Researches on Land and Sea: Ethnological Observations during the *Challenger* Expedition” examines the ethnological research of the expedition. While the *Challenger* is well remembered for its contributions to oceanographic science, less is known about the expedition’s work in the nineteenth-century sciences of ethnology and anthropology. Ethnology, the study of other races and cultures, played an important role in Victorian science, and from this tradition the scientific staff of the *Challenger* expedition made ethnological observations, journal entries and field notes at almost all terrestrial stops over the course of the expedition. While one might assume that these interests were inconsequential to the central focus on oceanographic knowledge, they were an integral part of the expedition’s mission and its resulting scientific legacy. The *Challenger* materials indicate that natural history and ethnology were conceived of in similar ways: just as nineteenth-century naturalists were trying to accommodate the entirety of the natural world into a single comprehensive and commensurable knowledge system, so too were ethnologists trying this with the human world. And therefore, if we can see, and acknowledge, the cultural context of early race sciences, we should also be able to identify similar cultural influences in the study of the ocean.

Chapter 6: “The Modern Ocean” interrogates the expedition’s mantle as *modern science*. Modernity demands historicity, a temporal framework that demonstrates continuities and ruptures with the past and present. At the time of the expedition the ocean had a long and established history, and it was one that informed the *Challenger*’s scientific staff; however, the modern formation of the expedition supplanted this history with a newly conceived scientific history of the ocean. Although the Challenger came from a long tradition of maritime expeditions and natural history, it marks the beginning of modern oceanography specifically because it reconfigured these traditions into what appeared to be a revolutionary new kind of scientific epistemology.

This thesis demonstrates the modern conditions of possibility that allowed the *Challenger* expedition to take shape as it did, how it came to be viewed as an emblematic moment in modern science, and how modernity decontextualised the events of the expedition from longer histories of colonisation, scientific practice, and Victorian culture.

I. COSMOPOLITAN NATURE: CIRCUMNAVIGATIONS, NATURAL HISTORY, AND THE DEBATE OVER NATURAL SELECTION

Introduction

When HMS *Challenger* began its circumnavigation of the globe in 1872 Charles Darwin's publication *On the Origin of Species* had been in circulation for over a decade.[24] While both Darwin and fellow nineteenth-century naturalist Alfred Russel Wallace had incited considerable controversy with the introduction of the theory of evolution in 1859, by the 1870s the naturalist community in London was firmly grounded in evolutionary thinking. Many naturalists, including Darwin's most well-known ally Thomas Huxley, had turned their attention towards unanswered questions within an evolutionary framework. Darwin had asserted that all living creatures had evolved from a single origin and many had set their sights on identifying what, and where, that origin might be. The deep sea was a place of promise in many respects, but naturalists in particular believed that the ocean could house answers to many of these unanswered questions about evolution. As Helen Rozwadowski argues, "Darwin's evolutionary theory provided a new research program for taxonomists after 1859", which particularly suited marine naturalists.[25] By the early 1870s as William Carpenter, Charles Wyville Thomson and others advocated for a circumnavigation dredging expedition, the deep sea had come to be viewed as a potential depository of historical fossils which would shed light on past

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[24] Charles Darwin, *On the Origin of Species by Means of Natural Selection*, John Murray, Albemarle Street, London, 1859.

[25] Helen Rozwadowski, *Fathoming the Ocean: The Discovery and Exploration of the Deep Sea*, Belknap Press, Cambridge, MA, 2005, p.110.

geological and zoological changes. It was from this background that the *Challenger* naturalists set sail on a mission to examine depths of the ocean never before reached.

In 1880, nearly five years after the conclusion of the *Challenger* expedition, head naturalist Charles Wyville Thomson released the first official *Scientific Report* in what would eventually become a fifty-volume publication. This report was accompanied by Wyville Thomson's *General Introduction* in which he provided a short history of the expedition's origins in addition to an outline of the technologies, techniques, and practices used during the voyage. He also summarised some of the most significant findings from the expedition and asserted several generalised theories about the ocean and its natural history. In his conclusion he seemed at first to confirm the popular notion that the deep sea provided a window to early natural history:

> The discovery of the abyssal fauna, accordingly, seems to have given us an opportunity of studying a fauna of extreme antiquity, which has arrived at its present condition by a slow process of evolution from which all causes of rapid change have been eliminated.[26]

He then, however, made the following, rather surprising, conclusion:

> I believe that the study of the abyssal fauna, revealing many delicate chains of structural affinity linking the fauna of the present with that of the past, brings into prominence a new mass of facts… *in powerful support of the doctrine of Evolution*. On the other hand… the character of the abyssal fauna *refuses to give the least support* to the theory which refers the evolution of species to extreme variation guided only by *natural selection*.[27]

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[26] Charles Wyville Thomson, *Report of the Scientific Results of the Voyage of HMS Challenger during the years 1872 – 1876 under the Command of Captain George S. Nares, R.N., F.R.S. and Captain Frank Turle Thomson, R.N. Prepared under the Superintendence of the Late Sir C. Wyville Thomson, Knt., F.R.S., &c. Regius Professor of Natural History in the University of Edinburgh, Director of the Civilian Scientific Staff on Board and now John Murray, One of the Naturalists of the Expedition: Introduction to the Zoology Reports,* Her Majesty's Stationery Office, London, 1880, p.50.

[27] Wyville Thomson, *Introduction to the Zoology Reports,* p.50, emphasis added.

In short Wyville Thomson asserted that fauna from the abyssal region, which he broadly defined as oceanic depths below two-hundred fathoms,[28] affirmed the theory of evolution but provided no evidence in support of the central process by which evolution occurred: natural selection. The resulting controversy incited by Wyville Thomson's claims became evidence of the high stakes of scientific knowledge claims made by the *Challenger*'s scientific staff. The expedition, which had been undertaken in part to further knowledge of evolutionary theory, had resulted in a challenge to one of its fundamental components. Darwin was quick to defend the concept of natural selection and attacked Wyville Thomson in a letter which his son would later characterise as, "the only instance in which [Darwin] wrote publicly with anything like severity".[29] Given that Darwin had attracted innumerable attacks against his theory when it was first introduced, it may at first seem strange that he reacted so strongly at this late stage of his career when the theory of evolution had been generally accepted. In this chapter I argue that Darwin's reaction, and the nature of his exchange with Wyville Thomson, is evidence of the significance of both the *Challenger* expedition and its knowledge making of the natural world.

Although Darwin labelled Wyville Thomson's critique of natural selection as similar to that of "theologians and metaphysicians" it was in fact distinctly different because it was based on the same epistemology and expertise as Darwin's. [30] Additionally both Darwin's and Wyville Thomson's claims were founded on the basis of global maritime expeditions. That each man had completed a circumnavigation was neither coincidental nor superfluous to the scientific

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[28] Equal to six feet.
[29] Francis Darwin, *The Life and Letters of Charles Darwin, Vol. III*, London, 1887, p.242.
[30] Charles Darwin, 'Letter to the Editor: Sir Wyville Thomson and Natural Selection', *Nature,* 23, 576 (1880), p.32.

knowledge claims that they made. It was specifically their participation in the circumnavigation that gave them the position and authority to make particular arguments about the natural world. Therefore when Wyville Thomson questioned one of the foundational concepts of Darwin's evolutionary theory, it was the shared experience of a maritime circumnavigation and the authority to knowledge claims which it implied, that made the challenge so significant. Wyville Thomson claimed his research had demonstrated exactly what Darwin and other naturalists had anticipated and hoped for from the deep sea: it was a new frontier that promised answers to unresolved questions about the natural world.[31] But controversially, the answers it seemed to provide threatened one of the central tenets of Darwin's life work.

While the public feud between Darwin and Wyville Thomson was short-lived, their public exchange of letters is representative of the central debates around evolution and theories of the natural world that dominated nineteenth-century scientific discourse. It's my contention that the circumnavigational route of the *Challenger* gave shape to the types of knowledge claims that Wyville Thomson and the other naturalists were able to make. Their understanding of the deep sea, and their theories of natural history and climate, depended on a detailed and comprehensive study of the global ocean that involved thousands of data points taken over the course of their expedition. Further, the success of the expedition in establishing fundamental scientific knowledge of the ocean that would survive well into the twentieth century must be understood within a much longer history of the relationship between exploration, discovery and scientific knowledge production.

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[31] Wyville Thomson, *Introduction to the Zoology Reports*, p.50.

Circumnavigations: Science, Exploration, and Expansion of the Globe

That the voyage of HMS *Challenger*, which originated from the Circumnavigation Committee of the Royal Society, was a circumnavigation was neither coincidence nor inconsequential to the mission and accomplishments of the expedition. Circumnavigations demonstrated global power. The British Navy was particularly invested in these grand-scale voyages given the association between the British Empire and global ocean dominance. The histories of the British Empire and of the ocean were deeply entwined by the nineteenth century, and the study of the ocean was an extension of this history.[32] One of the most important accomplishments of the expedition was the construction of the ocean as a coherent and comprehensive object, one that was both large in scale and diverse in nature but could still be known as a single entity. The knowledge production of such an object was neither easy nor straightforward, but it rested with circumnavigation.

From the earliest conceptions of a round earth, circumnavigations were conceived and perceived as demonstrations of power. The function of individual expeditions varied but each was invested in a shared set of values related to knowledge of the earth, technological achievement, and financial resources. The realisation of this specific type of expedition occurred through several significant epistemological shifts in the early modern period. As Joyce Chaplin argues in her history of circumnavigations, the conception of a round earth, and the first successful attempt to traverse it, laid the foundation for the realisation of empire, beyond the

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[32] Michael Reidy and Helen Rozwadowski, 'The Spaces in Between: Science, Ocean, Empire', *Isis*, 105, 2, (2014), pp.338- 351.

conceptualisation of it: "If the Magellan/Elcano expedition had made the globe into a real object, a global stage on which humans actually did something, it also made plans for global empire real, more than metaphors."[33] After Magellan and Elcano's successful mission in the sixteenth century, they were described as having encircled, surrounded, and encompassed the globe. These terms, Chaplin asserts, had strong military connotations which emphasises the origins of these early circumnavigations. The term circumnavigation itself was not employed until the early seventeenth century.

The connection between circumnavigations and oceanic science can be found even in the linguistic roots. While the term fathom is today typically defined as oceanic depth measurements (in noun form) or to conceive or understand (in verb form), the term's original definition was "to encircle with extended arms".[34] The word, in verb form, made its first appearance in the English language in the fourteenth century, and was used both literally and figuratively (as in to understand) by the seventeenth century. The term's association with the ocean appears to have begun in the seventeenth century when it meant to reach the bottom of, either figuratively or literally. The noun fathom, representing a unit of measurement, was first approximated as an arm's length, and the contemporary measurement (six feet in length and typically used to denote depth) first came to use at the end of the seventeenth century and was firmly defined by the beginning of the eighteenth century. Although contemporary usage of the term tends towards the figurative, it is the literal meaning which provides a distinct connection to the *Challenger* and its circumnavigation. To fathom was to encircle, to encompass fully. And when the

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[33] Joyce Chaplin, *Round About the Earth: Circumnavigation from Magellan to Orbit*, Simon and Schuster, New York, 2012, pp.36-37.
[34] *Oxford English Dictionary* (Second Edition), Oxford University Press, Oxford, 1989.

Challenger set sail they had two main goals, to circumnavigate the globe, to encircle it completely, and to penetrate the deep sea, to reach the bottom. In this sense, the *Challenger* was a fathoming twice over. But while the exploration of the deep sea has been of continual interest to historians, oceanographers, and others, the aspects of the circumnavigation have received far less attention.

The association between maritime exploration and discovery predates the Age of Discovery.[35] In particular, the idea of an expanding globe began as a conceptual and semiotic shift and preceded the rise of empirical observation. In the early modern period cultural and geographical epistemologies accommodated a growing worldview based primarily on fictional travel narratives and other speculative writing. By the sixteenth century, maritime culture promised discovery, as David Wootton highlights, "voyages of discovery" as a phrase and concept developed in the latter part of the century.[36] It was not until an empirical revolution in the eighteenth century that authenticity and direct witnessing became requisite characteristics for authoritative knowledge production. In this way, an expanded globe was first imagined into existence. As maritime expeditions became more prevalent in the sixteenth and seventeenth centuries, geographical knowledge came to be constituted through both exploration and imagined possibilities.[37] The conceptual imaginings of this new geography were as important as the maritime expeditions in establishing knowledge claims. David Mackay suggests that the "utopian travel writing" in the seventeenth century gave way to "speculative accounts of territories acknowledged to be as yet

[35] Anthony Pagden, *European Encounters with the New World*, Yale University Press, New Haven, 1993.
[36] David Wootton, *The Invention of Science: A New History of the Scientific Revolution*, Penguin UK, London, 2015.
[37] John R. Gillis, *Islands of the Mind: How the Human Imagination Created the Atlantic World*, Palgrave Macmillan, New York, 2004.

undiscovered".[38] These lands, including the much-discussed *Terra Australis*, were "known" in the sense that there was a general belief in their existence and a constructed vision of their nature. The epistemological reality of these lands did not depend upon some empirical confirmation of their ontological reality. There is some debate among historians around characterising these speculative, or mythical, narratives of undiscovered lands. Mackay argues that in comparison to seventeenth-century travel writings, this eighteenth-century genre was less fantastical and more concerned with the commercial promise that new lands could offer to European powers.[39] Kerry Howe argues however that the undiscovered Pacific of the eighteenth century was the ultimate utopia. Howe suggests that the history of the Pacific after Cook's voyages is dominated by the metaphor of Paradise Lost. Europeans had been searching for paradise on earth. As the Pacific was perceived as the last unexplored part of the world, when they failed to find paradise there, they concluded that there was no possibility of paradise on earth. Regardless of these competing visions, both demonstrate the potentiality with which the Pacific was imbued.[40]

By the seventeenth and eighteenth centuries the imperial competition and economic interests which fuelled the Age of Discovery were tightly interwoven with knowledge claims about the natural world. As maritime exploration became more prevalent, and larger-scale missions were successfully completed, direct observation and authentic witnessing became important characteristics to scientific knowledge production. Parallel to the conceptual shift from imagination to speculation, empirically-based geography experienced a shift over the same period from a

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[38] David Mackay, 'Myth, Science and Experience', in Alex Calder, Jonathan Lamb, and Bridget Orr, eds. *Voyages and Beaches: Pacific Encounters, 1769 – 1840*, University of Hawai'i Press, Honolulu, 1999, p.108.

[39] Mackay, p.108.

[40] K.R. Howe, *Nature, Culture and History: The 'Knowing' of Oceania*, University of Hawai'i Press, Honolulu, 2000, p.14.

revolutionary cosmography to a new and defined globe. The round earth which had revolutionised geography had been established and accepted as fact; but there were still vast regions of this newly constructed globe which had not been directly observed or experienced by European explorers. Importantly, however, while these regions had not yet been explored, there was general consensus as to their existence. By this period the concept of discovery "carrie[d] an implicit sense that what has now been revealed had an existence prior to and independent of the viewer".[41] Explorers and geographers of the eighteenth and nineteenth century anticipated their discoveries, and the Pacific became the primary location which offered the potential for revealing previously unknown mysteries. Explorers of the eighteenth century firmly believed there to be known but "undiscovered" lands in the Pacific. Questions of geography, geology, and natural history were all tied together in the mystery of the Pacific Ocean.

The paradox of the Age of Discovery is that just as it was a period of discovery it was also a period of multiplying unknowns. The expanding globe dismantled the comprehensive cosmography of an earlier period, and laid bare the potential for an entirely revolutionary geography which would be re-constructed from new foundations. The incoherence that this created made the Age of Discovery one of extreme epistemological disruption. Christopher Columbus's encounter with the Americas exemplifies this. Anthony Pagden has argued that, "for all Europeans the events of October 1492 constituted a 'discovery'. Something of which they had had no prior knowledge had suddenly presented itself to their gaze".[42] But as Pagden, Anthony Grafton and others point out Columbus did not comprehend the New World

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[41] Pagden, *European Encounters,* p.6.
[42] Pagden, *European Encounters,* p.6.

as a new world.[43] Rather, he conceived of it in terms of lands that had previously been described by earlier explorers. Therefore, in Columbus' time his discovery was of an unknown unknown. The discovery of these unknown unknowns in the Age of Discovery – including new ocean spaces, the American continents, and the non-discovery of Terra Australis – provided the framework for an entirely new geography for explorers of the eighteenth century. This new framework transformed unknown unknowns into known unknowns. As the new geography became established in Columbus' time it was flexible and unbounded allowing for constant revisions to geographical knowledge, whereas by the eighteenth century the framework of geography was established enough to dictate what kinds of new knowledge claims it would accommodate. When Cook set out on his ambitious voyages in the late eighteenth century the Pacific was viewed as the world's most important known unknown. Many had speculated as to what the region might hold: Terra Australis, paradise on earth, or the lost city of Atlantis. But one of the most important legacies of Cook's expedition into the nineteenth century was that it had discovered the true nature of the Pacific, according to Europeans, and disproved the imagined reality of each of these possibilities.[44] By the time HMS *Challenger* set sail a hundred years after Cook's voyages, the Pacific was seen to be "known". But it was from this tradition of known unknowns that the deep sea came to replace the Pacific as the new space of potentially unlimited discoveries.

[43] Anthony Grafton, *New Worlds, Ancient Texts: The Power of Tradition and the Shock of Discovery*, Cambridge, MA, 1992.
[44] Howe, *Nature, Culture and History*, p.15.

Scientific Circumnavigations

Just as circumnavigations inspired new ways of conceiving of geographical discoveries over the seventeenth and eighteenth centuries, they also informed new scientific worldviews in the same period. Francis Bacon's conception of a revolutionary empirically based science in the seventeenth century was firmly grounded in the tradition of exploration of an expanding globe from the Age of Discovery. Not coincidentally, the cover page to his famous 1620 publication *Novum organum*, in which he introduced what would come to be known as the modern scientific method, depicted a ship sailing between the Pillars of Hercules, which represented the boundaries of ancient thinking, into the Atlantic Ocean, which represented both the unknown globe and the unbounded limits of new knowledge.[45] Historian Neil Rennie argues that Bacon's dominant theme was "the analogy between the new world of the voyagers and the new world of learning to be discovered and explored".[46] The ocean was therefore both a literal and metaphorical place for scientific discoveries.

The unique role of circumnavigations in connecting science, exploration and discovery can be traced back to the fifteenth century and the development of modern geography. In 1492 Columbus sailed westward from Spain in search of a new route to Asia and its wealth of spices. On his voyage he encountered lands not previously known by any European and in doing so demonstrated that the earth was round. While it is generally accepted that Columbus's reputation as the first to claim the earth was round is pure mythology his voyage played a significant role in laying the epistemological foundations for a round earth. In this same year German cartographer

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[45] Neil Rennie, *Far-Fetched Facts: The Literature of Travel and the Idea of the South Seas*, Oxford, 1995, p.39.
[46] Rennie, *Far-Fetched Facts*, p.38.

Martin Behaim created the world's oldest surviving globe, which depicted a round earth, the first physical representation of a revolutionary view of the natural world.[47] In this way, one could argue that it was in the late fifteenth century that the globe took shape. And importantly as historian Robert Silverberg points out, "only a spherical planet can be circumnavigated".[48] Circumnavigations play a significant role in this history of exploration and expansion both in form and function. They represent, both materially and symbolically, the coherence of the round-earth episteme. From their earliest conception they were a demonstration and enactment of power. The pursuit of a circumnavigation required a large set of epistemological, financial and political resources. The act itself required ownership and authority of geographical knowledge and scientific techniques which would allow a ship to successfully navigate the world's oceans, the financial support – typically from the monarchy – to undertake such a large voyage, and political backing to navigate contested maritime and terrestrial spaces along the way.

Just as maritime expeditions facilitated new conceptions of discovery, these discoveries also facilitated new conceptions of the ocean. As the great European powers of the fifteenth and sixteenth centuries began to sponsor large-scale maritime expeditions in pursuit of territorial expansion, exotic commodities and economic trade opportunities, the ocean itself became a place of discovery. The true discovery in the Age of Discovery was the ocean itself;[49] it marked new conceptualisations of the ocean and how it connected regions of the globe together. Historian J.H. Parry argues that the true accomplishment of Magellan's voyage to the Pacific and

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[47] Chaplin, *Round About the Earth*, p.11.
[48] Robert Silverberg, *The Longest Voyage: Circumnavigation in the Age of Discovery*, Athens, OH, 1972, p.5.
[49] J.H. Parry, *The Discovery of the Sea*, Berkeley, 1974, p. xii.

Columbus's voyage to the Americas was in creating a network of two localities, their European homes and the distant unknown. Both lands, Parry argues, were places of local knowledge known to different populations and the voyages succeeded in creating a connection which linked the two.[50] Similarly, Joyce Chaplin argues that prior to the Age of Discovery the globe was constituted by small bodies of water, all places of local knowledge, which were neither conceptually nor geographically connected.[51] By the sixteenth century these localities came to be connected through traversable waterways, thereby constituting the ocean as it was understood into the modern era.

By the nineteenth century scientific circumnavigations were a distinct type of achievement within the natural sciences. Particularly following Cook's voyages, circumnavigations held a particular type of authority in the pursuit of knowledge of the natural world. Circumnavigations facilitated research and observations across various regions, climates, land formations and oceans. They provided the opportunity to aggregate data in a way that could not be achieved by terrestrial-based science, or even regional-specific maritime voyages. Rhetorically and semantically much of the epistemological authority these circumnavigations held was due to the much longer tradition of exploration and discovery that had occurred in the early modern period.

HMS *Beagle* and HMS *Challenger*

Charles Darwin's voyage on HMS *Beagle*, which occurred at the very start of his scientific career, laid the foundation for his theory of evolution and the process of natural selection. Darwin published the seminal text *On the Origin of Species* in 1859,

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[50] Parry, *The Discovery of the Sea*, p.xiv.
[51] Chaplin, *Round About the Earth*, p.11.

twenty-three years after the conclusion of the voyage. Famously, Darwin only chose to publish after learning that his colleague and well-known naturalist Alfred Russel Wallace was soon to publish a very similar theory based on his own experiences on natural history maritime expeditions primarily in Asia.[52]

My focus here is upon how Darwin understood and articulated the connections between the *Beagle*'s expedition and his naturalist theories. In 1831 when Robert Fitzroy, a young naval captain, petitioned the Admiralty to sponsor a surveying expedition to South America Charles Darwin was a twenty-two year old Cambridge medical student with a budding interest in geology and natural history. The primary mission of the voyage was to conduct a large-scale survey of South America.[53] In the course of arrangements for the expedition Fitzroy desired to recruit a gentleman companion who would accompany him for the duration and who could also engage in natural history. Fitzroy was personally motivated to have a companion as he aimed to limit his socialising with the officers on board in order to maintain the strict hierarchy he believed was required for a successful voyage.[54] Although Darwin had had some experience in natural history he secured his position on the expedition through his social standing and connections. Darwin's role on the ship was distinct from the others on board in that he had no official duties and all of his expenses were covered by his father. And while it was not uncommon for maritime expeditions to involve natural history the work was typically supplementary to other naval priorities

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[52] See James T. Costa, *Wallace, Darwin, and the Origin of Species*, Harvard University Press, Cambridge, MA and London, 2014.

[53] This earlier expedition marked Fitzroy's first in command of a ship. In 1828 HMS *Beagle* was the support vessel for an expedition under Captain Philip Parker King tasked with surveying parts of South America. During the course of the expedition the Captain of the *Beagle*, Pringle Stokes, killed himself, leading Captain King to appoint Fitzroy to take over the command.

[54] Michael S. Reidy, Gary Kroll, and Erik M. Conway, *Exploration and Science: Social Impact and Interaction*, ABC CLIO, Santa Barbara, Denver and Oxford, 2007, p.106.

and was usually conducted by officers and crew members who had other responsibilities. As historian Iain McCalman explains:

> Fitzroy's request for a supernumerary naturalist was unusual. The Admiralty and Naval boards were not opposed to having a naturalist on survey voyages, but insisted that naturalism should be an extra and unpaid part of the work of someone on the ship's muster. By convention, the position had come to be regarded as the province of the surgeon or the assistant surgeon.[55]

With no official responsibilities and his pursuits in natural history well equipped and fully funded by family money, Darwin was in a privileged position to pursue his naturalist interests with undivided attention. However, with no real mandate from the expedition for any natural history, Darwin's locations, terrestrial expeditions, and collecting schedules were all at the mercy of the *Beagle*'s surveying route and routine. Further, his social position made him an outcast to the highly ordered organisation of the ship. McCalman notes that early on Captain Fitzroy, who had an amiable relationship with Darwin throughout the voyage, quickly gave him the nickname "Philos" which connoted, for better or worse, Darwin's role as philosopher, one who was "devoted to the study of such subjects as the character of man, nature, morality, literature and art", but also one who was out of place on board a ship.[56]

Darwin consistently referred to the *Beagle*'s voyage as a circumnavigation, and often invoked his participation as a credential in his study of natural history.[57] The shape and route of the voyage also gave a conceptual framework for how Darwin thought about his own geological and naturalist work. In a letter to his colleague W.D. Fox, he wrote that he intended to structure his contribution to the book he and

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[55] Iain McCalman, *Darwin's Armada: Four Voyages and the Battle for the Theory of Evolution*, Simon and Schuster, London, 2009, p.28.
[56] McCalman, *Darwin's Armada*, p.39.
[57] See C.R. Darwin to C.A. Murray, 24 December 1855, Darwin Correspondence Project, "Letter no. 1798," accessed on 16 June 2018, http://www.darwinproject.ac.uk/DCP-LETT-1798

Fitzroy were writing about the *Beagle* voyage as a "kind of journal of a naturalist, not following however always the order of time, but rather the order of position".[58] Whereas most nineteenth-century naturalists tended to publish their accounts of expeditions as diaries or journals, often with stylistic inspiration from popular fictional exploration narratives like *Robinson Crusoe*,[59] Darwin prioritised a geographical rather than chronological conceptualisation of his experience. Darwin used his narrative structure to emphasise regional comparisons and geographical significance within his scientific observations. The scale of the *Beagle*'s voyage, specifically the geographical area covered by its circumnavigation, allowed Darwin to make grand knowledge claims about the natural history of the world rather than simply of individual regions.

From the earliest murmurings of such an expedition, the *Challenger* was conceived of as a circumnavigation and its expansive character was continually emphasised in accounts of the voyage before, during, and after. The *Narrative*, which was, as with Darwin's writings on the *Beagle* voyage, in the style of earlier voyage narratives, reflects this:

> The vast ocean lay scientifically unexplored. All the efforts of the previous decade had been directed to the strips of water round the coast and to enclosed or partially enclosed seas; great things had certainly been done there, but as certainly far greater things remained to be done beyond. This consideration led to the conception of the idea of a great exploring expedition which should circumnavigate the globe, find out the most profound abysses of the ocean, and extract from them some sign of what went on at the greatest depths.[60]

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[58] C.R. Darwin to W.D. Fox, 12 March 1837, Darwin Correspondence Project, "Letter no. 348," accessed on 16 June 2018, http://www.darwinproject.ac.uk/DCP-LETT-348

[59] Richard Corfield, *The Silent Landscape: The Scientific Voyage of HMS Challenger*, The Joseph Henry Press, Washington, DC, 2003, p.228.

[60] T.H. Tizard, H.N. Moseley, J.Y. Buchanan, and J. Murray, *Report of the Scientific Results of the Voyage of HMS Challenger during the years 1872 – 1876 under the Command of Captain George S. Nares, R.N., F.R.S. and Captain Frank Turle Thomson, R.N. Prepared under the Superintendence of the Late Sir C. Wyville Thomson, Knt., F.R.S., &c. Regius Professor of Natural History in the University of Edinburgh, Director of the Civilian*

The immediate predecessors to the *Challenger* were the voyage of the HMS *Lightning* (1868) and the two voyages of HMS *Porcupine* (1869). All three expeditions, which were localised to the Atlantic, developed technologies and techniques to sound and dredge at oceanic depths never before reached by British naturalists.[61] After the success of these missions, prominent naturalist William Carpenter, who had spearheaded the voyages, again appealed to the First Lord of the Admiralty for a larger circumnavigation expedition.[62] While the proposed expedition was potentially revolutionary in form it was not in function. The *Challenger* was conceived of, and actively pursued, in the same tradition of practices and techniques as the *Porcupine* and *Lightning*. The participants themselves saw their tradition dating back much further than this, to oceanographic research that had been conducted over the previous fifty years. The most important contribution the *Challenger* was expected to make to this body of work was its comprehensive coverage of the globe, and the application of sounding and dredging techniques across all of the world's major oceans.

Through discussions and negotiations between the naval hydrographer, the Lords of the Admiralty and officers of the Royal Society the expedition was agreed in principle, with a committee of Royal Society members appointed to oversee the organisational planning of the expedition. The *Circumnavigation Committee*, as it came to be known, became the administrative coordinator for the expedition and

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Scientific Staff on Board and now John Murray, One of the Naturalists of the Expedition: Narrative of the Cruise of HMS Challenger with a General Account of the Scientific Results of the Expedition, Parts I and II, Her Majesty's Stationery Office, London, 1885*,* p.1.

[61] Tizard et. al., *Narrative,* p.51.

[62] Charles Wyville Thomson, *A Preliminary Account of the General Results of the Exploring Voyage of HMS Challenger Vols. I and II*, London, 1878, p.122; and Royal Society Minutes of the Council, Vol. IV, p.6, RS, London, UK.

acted as the primary mediator between the Royal Admiralty, the Treasury and other governmental branches, and the expedition's scientific staff.[63] By April of 1873 the expedition's officers as well as the six-member scientific staff had been selected. The officers were led by Captain George S. Nares, a well-established naval officer with a strong background in surveying.[64]

The circumnavigational nature of the *Challenger* imbued all aspects of the expedition both in purpose and in function. The initial mandate, which was agreed by the Admiralty and the Royal Society, included an extensive list of regions and locations to visit with specific topics of interest associated with each one. There was no part of the globe that was to be left unexplored by the *Challenger*'s staff. The established route informed various aspects of their record keeping and would come to be one of the key organisational classifications of data. The large amount of stationery office materials that were printed up prior to departure included hundreds of copies of what would come to be the ship's "station logs": forms in which they logged a standard series of information at each of the three-hundred plus sounding stations marked around the globe. Each form was initially identified by a latitudinal and longitudinal position, before accounting for species found, depths reached, temperatures taken, and other observations made.[65]

The legacy of the *Challenger* expedition within the history of scientific circumnavigations is notable in that to some it marked the ending of the tradition. In her comprehensive history of circumnavigations Chaplin says of the *Challenger*, "Given the intensifying sense of command over nature, it was appropriate that

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[63] Royal Society Minutes of the Council, Vol. IV, p.73, RS, London, UK.
[64] Captain Nares was reassigned halfway through the Challenger's voyage in order for him to become captain of the Arctic Expedition in search of the North Pole aboard HMS *Discovery* and HMS *Alert* in 1875.
[65] Station Logs, 1872 – 1876, Murray Collection, MSS, Box 93, NHM, London, UK.

history's last great scientific circumnavigation would demystify the sea itself."[66] That maritime circumnavigations come to end just as the ocean comes to be a known and manageable space, provides historical symmetry that fits well with Chaplin's broader narrative. Throughout the text Chaplin highlights the extreme challenges and dangers that the ocean wrought on those who attempted to master it, and she locates the *Challenger* to a period where seafaring had become almost mundane.[67] Mortality rates, mutinies, shipwrecks and other disasters had all decreased almost immeasurably over the centuries since the first circumnavigation by Magellan and his crew. Chaplin also emphasises the relative ease with which HMS *Challenger* was able to sail across international waters without encountering or causing any international hostilities. She argues that this was an effect of "paper internationalism", the ability to traverse the oceans and enter various national territories solely through the possession of documentation that highlighted the scientific nature of their work and denoted the non-aggressive and purportedly apolitical nature of their missions.[68]

HMS *Challenger*'s Route

In the Naval dockyards of Sheerness HMS *Challenger* underwent a five-month refitting before being commissioned on November 15th 1872.[69] After being "carefully swung" to calibrate its magnetic equipment, the ship finally set sail on December 7th headed for Portsmouth, from which it departed on its voyage.[70] From Portsmouth the expedition headed south towards Gibraltar and the Canary Islands before making its first traversal of the Atlantic Ocean en route to the West Indies.[71]

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[66] Chaplin, *Round About the Earth,* p.226.
[67] Chaplin, *Round About the Earth*, p.141.
[68] Chaplin, *Round about the Earth*, p.158.
[69] Tizard et. al., *Narrative*, p.18.
[70] Tizard et. al., *Narrative*, pp.18-19.
[71] Tizard et. al., *Narrative*, p.52.

After visiting St. Thomas and Bermuda the ship headed north up the east coast of North America towards Halifax, before circling back towards Bermuda on its way back across the Atlantic towards the Azores and Cape Verde. The ship then once again crossed the Atlantic as it headed south from Cape Verde towards the east coast of Brazil, before sailing southeast towards the Cape of Good Hope. The period spent between South America and Africa was extremely fruitful for the expedition and its scientific staff. They made multiple terrestrial expeditions to several islands along the way including St. Paul's Rocks, Fernando Noronha, the Tristan de Cunha Group, and Inaccessible and Nightingale Islands.[72] The experiences here clearly captured the imaginations of the expedition's participants as both scientific staff and naval crew alike wrote not only of their time here but also of the many stories and histories that they collected of this region.[73]

After rounding the Cape of Good Hope in December 1873, HMS *Challenger* continued along eastward towards Australia, coming near but ultimately bypassing Antarctica. This was a period with very few terrestrial visits, and in what feels like a universal reflection of the isolation felt by the expedition and its crew, the record-keeping and imagery produced during this period are primarily of the icebergs witnessed in the expanses of the Southern Ocean. It is purported that the *Challenger* staff took the very first photographs of Antarctic icebergs, and the formations clearly evoked the same wonderment and awe that they are still capable of today.[74]

This long stretch of oceanic exploration brought the ship to the east coast of Australia, where they spent relatively long periods on land in Melbourne and Sydney

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[72] Tizard et. al., *Narrative*, p.194.

[73] Diary of J.J. Wild, 1872 – 1876, Murray Collection Section 1, 6 – 9, NHM; Journal of botanical and zoological observations made during the voyage HMS Challenger made by Henry Nottidge Moseley, 1873 – 1875, MSS MOS, NHM, London, UK.

[74] James R. Ryan, *Exposures: Photography and Exploration*, Reaktion Books, London, 2013.

before a rather harrowing few days crossing the Tasman Sea towards New Zealand.[75] From there HMS *Challenger* encountered several Pacific Island groups including the Kermadec and Friendly Islands, Tonga, and Fiji, before sailing around the Northern coast of Australia through the Torres Strait and up through the Indonesian Islands. As HMS *Challenger* headed north it stopped at many of the Southeast Asian islands including the Arrou Islands, Ki Islands, Banda Group, Ternate and Samboangan before visiting the Philippines and Hong Kong. At Hong Kong the ship made a quick reversal back south heading by Humboldt Bay before stopping at the Admiralty Islands north of present day Papua New Guinea and East Timor. It next sailed north again to Japan before heading east towards Hawaii, the Sandwich Islands and Tahiti. The next leg saw it make a turn due south, during which it visited several islands, before reaching the west coast of Chile and rounding the southern cape of South America. From there it stopped at Montevideo and Asunción before heading across the Atlantic one last time (the fifth in total), before it traced the east coast of Africa on its way back towards England. On May 25th the ship was again carefully swung to ascertain the errors of the compass and dipping needing and the results were compared against those recorded at the start of the voyage.[76] Finally on June 6, 1876 the crew was paid at Chatham. As might be expected from any Victorian expedition, the prolific record keeping resulted in a detailed "synoptic table" which Wyville Thomson included in his narrative account. It summarised the traversal of 68,890 nautical miles and 362 observing stations (by his account, although records from his staff reflect at least 368)[77], segmented down to each terrestrial stop including origin and destination, dates of departure and arrival, distance travelled in nautical miles,

[75] Tizard et. al., *Narrative*, pp.463-467.
[76] Tizard et. al., *Narrative*, p.941.
[77] Tizard et. al., *Narrative*, p.941.

coal expended, number of days at sea, number of days in harbour, number of soundings obtained, number of serial temperatures taken, number of dredgings, and number of trawlings.

Humboldtian Science

Over the course of the eighteenth century as more circumnavigations were pursued and successfully completed the natural sciences of zoology, botany, geology, and ethnology evolved alongside. The newly expanded globe broadened notions of nature and the natural world, thereby expanding the ways in which these were studied. By the nineteenth century, the field of natural history was firmly intertwined with the tradition of maritime expeditions. Cook's famous circumnavigations in the late eighteenth century had established a new precedent for the ways in which naval voyages could facilitate and expand the boundaries of natural history. The extended works of Joseph Banks, George Forster, and other participants on Cook's three voyages not only introduced unknown lands and peoples to a European audience but also framed this vast region of the globe through natural history. Bernard Smith argues that Joseph Banks was, "the first independent scientist to grasp the new possibilities opening in the wake of this more scientific voyaging".[78] It was in this tradition that German naturalist Alexander von Humboldt came of age; and his theories of the natural world, which would come to dominate the scientific discourse of the nineteenth century, were firmly embedded in the tradition of voyaging and exploration. As Sandra Rebok explains Humboldt was directly inspired by the grand maritime expeditions of the early modern period.

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[78] Bernard Smith, *Imagining the Pacific: In the Wake of the Cook Voyages*, Yale University Press, New Haven, 1992, p.42.

> Humboldt came of age in an era of great explorations, such as the voyages undertaken by Louis Antoine de Bougainville, Jean-Francois de La Perouse, James Bruce, Carsten Niebuhr, and Alejandro Malaspina and Jose de Bustamante; or those carried out by James Cook. The descriptions of their adventures had fascinated Humboldt from his early youth and formed his image of the tropical realm idealized by the philosopher Jean-Jacques Rousseau.[79]

Humboldt's own expedition experiences, which would come to be a substantial influence on his natural history, were first inspired when he was invited to join Nicolas Thomas Baudin's French Circumnavigation in 1798.[80] Although this particular expedition was cancelled before it set sail, it catalysed Humboldt in his own maritime pursuits. In 1799 he and French botanist Aimé Bonpland were able to gain approval from King Carlos IV of Spain to allow them to sail through the Spanish colonies on a maritime voyage Humboldt funded through his own inheritance.[81] This voyage, along with several other maritime and terrestrial expeditions across Europe and North America became a fundamental part of Humboldt's theories and writings on natural history.

Humboldt was a natural philosopher who was a product of European Enlightenment thinking. Born in 1769, his career spanned the end of the eighteenth century through to the mid-nineteenth century, culminating in *Cosmos*, a grand opus which he was still working on at the time of his death in 1859.[82] As environmental historians trace the origins of early environmentalism and a holistic way of thinking about the natural world, they have looked to Humboldt and his nineteenth-century

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[79] Sandra Rebok, *Jefferson and Humboldt: A Transatlantic Friendship of the Enlightenment*, Charlottesville, VA, 2014, p.6.
[80] Rebok, *Jefferson and Humboldt,* p.7.
[81] Rebok, *Jefferson and Humboldt,* p.7.
[82] Nicolaas Rupke, 'Introduction' in Alexander von Humboldt, *Cosmos*, Johns Hopkins University Press, Baltimore, 1997.

worldview.[83] Although Humboldt himself did not coin the term ecology[84], his unifying theories of nature certainly contributed to an ecological way of thinking about the world in the nineteenth century. In particular, Humboldt viewed the globe as an interconnected space, and wanted to build a global ecology that highlighted the particularities of nature in separate regions but also defined and understood them as related on a universal level. As historian Iain McCalman explains, "Humboldt envisaged an ecological mapping of the entire globe."[85] Humboldt's vision for a global understanding of nature depended on an aggregated view of the climate and environment, to use the language of his day, to allow for comparison of regions.

In his early work Humboldt used the term *physique du monde* to represent his views of a universal science. He understood the natural world to be connected to both the celestial and the human world. While other natural philosophers of the early modern period, particularly post-enlightenment, had theorised about the connections between these three previously distinct categories, Humboldt's work was distinctly of note to his contemporaries for his interest in *causal* connections between the three. As Rebok argues, "Humboldt was especially preoccupied with the distribution of vegetation and its relationship to climatic zones, as well as other factors that affected the way plants took hold in specific regions, and less with detailed descriptions of individual plants or species."[86] For Humboldt, these categories were not only regulated by the same natural laws but he speculated that they could have a causal effect on each other, particularly between the natural world and the human state.

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[83] Aaron Sachs, *The Humboldt Current: Nineteenth-Century Exploration and the Roots of American Environmentalism*, Penguin, New York, 2007.
[84] That distinction goes to Ernst Haeckel a well-known German naturalist of the nineteenth century who also contributed to the *Challenger Scientific Reports*.
[85] McCalman, *Darwin's Armada*, p.44.
[86] Rebok, *Jefferson and Humboldt,* p.107.

At the end of his career Humboldt published what would become his most well-known text and which would come to best represent his natural philosophy: *Cosmos*. Released as a five-volume text from 1845 to 1862 (the last volume published posthumously) the book was based on a series of lectures he had given in Paris and Berlin in the 1820s. In this text Humboldt boldly articulated a theory of the universe which suggested the heavens and the earth were not only dictated by the same set of natural laws and forces but were connected and engaged with one another. While he was not a singular voice in the enlightenment notion that the heavens were not divinely different from the natural world, his ideas provided one of the most expansive and comprehensively constructed theories of the natural world in the nineteenth century. Humboldt understood the term *cosmos* to have multiple meanings and connotations that not only referenced the heavens but also represented the unification of the natural order that was at the heart of his natural history. As Humboldt explained:

> Thus the word Cosmos, which primitively, in the Homeric ages, indicated an idea of order and harmony, was subsequently adopted in scientific language, where it was gradually applied to the order observed in the movements of the heavenly bodies, to the whole universe, and then finally to the world in which this harmony was reflected to us.[87]

Humboldtianism also came to be closely aligned with the political notion of cosmopolitanism that arose in the nineteenth century. A distinctly modern idea, cosmopolitanism represented notions of universalism and was antithetical to the category of nationalism which had developed in the early modern period. As historian Nicolaas Rupke has also highlighted, "The *Cosmos* not only removed the lateral

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[87] Alexander von Humboldt, *Cosmos: A Sketch of the Physical Description of the Universe, Vol. 1*, Longman, Brown. Green, and Longmans, Paternoster Row; and John Murray, Albemarle Street, London, 1846, p.38.

barriers of nationalism (first prong) but it also removed vertical class barriers in any society (second prong)."[88] The social and cultural aspects of cosmopolitanism were not directly tied to Humboldt's natural philosophy, although there were shared themes and values that came to define both the scientific and political theories. This is not to say that Humboldt was uninterested or even unaware of the connections between scientific knowledge and political discourse. From his earliest work Humboldt sought to make connections between the natural world and the state of man, and his theories of natural philosophy were interventionist in the sense that they articulated a direct connection between nature and civilisation.[89] As historian Aaron Sachs explains Humboldt's early work on human geography – specifically his 1808 tract *Political Essay on the Kingdom of New* Spain – led him to develop "an interdisciplinary form to which he could turn whenever he wanted to examine humanity's relationship to nature as an explicitly social problem".[90]

Both Darwin and Wyville Thomson were well read in Humboldt's work, and inspired to conduct natural history in a similar tradition. The young Darwin that climbed aboard the HMS *Beagle* was a devoted Humboldtian who pursued his naturalist tasks with "zeal".[91] While at sea on the *Beagle* Darwin celebrated the wonder of the natural world by exclaiming, "But when on shore, and wandering in the sublime forests, surrounded by views more gorgeous than even Claude ever imagined, I enjoy a delight which none but those who have experienced it can understand – If it is to be done, it must be by studying Humboldt".[92]

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[88] Rupke, 'Introduction', p.xxxiii.
[89] Sachs, *The Humboldt Current*, p.45.
[90] Sachs, *The Humboldt Current*, p.45.
[91] McCalman, *Darwin's Armada*, p.44.
[92] C.R. Darwin to W.D. Fox, May 1832, Letter 168, Darwin Correspondence Database, http://www.darwinproject.ac.uk/entry-168 accessed on Tue Jan 19 2016.

In his official publication *The Voyage of The Beagle* Darwin's emphasis on the circumnavigation highlights the influence of Humboldtian thinking:

> Our Voyage having come to an end, I will take a short retrospect of the advantages and disadvantages, the pains and pleasures, of our circumnavigation of the world. If a person asked my advice, before undertaking a long voyage, my answer would depend upon his possessing a decided taste for some branch of knowledge, which could by this means be advanced…[93]

This language was in the tradition of travel writing that had originated in the sixteenth century with the earliest voyage narratives, and was very much in keeping with Humboldt's own style. He continues:

> The pleasure derived from beholding the scenery and the general aspect of the various countries we have visited, has decidedly been the most constant and highest source of enjoyment. It is probable that the picturesque beauty of many parts of Europe exceeds anything which we beheld. But there is a growing pleasure in comparing the character of the scenery in different countries, which to a certain degree is distinct from merely admiring its beauty. It depends chiefly on an acquaintance with the individual parts of each view. I am strongly induced to believe that as in music, the person who understands every note will, if he also possesses a proper taste, more thoroughly enjoy the whole, so he who examines each part of a fine view, may also thoroughly comprehend the full and combined effect.[94]

Here we see Humboldt's influence in the emphasis on the study, and comparison, of regions in order to construct a global natural history. While Darwin does not directly invoke the circumnavigation, it is clear that a round-the-world expedition facilitated and allowed for this regional comparison in ways not otherwise possible. This same theme can be found in an oft-referenced section of Darwin's *Beagle* diary from his time in Australia. In this entry Darwin first describes the observation of a platypus and notes that given its behaviour it could be mistaken for a

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[93] Charles Darwin. *Voyage of the Beagle*, Second Edition, John Murray, Albemarle Street, London, 1845, p.501.
[94] Darwin, *Voyage of the Beagle*, p.502.

water rat, but in appearance it was an extraordinary animal. He then uses the comparison of a European ant and one observed in Australia to suggest that no two “Creators” (invoking the Christian notion of God the Creator) could introduce two such similar specimens, especially so far away from each other. The entry concludes by posing the following response:

> Now what would the Disbeliever say to this? Would any two workmen ever hit on so beautiful, so simple & yet so artificial a contrivance? It cannot be thought so. – The one hand has surely worked throughout the universe. A Geologist perhaps would suggest, that the periods of Creation have been distinct & remote the one from the other; that the Creator rested in his labor.[95]

In this we see suggestions of both Christian and atheist formulations of a single origin. Historians have debated the significance of this passage in Darwin’s own personal views on Christianity and Creation-based natural history[96], but regardless of whether Darwin believed in a Creator or not, it’s evident that his thinking on the subject was firmly grounded on the paradox of variation of species across large geographical distances. McCalman points out that Darwin’s reference to distinct periods of creation directly aligns him with the Lyell’s geological theory that the earth had experienced multiple periods of geological creation.[97]

In her work comparing the practices of Darwin and Alfred Russell Wallace, Melinda Fagan highlights Darwin’s focus on detailed observation of individual specimens rather than on broader categories of classification.[98] Fagan argues that in comparison to Wallace, who was much more concerned with making complete

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[95] Charles Darwin, R.D. Keynes, ed., *Charles Darwin's Beagle Diary*, Cambridge University Press, Cambridge, 2001, p.403.

[96] See Frank Burch Brown, ‘The Evolution of Darwin’s Theism’, *Journal of the History of Biology*, 19, 1 (1986), pp. 1-45, and Frank Sulloway, ‘Darwin’s Conversation: The Beagle Voyage and Its Aftermath’, *Journal of the History of Biology*, 15, 3 (1982), pp. 325-396.

[97] McCalman, *Darwin’s Armada,* p.75.

[98] Melinda B. Fagan, ‘Wallace, Darwin, and the Practice of Natural History’, *Journal of the History of Biology*, 40, 4 (2007), p.603.

inventories of species and diversity within particular regions, Darwin's interest in novel and unique forms led him to make generalisations from individual specimens.[99] Wallace was more closely aligned with the style of natural history promoted by Humboldt than was Darwin. But more significantly, I would argue, Fagan's descriptions of Darwin's motivations and processes reveal the limits to which the course of the *Beagle* influenced Darwin's ability to theorise about global natural history. Given the constraints Darwin faced in selecting his observational sites, he was not in a position to methodically cover the globe or even entire regions. Instead, Darwin depended on making detailed observations of the specific locations chosen by HMS *Beagle*'s crew. In some ways this challenges the narrative of a global circumnavigation that Darwin attempted to construct for himself in the years following the *Beagle*'s voyage, particularly once he published *the Origin of Species*. Importantly however, Darwin invoked the circumnavigation in order to legitimise many of his knowledge claims, particularly in asserting generalised theory from specific examples.[100] Darwin's most famous observational example came in his comparison of finches across the Galapagos Islands in South America.[101] Darwin argued that the anatomical and physiological differences between types of finches on each island reflected the discrete and unique environments of each locale; an island whose plants offered larger seeds also accommodated finches with broader and stronger beaks, for example. It is telling that such a localised example became the foundational evidence for a theory which attempted to explain evolution, and natural selection, across the entire globe.

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[99] Fagan, 'Wallace, Darwin and the Practice of Natural History', p.624.
[100] Darwin, *Voyage of the Beagle*, p.504.
[101] Darwin, *Voyage of the Beagle*, p.372.

Just as with Darwin's writings, the writings from the *Challenger* expedition also reflected a Humboldtian approach in its emphasis on circumnavigation.

> The *Challenger* during her long cruise passed over an extended area under very varied surface conditions. From the circumstances of her voyage it was impossible to examine any one locality fully, but enough was done to enable us to gain a sufficient idea of the general distribution of the more conspicuous animals living on the bottom of the sea, to justify the conclusion that, at depths below 500 to 600 fathoms, a fauna exists of extreme uniformity, which it is impossible as yet to break up into regions or provinces on zoological grounds. Apparently all the classes and most of the leading orders of marine invertebrate are fully represented, but their representation is not in the same relative proportions as in the lesser depths with which we have been hitherto acquainted.[102]

Similarly, the scientific theories put forth by Wyville Thomson in the *Introduction to the Zoology Reports* reflect the influence of the circumnavigation on the types of research questions and style of investigation he and his scientific staff had pursued. His theories in this report can be summed up by his eight-point conclusion. 1) Animal life is found at all depths of the ocean, and there is no depth-limit to supporting life in the ocean. 2) Temperature is the primary factor in determining the distribution of marine animals. As an example of this he argues that "abyssal fauna" only occupy the "abyssal region" which, "extends from depths of 500 to 600 fathoms to the bottom", and which has a normal temperature range from 32 degrees Fahrenheit to 40 degrees Fahrenheit. 3) Marine animals are impacted to a certain extent by pressure and absence of light, but do not seem to be affected by water salinity, or the presence of gases in the water. 4) Abyssal fauna is "remarkably uniform" throughout the oceans. 5) The ocean basins most likely date from an early geological epoch, and given this the mean depth of the sea (measured at 2500 fathoms) and the temperature range of the abyssal region have remained the same over time. 6) Geological evidence shows

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[102] Wyville Thomson, *Introduction to the Zoology Reports*, p.43.

that the fauna of shallow water areas has changed over time, but that these specimens are "comparable" with current shallow water fauna. Geological evidence for the abyssal region is more difficult to acquire, but there is enough evidence to conclude that there has been abyssal fauna since the Jurassic, Cretaceous and Tertiary periods. 7) Current abyssal fauna does not appear to be related to shallow water fauna. 8) And that observed abyssal fauna appear similar in form to fossil formations in the deep sea which would indicate that they have slowly changed over time under certain natural forces for which there is little understanding.[103]

Notably, one of Wyville Thomson's most important knowledge claims was that oceanic life could survive at all depths. This countered Edward Forbes's azoic theory of the ocean which asserted that life was not sustainable below 300 fathoms (the azoic zone). Forbes's zonal theory of the ocean also asserted that species which could be found at various depths were more likely to be found across a broader geographical area; thereby drawing a direct correlation between depth and breadth. Therefore Wyville Thomson's argument against the azoic theory, while directly addressing a theory related to depth, was in fact only provable by covering large geographical areas.

It's important to note that from the earliest formulations of evolutionary theory, geological time was a fundamental element. Darwin was strongly influenced by the work of noted geologist Charles Lyell who, when writing in the early 1800s, expanded conceptions of time by proposing a vastly older age of the earth. In his famed three-volume text *Principles of Geology*, a copy of which was included in HMS *Challenger*'s library, Lyell argued that the geological earth had taken shape due to natural causes that could be readily observed, as opposed to ancient or divine

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[103] Wyville Thomson, *Introduction to the Zoology Reports*, p.49.

causes separate from the contemporary world. It was the expansion of time as presented by Lyell which allowed for observed environmental forces – ones that were seemingly miniscule and insignificant – to make significant, almost inconceivably large, geological changes. Importantly, the chronological revolution was a causal explanation for Lyell rather than a theory in itself. The real revolutionary theory for Lyell, keeping in line with other cosmological theories of the eighteenth and early nineteenth centuries, was that global changes could be explained through natural forces rather than supernatural ones.[104] For Darwin, this revolution in global chronology was essential to his thinking about the processes of evolution. Just as Lyell had argued that the shape and form of the earth's surface had been created by observable natural forces over hundreds of millions of years, Darwin argued that species evolved as a process of adaption to natural environments over extended periods of time. This understanding of time and evolution was just as significant to Wyville Thomson. The deep sea had already promised new dimensions and understandings to the age of the earth prior to deep-sea investigations. For Wyville Thomson the data collected from the *Challenger* supported his assumption that the abyssal region had remained relatively stable over the age of the earth, making it a unique environmental space from which to examine the effects of environmental changes, or lack thereof, on evolution.

In the seventeenth and eighteenth centuries, as more and more lands were observed and recorded by travelling Europeans for the first time, there was a sense that these places held information about the history of both the natural and human worlds. Early anthropology of the eighteenth century was imbued with a sense of

[104] Charles Lyell, *Principles of Geology: being an attempt to explain the former changes of the Earth's surface, by reference to causes now in operation,* Volume I, John Murray, Albemarle Street, London, 1830.

urgency concerning the imminent extinction of primitive cultures.[105] It was understood that these cultures should be studied and recorded as a way of understanding the history of human culture and the development of civilisations. In the same way, newly discovered lands, or in some cases undiscovered speculative lands, were seen to hold information about the geological and botanical histories of the earth. By the turn of the nineteenth century, particularly after Captain Cook's expeditions to the South Pacific, Europeans tended to believe that the entirety of the geological globe had been discovered, and they soon turned towards the deep sea as a last frontier for the undiscovered utopias.[106] In the same way, there was a parallel with the promises of an untouched, and unchanging historical landscape of the natural world. By the nineteenth century the deep sea not only promised an archaic and historical landscape, it also became tied to evolutionary theory and promised to deliver the true origins of life, as theorised by Darwin and other evolutionary thinkers.

> During the Silurian period, as now, and extending continuously from that early time to the present day, a continuous ocean with a mean bottom temperature oscillating about the freezing point, has in all probability covered the greater part of the earth. Throughout all this time an abyssal fauna, of whose existence we have evidence in every rescued page of geological history, must have migrated continuously, becoming slowly changed during the lapse of immeasurable time with the slightly altering phases in the distribution of sea and land. It seems only natural that migration through so great a lapse of time, over an area under such uniform conditions, should have become at length universal, and that a singularly uniform fauna should have been the result.[107]

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105 Bronwen Douglas and Chris Ballard, eds., *Foreign Bodies: Oceania and the Science of Race 1750 – 1940,* Australia National University Press, Canberra, 2008, p.xiv.

106 Howe, *Nature, Culture and History*, p.14.

107 Wyville Thomson, *Introduction to the Zoology Reports*, p.43.

Just as the Pacific region provided a historical lens on human culture, the deep sea became the foundational site for natural history. It promised a window to the past, to the origins of life itself, which could be found nowhere else on earth. While this may have been viewed as a nineteenth-century idea, it was firmly grounded in the concepts of potential and possibility which had been tied to exploration and discovery for hundreds of years before.

The Debate Over Natural Selection

In 1880 when the first volume of the Zoology Reports was published, naturalist Thomas Huxley published a five-column review in the November 4th issue of the weekly science journal *Nature*.[108] As Huxley rightly pointed out, this volume of reports marked the first official publication of material from the expedition which had completed its voyage over four years earlier. He pardoned the delay by acknowledging the mammoth task of specimen management required and also provided insight into some of the structural choices Wyville Thomson made to engage zoology and botany experts to write up the specialised reports rather than depend solely on the six individuals of the scientific staff who accompanied him on the expedition. Huxley's account was strongly sympathetic, but it also politely glossed over some of the more contentious reasons for the extended delay in publication. At the conclusion of the expedition Wyville Thomson had become embroiled in a heated debate with representatives of the British Museum[109] and the British government over ownership of the specimens collected over the course of the

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[108] Huxley, Thomas Henry, 'The First Volume of the Publications of the "Challenger"', *Nature,* 23, 575, (1880), pp.1-3.

[109] Prior to 1881 the institution now known as the Natural History Museum was a collection held under the British Museum.

expedition.[110] Wyville Thomson had planned on returning to Edinburgh, where he held the Regius Chair of Natural History at the University of Edinburgh, in order to sort through and work on the results of the expedition, whereas the British Museum argued that the specimens were national property and would be more appropriately housed at the Museum in London. Although Wyville Thomson ultimately prevailed – and consequently established The Challenger Office in Edinburgh which coordinated the administrative task of arranging the specimen collection and coordinating the publication of *Scientific Reports* – the incident made Wyville Thomson unpopular with several prominent London naturalists and his reputation with government officials never fully recovered. Interestingly, in private letters Charles Darwin was highly critical of the British Museum naturalists who lambasted Wyville Thomson and Huxley's review was further evidence of the support he received from some.[111]

Huxley reserved the bulk of his review for a critique of two specific points made by Wyville Thomson in the *Introduction*, primarily relating to his general conclusions. Firstly, Huxley was sceptical of Wyville Thomson's claim that geological evidence indicated that the oceanic basins had been little changed over geological time. Secondly, he took issue with Wyville Thomson's discussion of evolution and natural selection in relation to the abyssal region. As recounted by Huxley, Wyville Thomson concluded that the study of the abyssal fauna aligned with and showed support for the theory of evolution, but he also contended that the nature of abyssal fauna did not support the theory of natural selection, that is to say, the mechanism through which evolution occurs. Notably, these two arguments were

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[110] Unconfirmed meeting minutes of the Council of the Royal Society, 26 October 1876, JDH/1/14/2/221, RS, London, UK; and [no author], *Correspondence Concerning the Specimens and Collections made by the 'Challenger' Expedition*, Taylor & Francis, London, 1877.

[111] P.L. Sclater to C.R. Darwin, 2 June 1877, Darwin Correspondence Project, "Letter no. 10981," accessed on 16 June 2018, http://www.darwinproject.ac.uk/DCP-LETT-10981

tightly connected in Wyville Thomson's original argument, however Huxley chose to address them as separate points. For Wyville Thomson the apparent geological stasis of the abyssal region had a direct effect on the evolution of the abyssal fauna. He argued that the absence of geographical change in this oceanic zone had resulted in minimal evolutionary changes in the fauna.

> That the present abyssal fauna is the result of progressive change there can be no room for doubt; but it would seem that in this case the progress has been extremely slow, and that it has been brought about almost in the absence of those causes, - such as minor and local oscillations of the crust of the earth producing barriers, and affecting climate, - on which we are most inclined to depend for the modification of faunae.[112]

The absence of change both in the geological formation of the ocean basins and in the corresponding abyssal fauna was not merely a natural phenomenon, it was also a historical one. The lack of change provided him and the other naturalists a window into an ancient environment otherwise inaccessible and therefore made this oceanic zone a promising area of study.

Huxley's critique of Wyville Thomson's geology was levelled only at the claims of an unchanging and ever-present oceanic basin. Huxley argued that he was not convinced of Wyville Thomson's evidence that the abyssal region had been constantly and continuously underwater and posited that there was no evidence against the hypothesis that, "an area of the mid-Atlantic or of the Pacific sea-bed as big as Europe should have been upheaved as high as Mont Blanc and have subsided again any time since the Palaeozoic epoch".[113] Rather strangely, Huxley then immediately turned towards the second of Wyville Thomson's two points, the critique of natural selection. But rather than challenging the evidentiary link that Wyville

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[112] Wyville Thomson, *Introduction to Zoology Reports*, p.50.
[113] Huxley, 'The First Volume of the Publications of the "Challenger"', p.1.

Thomson had introduced between the two points, Huxley instead honed in on Wyville Thomson's understanding of variation and variability.

In Huxley's framing, Wyville Thomson's main argument against the process of natural selection centred on variability. Wyville Thomson argued that the process of natural selection would be evidenced by "transitional" specimens which reflected the distinct characteristics of more than one species. But as, "there is usually no difficulty in telling what a thing is", he concluded that transitional specimens did not exist in the abyssal region.[114] The argument hinged both on how the process of natural selection worked and what counted as evidence of this process. Wyville Thomson's argument, which Huxley considered "hardly so cogent as might be desirable",[115] is constructed as a traditional deduction from evidence to theory. It reads in full:

> Species are just as distinctly marked in the abyssal fauna as elsewhere, each species varying within its definite range as each species appears to have varied at all times, past and present. If all the species living on the floor of the ocean were, and had always been, in a state of instability, acted upon by external influences, and perpetually passing by insensible gradations into other species, it seems certain that the general impression drawn from a fauna such as that of the abyssal region must have been one of indefiniteness and transition. This is not the case. Transition forms, linking species so closely as to cause a doubt as to their limit, are rarely met with.[116]

Huxley challenged this last point by returning to Wyville Thomson's first point. He argued that if Wyville Thomson was willing to acknowledge that species included variability, then he must also acknowledge that there are examples of transitional specimens which are difficult to identify. This positioning highlights the distinction between intra-species and inter-species variability, both of which were

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[114] Huxley, 'The First Volume of the Publications of the "Challenger"', p.3.
[115] Huxley, 'The First Volume of the Publications of the "Challenger"', p.2.
[116] Wyville Thomson, *Introduction to the Zoology Reports*, p.50.

important to different aspects of Charles Darwin's initial formulation of natural selection and the theory of evolution. It's interesting then that Huxley honed in on the distinction in order to argue against Wyville Thomson, as it would seem that Wyville Thomson was using definitions of variability entirely in line with Darwin's usage, albeit in order to make an opposing claim.

Huxley concluded his review by suggesting that the true value of the expedition "does not lie in the speculations which may be based upon it", but in the tangible collections and data acquired from the voyage.[117] In labelling Wyville Thomson's theorising as speculation, Huxley dismissed the challenge to Darwinian theory. Given that he never again addressed the controversy either publicly or privately it is unclear as to whether Huxley took issue with Wyville Thomson's theoretical argument or the evidence he used to present it. It is known, however that Huxley had a close working relationship with Wyville Thomson and the other *Challenger* naturalists, and in fact authored one of the zoology reports that would be published in a later volume.

Immediately after Huxley's review was published Darwin entered the fray. In a private letter to Huxley, Darwin indicated his own stakes in the debate and looked to Huxley to review his drafted response. Alongside a copy of the letter he intended to send into *Nature* Darwin wrote:

> On reading over your excellent review with the sentence quoted from Sir Wyville Thomson, it seemed to me advisable, considering the nature of the publication, to notice 'extreme variation' and another point. Now, will you read the enclosed, and if you approve, post it soon. If you disapprove, throw it in the fire, and thus add one more to the thousand kindnesses which you have done me. Do not write: I shall see result in next week's Nature. Please observe that in the foul copy I had added a final sentence which I do not at first copy, as it seemed to me inferentially too contemptuous; but I have now pinned it to the

[117] Huxley, 'The First Volume of the Publications of the "Challenger"', p.3.

> back, and you can send it or not, as you think best,—that is, if you think any part worth sending.[118] My request will not cost you much trouble-i.e. to read two pages, for I know that you can decide at once. I heartily enjoyed my talk with you on Sunday morning. P.S.—If my manuscript appears too flat, too contemptuous, too spiteful, or too anything, I earnestly beseech you to throw it into the fire.[119]

Darwin's letter indicates that he had not yet read Wyville Thomson's publication, but instead was basing his own response on Huxley's review. This is particularly evident in that Darwin chose to emphasise extreme variation, the same angle Huxley had used, as a response to Wyville Thomson despite Wyville Thomson's own emphasis on transitional specimens, geological formations and causal evidence. Publicly, Charles Darwin picked up where Huxley had left off with a letter to the editor which was published the following week in the November 11th issue. The letter began, "I am sorry to find that Sir Wyville Thomson does not understand the principle of natural selection, as explained by Mr. Wallace and myself."[120] Darwin's scathing letter dedicated very little attention to Wyville Thomson's arguments directly and instead haughtily reiterated the basis of his own theories. In effect Darwin simultaneously dismissed Wyville Thomson as someone not to be taken seriously while also avoiding any actual engagement with Wyville Thomson or the evidence he posited. Darwin dismissively notes, rightly or wrongly, that Wyville Thomson's views are not dissimilar from those of the "theologians and metaphysicians" who were well known in their criticism of Darwin and his theories.

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[118] The omitted final sentence read, "Perhaps it would have been wiser on my part to have remained quite silent, like the breeder; for, as Prof. Sedgwick remarked many years ago, in reference to the poor old Dean of York, who was never weary of inveighing against geologists, a man who talks about what he does not in the least understand, is invulnerable".

[119] C.R. Darwin to T.H. Huxley, 5 November 1880, in Francis Darwin and A.C. Seward, eds., *More letters of Charles Darwin. A record of his work in a series of hitherto unpublished letters*. John Murray, Albemarle Street, London, 1903, p.388.

[120] Darwin. 'Letter to the Editor', p.32.

He then distinguishes between variation and “extreme variation”, although it’s not clear what his intentions are with this distinction. The tone of the letter was not lost on *Nature*’s readership or supporters of the two men. The debate was so contentious that accounts of the exchange were published in other periodicals including *Science* in the proceeding months.[121]

The final part of this public debate occurred the following week when Wyville Thomson responded in a letter to the editor which was published in the November 18th issue. Wyville Thomson sarcastically asserted his own knowledge and expertise in understanding the concept of variation before elaborating on his original argument. His response centred on the following question:

> Are physiological species the result of the gradual modification of pre-existing species by natural selection, or by any similar process; or are they due to the action of a law as yet utterly unknown, by which the long chain of organisms rolls off in a series of definite links?[122]

Wyville Thomson returned to Darwin’s original analogy of domestic breeding in order to illustrate his point. He suggested that while one could look at a flock of sheep and observe whether they looked physiologically similar, without prolonged observation one could not know whether they were of the same species, which he defined as, “animals fertile with one another and producing fertile progeny”.[123] Wyville Thomson emphasised that his research had not indicated any evidence supporting natural selection as the mode of evolution.

Although Wyville Thomson concluded his letter by stating, “I will ask you in a week or two for space for a short paper on ‘The Abyssal Fauna in Relation to the

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[121] [no author]. ‘Natural Selection’, *Science,* 25, 1 (1880), p.287.
[122] Charles Wyville Thomson, ‘Letter to the Editor: Sir Wyville Thomson and Natural Selection’, *Nature,* 23, 577, (1880), p.53.
[123] Wyville Thomson, ‘Letter to the Editor’, p.53.

Origin of Species'",[124] there is no evidence that he undertook such a paper and he never published anything specifically on this topic after 1880. This was most likely due to his failing health which would see him hand over control of The Challenger Office to John Murray in 1881 before dying at the age of fifty-two in March of 1882.[125] Although the argument appears to have ended after these brief exchanges, the debate is evidence of the high stakes that both men saw in articulating and defending their theories of geology, climate and evolution. Furthermore, the debate highlights the potential value that nineteenth-century naturalists saw in the ocean, and specifically the deep sea, in providing insight into as yet unanswered questions about evolution and the natural world.

By the late nineteenth century, Darwin's theory of evolution had widespread support from the scientific community and was slowly gaining acceptance from the general population. While Wyville Thomson's challenge to natural selection may now be read as an anomalous misstep in the scientific work of the *Challenger* expedition, it was in fact well grounded in the dominant theories of the natural world of the nineteenth century. Further, the work of the *Challenger*, and Wyville Thomson's views in particular were founded on the shared epistemology of Humboldtian thinking that informed Darwin and his own work. Both Darwin and Wyville Thomson's arguments depended on Humboldt's natural philosophy, whose theories of the natural world were in turn informed by a long tradition of circumnavigations and maritime science.

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[124] Wyville Thomson, 'Letter to the Editor', p.53.
[125] Darwin passed away at the age of 73 in April 1882, a month after the death of Wyville Thomson.

Cosmopolitan Species

One of the significant scientific findings of the expedition which underpinned Wyville Thomson's general conclusions was the prevalence of what he and the other *Challenger* naturalists referred to as "cosmopolitan species". A term little used prior to the expedition, this came to be a common classification used by the scientific staff to describe species which were found with little or no variation throughout various depths and geographical areas across the globe. Although the *Challenger* naturalists gave no indication in either their field notes or published works as to the origins or traditions of the concept, it is clear that it was not in popular usage prior to the expedition.[126]

The expedition represented ideals of both nationalism and cosmopolitanism; and it was contentiously argued both ways. As Tony Rice explains, "[At the time the *Challenger* was proposed] Britain was at the peak of her imperial power; Britannia unquestionably ruled the waves and British jingoism was alive and well. Consequently, many within the Admiralty, and outside, thought that Britain should lead the way in any innovative maritime undertaking",[127] and it was this thinking in part which motivated the government to sponsor such a large-scale expedition. Others however viewed this as a cosmopolitan project. As Wyville Thomson explained:

> …it was obviously necessary to invite the assistance of specialists in the different departments, and particularly in the different branches of Zoology. In doing this I had no hesitation in regarding the enterprise as thoroughly cosmopolitan in character; and although the manifest

[126] The first use of the term *cosmopolitan species* in the popular periodical *Nature* came in 1875 in a review of naturalist John Charles Melliss's text *St Helena: A Physical, Historical and Topographical Description of the Island, including its Geology, Fauna, Flora and Meteorology.* "Excluding the cosmopolitan species which have been manifestly introduced…" Interestingly, the term here is used in connection, or at least in connotation, of human introduction of foreign species.

[127] Anthony L. Rice, *Voyages of Discovery: Three Centuries of Natural History Explorations*, Natural History Museum, London, 1999, p.292.

> convenience of avoiding as far as possible the necessity for sending large series of specimens out of the country caused a preponderance of British workers on the list, I requested the cooperation of those naturalists with whom I was acquainted whose authority in the different groups was most generally recognized and who had time to undertake the task, without the slightest reference to nationality.[128]

So how did Wyville Thomson's critique of natural selection relate to his understanding of cosmopolitan species? Wyville Thomson and the other naturalists found cosmopolitan species from relatively early on in their fieldwork. These species indicated two separate but related notions of animals and their environment. Firstly, they demonstrated that species covered large geographical areas. Whether this was due to migration patterns or some other explanatory cause was not yet determined. Secondly, they demonstrated that geography was not the determining factor in the evolution of species. Wyville Thomson took this further to conclude that shared environmental factors found around these species, specifically temperature and oceanic depths, were the dominant factors. This strongly echoed Humboldt's own work on atmospheric zones, in which he focused on the temperature and climates of different altitudes as the predominant environmental influences on flora and fauna. Both Humboldt in the first half of the century and Wyville Thomson in the second observed a shared set of climatic features between similar altitudes and depths across the globe.[129] Where other naturalists were inclined to find commonalities in geographical regions, these two men were more focused on zones.

Tellingly Murray made this observation of the apparent universality of the natural world and its harmonious coherence:

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128 Wyville Thomson, *Introduction to the Zoology Reports*, p.50.

129 Michael Reidy, 'From the Oceans to the Mountains: Spatial Science in an Age of Empire', in Jeremy Vetter, ed., *Knowing Global Environments: New Historical Perspectives on the Field Sciences*, Rutgers University Press, 2010, pp.17-38.

> The Challenger's deepest sounding was about 27,000 feet in the western part of the Pacific…the deepest reliable soundings then are about five and half miles. Mount Everest, one of the Himalayas, is said to be 29,000 feet above the sea level – so that it is a curious coincidence, and one worth remembering, that the height of the highest mountain in the world is just about the same as the greatest depth which has yet been found in the ocean.[130]

Harkening back to Humboldt's discussion of the *Cosmos*, it is of note then that when the *Challenger* naturalists identified and discussed numerous cosmopolitan species of the ocean they were in fact bringing the order of the heavens down to the sea. Cosmopolitan species, with connotations of universality and order, came to represent the modern ocean. Through the *Challenger*'s circumnavigation, Wyville Thomson and his scientific staff were able to make claims about global distribution that had previously not been possible, but which also were not conceivable in a pre-modern epistemology of the globe, the natural world, nor the cultural landscape. The deep sea was anticipated as a place of promise and possibility, a mysteriously unexplored region that would provide answers about the natural world. Through their work and their focus on evolution, natural selection, and cosmopolitan species, Wyville Thomson and the *Challenger* naturalists made the deep sea the foundation of the modern understanding of natural order.

Conclusion

Historically the *Challenger* is often viewed as exemplary of nineteenth-century natural history. The scientific staff made innumerable contributions to the taxonomy of marine species which are now understood as foundational evidence for evolutionary theory. The *Challenger* is still acknowledged for the many novel marine

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[130] John Murray, 'The Cruise of the Challenger. (first lecture)', p.121.

specimens that were first discovered on the voyage. This reading of the expedition however erases the much more complex and controversial debates which characterised nineteenth-century natural history. While the theory of evolution was a revolution in modern epistemology, it was neither universal nor infallible even by the end of the century. Wyville Thomson's challenge to the concept of natural selection was so threatening to Darwin and his work specifically because it was built on the same epistemological grounding as the theory of evolution itself.

The direct debate between Darwin and Wyville Thomson appeared to have settled just as quickly as it arose. The exchange itself did not transform the field of natural history, nor did it appear to settle the question over the validity of natural selection. Importantly however it represented the boundaries of evolutionary thinking at the end of the nineteenth century and the stakes involved in making evolutionary knowledge claims. Further and, I suggest most importantly, it emphasised the unique role the deep sea came to play in understanding natural history.

Prior to the expedition, British naturalists imagined that the deep sea would provide answers to questions of the origins of life. But it was unanticipated that these answers would shift evolutionary thinking. The real contribution of the *Challenger* was not in providing new knowledge of the deep sea, but that it established that the deep sea was *the* locale for understanding the entirety of the natural world. The expedition was therefore not contributory in its knowledge production but revolutionary. It transformed the deep sea from a known unknown into the fundamental arena for understanding natural history.

II. SITUATING THE LOCAL IN A GLOBAL EXPEDITION

Introduction

The circumnavigation became a defining factor of the expedition substantively and symbolically. The ability to encompass the globe, to both master the sea and produce scientific knowledge of it, was essential to the expedition's success. Several of Wyville Thomson's most compelling scientific claims depended on a global comparison of abyssal fauna, which could only be achieved by a global expedition. Further, the direct observation and collection of specimens across the globe allowed the *Challenger* naturalists to build a vast repository of information on maritime species and variation that made significant contributions to knowledge of natural history and the theory of evolution. Symbolically the expedition unfolded as a demonstration of the British Empire's domain as well as a performance of the very acts which constituted the Empire. The motivations for the expedition's sponsorship, the engagements of the ship's officers and scientific staff, the practices on board the ship, and the scientific knowledge that resulted from the expedition were all inextricably connected to the practices of Empire in Victorian Britain.

This was most apparent in the continual engagements the *Challenger* had with Britain's numerous colonial outposts distributed across the globe. Over the course of the four-year expedition the *Challenger* crew stopped at dozens of terrestrial territories and the events on land became a significant, if altogether different, part of the oceanographic mission. The *Challenger*'s visit to New Zealand is a fruitful example of the ways in which the *Challenger* took advantage of a vast colonial network in order to construct knowledge of the natural world. Highlighting a few aspects of HMS *Challenger*'s time spent in New Zealand provides a glimpse at the ways in which colonial relationships, and Victorian Britain's imperial network, constituted this global expedition and the scientific knowledge which it produced. Historians of Science have long been interested in the interconnection between colonialism and the production of scientific knowledge.[131] The *Challenger*, with its grand scale, mobility, and knowledge claims about the global ocean proves to be a particularly fruitful event through which to examine this relationship.

Localities

In the planning stages of the expedition various participating parties debated the boundaries and guidelines of the expedition's mission.[132] Scientific, naval, colonial and industrial interests, all of which were intertwined to some extent, had to be negotiated and reconciled. In the final objectives and mandate of the expedition New Zealand and its South Pacific neighbours were singled out as of particular interest given that at the time the region had received relatively little attention from hydrographers and naturalists compared to colonial enclaves in other parts of the world.[133] This region was also of interest due to its proximity to the Antarctic, as

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[131] See David Philip Miller and Peter Hanns Reill, eds., *Visions of Empire: Voyages, Botany and Representations of Nature*, Cambridge University Press, Cambridge, 1996; Richard Harry Drayton, *Nature's Government: Science, Imperial Britain, and the 'improvement' of the World*, Yale University Press, New Haven, 2000; Alex Soojung-Kim Pang, *Empire and the Sun*: *Victorian Solar Eclipse Expeditions*, Stanford University Press, Stanford, 2002; Ann Laura Stoler, *Carnal Knowledge and Imperial Power: Race and the Intimate in Colonial Rule*, University of California Press, Berkeley, 2002; Warwick Anderson, *Colonial Pathologies: American Tropical Medicine, Race and Hygiene in the Philippines*, Duke University Press, Durham and London, 2006; and Jim Endersby, *Imperial Nature: Joseph Hooker and the Practices of Victorian Science*, University of Chicago Press, Chicago and London, 2008.

[131] Royal Society Minutes of the Council, Vol. IV, p.73, RS, London, UK.

[132] Royal Society Minutes of the Council, Vol. IV, p.73, RS, London, UK.

[133] Tizard, T.H., H.N. Moseley, J.Y. Buchanan, and John Murray. *Report of the Scientific Results of the Voyage of HMS Challenger during the years 1872 – 1876 under the Command of Captain George S. Nares, R.N., F.R.S. and Captain Frank Turle Thomson,*

there were some assumptions made about the geographical and zoological connection of the South Pacific and Antarctic regions. The original objectives read:

> The principal object of the proposed Expedition is understood to be to investigate the physical and biological conditions of the great Ocean basins…Particular attention should be paid to the zoology of the sea between New Zealand, Sydney, New Caledonia and the Fiji and Friendly Islands, as it is probable that the Antarctic fauna may be found there at accessible depths.[134]

Many believed that the Pacific would provide a window to the Antarctic world, otherwise inaccessible to naturalists.

Additionally, the ocean floor around New Zealand was of great interest for the ambitious aims of a global submarine telegraph network. In the 1860s, after many years of failed attempts, Britain had success with the trans-Atlantic telegraph cable which allowed for direct and unimaginably fast communication between Britain and the US.[135] After the success of the trans-Atlantic cable telegraph due in no small part to the surveying work done to map the inter-continental ocean floor, ambitions to map the global ocean floor were intertwined and supported by the desire to create a British telegraph network that crossed the globe. By the 1870s when HMS *Challenger* set sail, the oceanic floor between Australia and New Zealand was prioritised as a region

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R.N. Prepared under the Superintendence of the Late Sir C. Wyville Thomson, Knt., F.R.S., &c. Regius Professor of Natural History in the University of Edinburgh, Director of the Civilian Scientific Staff on Board and now John Murray, One of the Naturalists of the Expedition: Narrative of the Cruise of HMS Challenger with a General Account of the Scientific Results of the Expedition, Parts I and II, Her Majesty's Stationery Office, London, 1885, Appendix A, pp.21-33.

[134] John Murray. *Report of the Scientific Results of the Voyage of HMS Challenger during the years 1872 – 1876 under the Command of Captain George S. Nares, R.N., F.R.S. and Captain Frank Turle Thomson, R.N. Prepared under the Superintendence of the Late Sir C. Wyville Thomson, Knt., F.R.S., &c. Regius Professor of Natural History in the University of Edinburgh, Director of the Civilian Scientific Staff on Board and now John Murray, One of the Naturalists of the Expedition: A Summary of the Scientific Results: Historical Introduction,* Her Majesty's Stationery Office, London, 1885, p.23.

[135] Bruce Hunt, 'Doing Science in a Global Empire: Cable Telegraphy and Electrical Physics in Victorian Britain', in Bernard Lightman, ed., *Victorian Science in Context*, University of Chicago Press, Chicago and London, 1997, p. 318.

which could benefit from this network. Although sailing between Australia and New Zealand was described as one of the roughest trips of the *Challenger*'s entire voyage, the naval staff successfully measured and mapped this part of the ocean floor for the first time, which was an important step in the eventual cables that would connect New Zealand to the rest of the network.[136]

HMS *Challenger* in New Zealand

By all accounts, the expedition's time in New Zealand was underwhelming and disappointing. When HMS *Challenger* first arrived in New Zealand waters in June of 1874 the naval crew and scientific staff alike were in high spirits and looking forward to a promising few weeks in the area. The expedition had spent an extended amount of time in Australia, both at sea and on land, including very successful terrestrial expeditions in Melbourne and Sydney. The crew anticipated a similar experience in New Zealand. The first omen that this was not to be occurred almost immediately when, in sailing in rough weather from Queen Charlotte Sound to Port Nicholson (Wellington) – i.e. across Cook Strait, a leadsman stepped out onto the platform to take a sounding measurement and was promptly swept out to sea by the heavy winds and large waves. Although they, by their own accounts, searched for an hour they eventually sailed on presuming that he had drowned. In the four years at sea, this young leadsman was one of only four men lost.[137] This poor weather continued for the entirety of the eight days planned for Wellington and the full month

[136] As a postscript, Roy MacLeod in 'Passages in Imperial Science: From Empire to Commonwealth', *Journal of World History*, 4, 1 (1993), p.117, describes the demonstration of the success of these imperial ambitions occurred in 1924 when King George V was able to send a telegraph message around the world through entirely British cables in only 80 seconds.

[137] Joyce Chaplin, *Round About the Earth: Circumnavigation from Magellan to Orbit*, Simon and Schuster, New York, 2012, p.227.

in the waters around New Zealand and prevented many of the expedition activities the scientific staff had planned. The region appeared to have made a lasting impression on the expedition's participants, as there are more than a few personal accounts that lamented the terrible conditions and extreme seasickness induced by New Zealand's winter weather.

But to read the official *Narrative* of the expedition one would hardly detect that the time spent in New Zealand was such a failure. The reports provide rich, albeit brief, descriptions and comparative analysis of several types of specimens including trees, sea snails, littoral birds, as well as the New Zealand Peripatus and other types of sea and terrestrial worms. It is revealing however that later on the *Narrative* notes:

> Mr. W.T. Travers, F.L.S., to whom the Expedition was indebted for much kindness and scientific information during the stay at Wellington, brought on board specimens of Peripatus novae zealandiae and also of Land Planarians, together with the egg capsules of the latter, which were hitherto unknown…Mr. Travers also presented a Maori skull; and other Maori crania, together with some crania of the Chatham Islanders, were given by the authorities of the Colonial Museum. From the same Museum also some bones of Cetacea were obtained, which have been described by Professor Turner in his Report on the Bones of Cetacea collected by the Expedition.[138]

William Thomas Locke Travers was born in Ireland and immigrated to New Zealand in the 1850s. A lawyer and politician by trade, he was also a recreational naturalist who helped found the New Zealand Institute in 1872, the same year the *Challenger* first set sail. In this description we see that many of the physical materials

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[138] T.H. Tizard, H.N. Moseley, J.Y. Buchanan, and J. Murray, *Report of the Scientific Results of the Voyage of HMS Challenger during the years 1872 – 1876 under the Command of Captain George S. Nares, R.N., F.R.S. and Captain Frank Turle Thomson, R.N. Prepared under the Superintendence of the Late Sir C. Wyville Thomson, Knt., F.R.S., &c. Regius Professor of Natural History in the University of Edinburgh, Director of the Civilian Scientific Staff on Board and now John Murray, One of the Naturalists of the Expedition: Narrative of the Cruise of HMS Challenger with a General Account of the Scientific Results of the Expedition, Parts I and II,* Her Majesty's Stationery Office, London, 1885, p.474.

as well as much scientific knowledge published on New Zealand in the *Challenger*'s reports was in fact provided by Travers. Perhaps it is to the historian's benefit that the New Zealand trip was so disappointing as it forced the *Challenger*'s staff to acknowledge how they came to acquire the objects and knowledge of New Zealand included in their researches.

The personal journals and other published accounts of the expedition also highlight Travers's and others' contributions to the New Zealand part of this trip. In expedition naturalist Henry Nottidge Moseley's own personal account of the expedition entitled *Notes by a Naturalist*, the section on New Zealand, which in addition to a detailed discussion of the *New Zealand Peripatus* also includes some anthropological "observations" of New Zealand's Maori population, is almost entirely informed by previously published materials by Travers and others.[139]

The research on the *New Zealand Peripatus* proved valuable to Moseley and his colleagues as it demonstrated some unusual characteristics, including breeding in the middle of winter, and led them to the observation that the New Zealand species was more closely related to the American version than the Australian one; a conclusion that contributed to cosmopolitan thinking, rather than regional thinking about species.[140] Moseley, who went on to have a distinguished career, continued to publish on the *New Zealand Peripatus* for many years based primarily off of the specimens originally provided by Travers.

The *Challenger* is best known for its work on oceanography, and as evidenced by its time in New Zealand it also made significant contributions to terrestrial natural

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139 Henry Nottidge Moseley, *Notes by a Naturalist: An account of observations made during the voyage of HMS Challenger round the world in the years 1872 – 1876,* John Murray, Albemarle Street, London, 1892.

140 Diary of Henry Nottidge Moseley, 1873 – 1875, MSS MOS, NHM, London, UK.

history. One significant part of the expedition's work that has all but been forgotten in the historical memory, however, is its very large focus on ethnology and anthropology. Tucked in the middle of the extensive 75 *Zoological Reports* published from the expedition is a single one on human crania. While this inclusion of "uncivilized" humans within the zoological reports may appear anomalous today, the ethnological work of the *Challenger* naturalists was an important part of their assigned work.[141] It's notable that while the *Challenger* staff made numerous ethnological observations throughout their voyage, they depended on their colonial network for much of the historical and archaeological information used in the crania report. Like the Maori skulls contributed by Travers, almost all of the specimens discussed in the crania report were donated to the *Challenger* staff by individuals and museums they encountered during the expedition. The anthropological and ethnological work of the *Challenger* was as valuable to the expedition as the work in natural history and oceanography and in fact makes up a significant portion of the *Narrative* and other published accounts of the voyage. It was of an age, however, when exploration and direct observation were essential to credibility and authenticity. The short timelines and expansive aims of the expedition did not allow the *Challenger* scientific staff themselves to dedicate the time to this work, and they were heavily dependent on those in the colonies.

While Travers's contribution of zoological and human specimens is directly acknowledged, in other instances, the contributions of local participants are almost completely obscured. The expedition is well known for being one of the first to include a camera as part of the official equipment. Crew members and scientific staff took hundreds of photographs over the course of the expedition, some of which

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[141] See chapter 5.

became iconic representations of the expedition. The diversity of images, including those of top deck portraits, landscapes, anthropological artefacts and zoological specimens, provides insight into the wide variety of activities and investigations with which the scientific staff was engaged. Interestingly however, many of the images included from the time spent in New Zealand are of locations neither the ship nor its staff ever visited. Further, while these images were attributed to *Challenger* staff members, it is apparent that they were gifted to the staff by New Zealand locals.[142] Just as Travers's significant contributions informed the *Challenger* staff's knowledge of New Zealand, these images mediated the broader representation of the region to the scientific community back in Britain. It also gave the impression that the staff had been able to cover relatively large terrestrial expanses in a limited amount of time.

Glaringly, the colonial network enrolled by the *Challenger* reproduced the colonial power dynamics of the period. Indigenous and colonised peoples lived in each locality, however their presence was often diminished in the narrative accounts. To the extent they were acknowledged and recorded in the expedition's materials, they were viewed as objects of study rather than as participants. The many photographs that captured these individuals depicts them as ethnological studies. The exclusion of indigenous individuals contributed to the idea of an unadulterated, and uninhabited, natural world ripe for discovery. It also worked to erase any contributions they made to the knowledge gathered by the scientific staff, thereby denying any implications of, or claims to, indigeneity of the scientific knowledge of the expedition as a whole.

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[142] I am indebted to the participants of the conference *Finding New Zealand's Scientific Heritage* in 2015 who assisted in the identification of the original photographer of several photographs of New Zealand included in the *Challenger* collection which can now rightfully be attributed to D.L. Mundy.

Conclusion

The legacy of the *Challenger* lasted well beyond the ship's time at sea. In New Zealand, as elsewhere, the scientific results of the expedition's work were consumed and analysed for decades to follow. In one notable example, Augustus Hamilton, an early director of the Colonial Museum, published a New Zealand-specific pamphlet on the deep-sea fauna of New Zealand based on the *Challenger* results. This type of local interpretation was not unusual, and it demonstrates a fascinating inversion of the original relationship between the global and the local.[143] During the expedition, the scientific staff depended on local networks and knowledge in order to construct a global study of the ocean. Once the scientific results were published, including several important theories of global natural history, naturalists were able to use these newly proposed theories and apply them back to the local context. Hamilton in particular believed that the list of specimens collected and observed in the waters surrounding New Zealand should be used as a guideline for further local research and exploration to better understand the local deep-sea fauna.

The dominant narrative has celebrated the six members of the scientific staff for their expansive and exhaustive study of the land and sea. But while they certainly were engaged in the practical work of the expedition, they were also dependent on a large network of colonial participants who used their location and their local knowledge to benefit the scientific work that resulted from the *Challenger* and its *Scientific Reports*. The New Zealand part of the expedition lasted until early July 1874, and by all accounts the naval crew and scientific staff alike were happy to say goodbye as they sailed towards Tonga. But while this time could have become a

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[143] Augustus Hamilton, *Deep-Sea Fauna of New Zealand: Extracted from the Reports of the Challenger Expedition*, John Mackay Government Printer, Wellington, 1896.

postscript in the broad *Challenger* narrative, instead I believe it is an important constituent part of how the entirety of the expedition came together. The *Challenger*'s history and its scientific legacy cannot be understood without these parts. Or to put it another way, the global expedition was in fact local.

III. THE SUPERIOR ADVANTAGES OF HMS *CHALLENGER*

Introduction

In 1868 Thomas Huxley, pre-eminent naturalist, member of the Royal Society and at this time already well known as "Darwin's Bulldog" for his staunch support of Darwin's publication *On the Origin of Species* and the theory of evolution, announced the discovery of a new specimen which he named *Bathybius Haeckelii*.[144] *Bathybius* was a gelatinous protoplasm found on the bottom of the ocean floor and Huxley believed it to be the most basic structure of organic life. In just a few short years, however, in 1875, *Bathybius* experienced an inauspicious end when Huxley published a short piece in the journal *Nature* admitting that his discovery was a mistake.[145] His absolute and succinct abandonment of this potentially revolutionary finding came after naturalist Charles Wyville Thomson and his fellow naturalists on board HMS *Challenger* determined that the substance was merely an inorganic precipitate of lime.[146]

The *Bathybius* episode has been treated as an interesting anecdote included in many broader narratives within the history of science; explanations of the specific events around the non-discovery have ranged from present-centred notions of factual

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[144] Thomas Henry Huxley, "On Some Organisms Living at Great Depths in the North Atlantic Ocean," in the *Quarterly Journal of Microscopical Science*, 8, new series 32 (1868), pp.203-212.

[145] Thomas Henry Huxley, 'Notes from the *Challenger*' *Nature*, 12 (1875), pp.13-15.

[146] John Murray, 'The Cruise of the Challenger. (second lecture) Delivered in the Hulme Town Hall, Manchester, December 11th, 1877. By Mr. John Murray, F.R.S.E. Member of the Scientific Staff, H.M.S. Challenger', in *Science Lectures for the People Delivered in Manchester*, Manchester, 1866-1880, p.138.

error to more historically situated understandings of Victorian science.[147] However, despite these explanatory differences histories have concluded, along with Huxley, that *Bathybius* was merely a 'mistake'.[148] This perspective fails to acknowledge the cultural and scientific factors which contributed to this moment of un-discovery. The bookend moments of the *Bathybius* story, its initial discovery and consequent un-discovery, exemplify the changing enterprise of scientific practice at the end of the nineteenth century. Huxley's original identification of the specimen and later the *Challenger* naturalists' conclusion of its inorganic status demonstrate how mobility, the movement of scientific spaces, people and specimens reconfigured the making of modern knowledge in this time period.

How was it that Thomas Huxley, the man in the metropole with all of his credentials and authority, was so quickly convinced to dispose of the notion of a substance which, just years earlier, he believed to be the answer to the great mystery of the origin of life? Furthermore, how was it that C. Wyville Thomson, on board a ship and thousands of miles away from London in the middle of the Pacific Ocean, could so quickly disprove Huxley's new scientific discovery? The answer, in part, can be found in *Challenger* naturalist John Murray's account of these events:

> Observe then that the original describers [Huxley] were led astray by the excessive precautions they took to ascertain the true state of matters at the sea bottom. Their conclusion was based on careful and painstaking observation, and it is no credit to us that with out superior advantages we should have pointed out the error.[149]

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[147] See Philip F. Rehbock, 'Huxley, Haeckel, and the Oceanographers: The Case of Bathybius Haeckelii', *Isis*, 66, 4 (1975), pp.504-533; Donald J. McGraw, 'Bye-Bye Bathybius: The Rise and Fall of a Marine Myth', *Bios*, 45, 4 (1974), pp.164-171; and Anne-Flore Laloë, 'Where is *Bathybius haeckelii*? The Ship as Scientific Instrument and a Space of Science', in Don Leggett and Richard Dunn, eds. *Re-inventing the Ship: Science, Technology and the Maritime World, 1800 – 1918*, Routledge, London and New York, 2012, pp.113-130.

[148] Huxley, 'Notes from the "Challenger"', p.15.

[149] Murray, 'The Cruise of the Challenger. (second lecture)'.

Murray does not attribute the differing conclusions to skills, practice, or expertise but instead gives primary credit to the 'superior advantages' available to the *Challenger* naturalists. But what exactly were these advantages? They hinged upon HMS *Challenger* itself; the physical manifestation of the ambitions and work of the deep-sea naturalists. The ship facilitated new temporal and spatial relationships between specimen collection and examination. HMS *Challenger*, which through its configuration and organisation came to be viewed as a space of scientific practice, transformed into a moving centre of calculation thereby allowing for observation and analysis at the immediate place and time of collection regardless of the distance from a metropolitan centre.

Huxley's initial discovery followed the traditional pattern of nineteenth-century maritime-based natural history where specimens would be collected, preserved and then brought back to the metropolitan laboratory for observation and analysis, whereas the eventual refutation occurred because collection and analysis could occur at the same time and place, even in the middle of the Pacific Ocean. The story of *Bathybius* highlights how *HMS Challenger*, as a moving centre of calculation, reconfigured peripheral localities as spaces in which authoritative scientific observation and analysis could occur, thereby revolutionising their role in late nineteenth-century scientific knowledge production. The particular configuration of relationships between Huxley, Thomson and his fellow naturalists and the *Challenger* ship led to the conclusion of the *Bathybius* episode that has already been accepted in historical accounts: *Bathybius* was seen to be not an organic protoplasm but an inorganic precipitate. While the *Bathybius* controversy was just a single example of the larger project of the *Challenger* expedition, it's an important episode for highlighting the ways in which the *Challenger* contributed to the unique form of knowledge production that occurred in the context of late nineteenth-century British colonialism.

Scientific Spaces

Historians of science have long taken interest in the ship as a scientific space.[150] Some have identified ships as an important component in the history of field sciences, as liminal spaces that extend the laboratory into the natural world (and transform the natural world into a laboratory).[151] Others have examined the role of ships and expeditions in the 'ecological imperialism' of the seventeenth and eighteenth centuries.[152] Ships have rightly taken a central role in the intersection of maritime, colonial and scientific histories. Richard Sorrenson famously developed the concept of 'ship as instrument' in his history of eighteenth century imperial geography.[153] Sorrenson argues that the maritime pursuit of geography in this period, exemplified by Captain Cook's three voyages, transformed the ship from a vessel to an instrument of scientific work.[154] Imperial geography required large-scale maritime voyages which could chart and survey expanses of distant lands. Through the process

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150 This move towards situating the *Challenger* expedition in the broader tradition of field sciences is strongly related to the well-trodden theme of laboratories and laboratory spaces within Science & Technology Studies (STS). Scholars have created an entire sub-field devoted solely to the topic of scientific spaces. Beginning in the 1970s several prominent sociologists of science including Steve Woolgar and Bruno Latour turned their focus to the culture of scientific spaces. They conducted anthropological ethnographies of laboratories in order to understand the cultural and social dynamics at play in the practice of science and in the construction of scientific knowledge. Over the past forty years this has developed into a common research project for scholars in STS to understand how certain spaces become designated as places of science and as places of authoritative knowledge production.

151 See Robert E. Kohler, *Landscapes and Labscapes: Exploring the Lab-Field Border in Biology*, University of Chicago Press, Chicago and London, 2002.

152 Alfred W. Crosby, *Ecological Imperialism: The Biological Expansion of Europe 900 – 1900*, Cambridge University Press, Cambridge, 1986.

153 Richard Sorrenson, 'The Ship as Scientific Instrument in the Eighteenth Century', *Osiris* 11, 1 (1996), pp.221-236.

154 Sorrenson, 'The Ship as Scientific Instrument', p.225.

of surveying the ship became an instrument from which explorers were able to produce detailed maps of coastlines. As Sorrenson explains, Captain Cook would mark the latitude and longitude of his stationary ship and then take a bearing of a prominent coastal feature. He would then relocate the ship before taking another bearing of the same feature. The aggregate data of these measurements could then be used to calculate the latitude and longitude of the coastal feature and together the various features would chart a coastline. In this way the ships mediated the distance between the colonies and the metropole by constructing a representation of the distant lands and produced knowledge, through the physical maps and charts, for the use of those in Britain.[155] In doing so, the ship transformed into an instrument of the knowledge-making process.

More recently scholars have used Sorrenson's model to expand the histories of oceanography and field sciences. Antony Adler uses Sorrenson's concept as the starting point for a new framework for the history of oceanography.[156] Adler's broad project is to replace a simple chronological periodisation with classifications more closely linked to the role of the ship: the ship as instrument, the ship as laboratory and the ship as invisible technician.[157] Within this he posits that by the nineteenth century the ship was no longer an instrument of science but was instead a laboratory, a transformed scientific space; and he identifies the *Challenger* as the exemplar of the ship as laboratory. The design of the *Challenger*, Adler argues, made it a space where scientific work could be done therefore bringing laboratory practices into the field. He suggests that the scientific staff of the *Challenger* preferred their oceanic-based

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155 Sorrenson, 'The Ship as Scientific Instrument', p.225.

156 Antony Adler. 'The Ship as Laboratory: Making Space for Field Science at Sea', *Journal of the History of Biology*, 47, 3 (2014), pp.333- 362.

157 The concept of an invisible technician was originally developed by Steven Shapin in his work on Robert Boyle and his laboratory participants. See Steven Shapin, 'The Invisible Technician', *American Scientist*, 77, 6 (1989), pp.554-563.

research to any done on land because of the uniformity with which the ship-based laboratories provided their work rather than the more difficult field-based practices on land.[158] Adler's article focuses on the physical space of the ship and he is keenly interested in the ship as a social space, arguing that the *Challenger* was also a laboratory for social experimentation. The organisation of the spaces on board the *Challenger* was both a sign of and a motivator for new relationships between scientists (Adler's term) and the naval crew. The *Challenger* is of interest to Adler in what it represents, but the history of the *Challenger* itself is less relevant to Adler's model building.

Similar to Adler, Anne-Flore Laloë builds on Sorrenson's work in her chapter in the edited volume *Re-inventing the Ship: Science, Technology and the Maritime World, 1800 – 1918*.[159] Laloë uses what she refers to as the "non-discovery of Bathybius haeckelii" to examine the role of the ship in nineteenth-century science. In her narrative the ship, as a scientific space, "played a pivotal role in the life and death of Bathybius".[160] Laloë chooses to redefine the concept of an instrument in order to accommodate the *Challenger* within Sorrenson's framework. Laloë argues, "This brings to the fore the complex ways in which space and science, both physically and socially, lay at the core of making science aboard each step of making, discovering and debunking Bathybius, with the ship as an instrument of science, a laboratory space, a site of social interaction and, perhaps foremost, a moveable space of science."[161]

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[158] Adler, 'The Ship as Laboratory', p.352.
[159] Laloë, 'Where is *Bathybius haeckelii*'?
[160] Laloë, 'Where is *Bathybius haeckelii*?', p.120.
[161] Laloë, 'Where is *Bathybius haeckelii*?', p.129.

Just as historians have focused on the spaces of HMS *Challenger*, so too did *Challenger* participants and close observers. The scientific spaces on board the ship were often invoked by the historical actors of the time as evidence that the HMS *Challenger* expedition was engaged in something uniquely different to earlier maritime expeditions involved in the study of the natural world. Arguably the two most famous naturalist expeditions prior to the late nineteenth century both aptly demonstrate the distinction between the *Challenger* expedition and earlier incarnations. In the lead up to Captain Cook's second voyage to the Pacific, Joseph Banks made several requests for the accommodation of his scientific work on board HMS *Resolution*. As Sorrenson describes, "Joseph Banks, flush with the acclaim he received for his botanizing on Cook's first voyage… was able to have a superstructure added to Cook's ship to accommodate his botanical equipment, specimens, artists, dogs, servants, and French-horn players,"[162] but Cook resolutely challenged the outfitting. Although it had originally been approved by the First Lord of the Admiralty, a friend of Joseph Banks, once the ship's sea trials demonstrated that the new refurbishments made the ship top heavy Cook demanded that they be undone and the First Lord of the Admiralty agreed. [163] This episode has been read in several ways, and the excesses requested by Banks appear to go beyond those required for scientific work, however it is demonstrative of the prioritisations of the Royal Navy, expedition officers, and naturalist participants.

Charles Darwin's experience on HMS *Beagle* fifty years later, while different to that of Banks's, also demonstrates the clear distinction between naturalist science as an expedition activity as opposed to the expedition's main purpose. Darwin noted

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[162] Sorrenson, 'The Ship as Scientific Instrument', p.226.
[163] Sorrenson, 'The Ship as Scientific Instrument', p.227.

in his published account of the expedition *The Voyage of the Beagle* (1845), "The object of the expedition was to complete the survey of Patagonia and Tierra del Fuego, commenced under Captain King in 1826 to 1830, -- to survey the shores of Chile, Peru, and of some islands in the Pacific -- and to carry a chain of chronometrical measurements round the World," and Darwin's participation was, "in consequence of a wish expressed by Captain Fitz Roy, of having some scientific person on board."[164] Darwin's presence on the voyage is an indication of the naturalist work that occurred on the *Beagle* expedition and others like it but also demonstrates its ancillary position.

In contrast to these earlier expeditions, public discussions of the expedition often highlighted the ship's physical conversion as evidence of its distinction as a *scientific* expedition. In the days following HMS *Challenger*'s departure from Sheerness a letter from Naval officer W.J. Grandy was read during the proceedings of the Royal Geographical Society in which he proclaimed:

> It was perhaps a little remarkable that it was exactly 100 years (1772) since Captain Cook set forth on his voyage. The *Challenger* was accompanied by a staff of officers who were not only naval surveyors, but scientific naturalists such as never before left on any expedition of this kind. Great results might therefore be expected, and he hoped that, in three years or little more, the expedition would return and fully justify the expectations that had been formed. The equipment of the *Challenger* reflected great credit on the authorities, and was worthy of the enlightened times in which we're supposed to live.[165]

Reference to the equipment and on-board accommodations were tied to notions of history and progress. Participants and observers positioned the expedition as an inaugural voyage into a new age of scientific engagement. As Murray proclaimed,

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164 Charles Darwin. *Voyage of the Beagle*, Second Edition, John Murray, Albemarle Street, London, 1845, p.1.

165 W.J. Grandy to [unknown], *Proceedings of the Royal Geographical Society of London*, Third Meeting, 9th December, 17, 1 (1872-1873), p. 56.

"…Our Challenger was a floating Zoological Laboratory, and I know the good work that can be done in a well furnished laboratory of this nature".[166]

This is a theme that has been taken up by many who identify the *Challenger* expedition as the beginning of modern oceanographic practices, and downplay the connections between the scientific practices developed on board the ship and the broader historical context surrounding the expedition. While one can easily argue that these laboratories on board HMS *Challenger* signified a shift in the scientific enterprise of British maritime science, the question remains whether these new types of spaces actually facilitated and produced new types of scientific knowledge.

The laboratories were intended to provide the equipment and space necessary for the naturalists to conduct analysis and observation at the site of collection. The significance of this was highlighted by a contemporary of the expedition in his review of Moseley's work on corals:

> Of still greater importance and merit was Mr. Moseley's study of corals allied to Millepora and Stylaster, previously unknown (or nearly so) in the living state, although familiar as dry and bleached museum specimens. These, when freshly dredged by the *Challenger*, were treated by Mr. Moseley with those subtle devices known only to trained histologists, and as a result, he has been able to give the full anatomy of the soft parts of these corals.[167]

The dried state of previously collected specimens had obscured certain characteristics which were only observable in a living state. The observations made by Moseley were specifically facilitated by the outfitted ship. Sketches of the zoology, natural history and chemistry labs on board the ship indicate that the spaces were well

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[166] John Murray to J. Barnois, Director of Zoological Laboratory Villefranche, 14 March 1882, Murray Collection, NHM, London, UK.

[167] E. Ray Lancaster, 'Moseley's Naturalist on the "Challenger"', *Nature*, 19, 488 (1879), p.416.

stocked and configured to mimic traditional laboratory spaces of the period.[168] The accessibility of appropriate apparatuses for analysis, not simply collection, of specimens made this expedition unique. Thomson and his crew regularly provided reports of their ongoing work back to the scientific societies of London, and in these reports they often refer to the scientific experimentation and analysis that the naturalists conducted in order to reach their conclusions.[169] Where earlier preliminary reports depended on speculation and observation, the naturalists of the *Challenger* could systematically, and repeatedly, test and analyse their specimen collections; and the presence of the *Challenger* labs gave legitimacy to the types of analysis the naturalists conducted. As historian Robert Kohler argues, the laboratory revolution of the nineteenth century conferred the laboratory space with a cultural authority. The knowledge produced from within a laboratory was trusted in ways that knowledge produced in the field was not.[170] By constructing laboratories on board the *Challenger* the sponsors of the expedition intended to make the ship a place of immediate knowledge production, rather than a mere instrument in the collecting of specimens, data and information.

The laboratories were a component part of a wholly transformed ship that differed in form and function from those of the Royal Navy. The upper deck housed

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[168] T.H. Tizard, H.N. Moseley, J.Y. Buchanan, and John Murray. *Report of the Scientific Results of the Voyage of HMS Challenger during the years 1872 – 1876 under the Command of Captain George S. Nares, R.N., F.R.S. and Captain Frank Turle Thomson, R.N. Prepared under the Superintendence of the Late Sir C. Wyville Thomson, Knt., F.R.S., &c. Regius Professor of Natural History in the University of Edinburgh, Director of the Civilian Scientific Staff on Board and now John Murray, One of the Naturalists of the Expedition: Narrative of the Cruise of HMS Challenger with a General Account of the Scientific Results of the Expedition, Parts I and II,* Her Majesty's Stationery Office, London, 1885, p.6.

[169] As an example see Rudolf von Willemöes-Suhm, 'Preliminary report to Professor Wyville Thomson, F.R.S., Director of the Civilian Scientific Staff, on observations made during the earlier part of the voyage of HMS 'Challenger'', *Proceedings of the Royal Society of London*, 24, 164-170 (1876), pp.569-585.

[170] Kohler, *Landscapes and Labscapes*, p.7.

three cordage racks which each held 2,000 fathoms (approximately 3,500 metres) of dredging rope. The deck also had several projecting platforms from which dredging and trawling were conducted, in addition to a specific central platform where the scientific staff could sift through the dredged mud and preserve the relevant specimens without disrupting the naval crew's on deck, where they handled the lines controlling the dredging and trawling operations.. Two shafts connected this platform to the side of the ship, so that the naturalists could simply dump the unwanted mud back into the ocean, "without dirtying the decks", and beneath these shafts were two large zinc containers which held the large amounts of spirit alcohol required to preserve specimens.[171] In addition to these platforms the ship also had two traditional sounding platforms from which "the ordinary sounding work of a surveying vessel" was conducted.[172] The upper deck also held an 18-horsepower donkey steam engine used solely for the purpose of hauling the large amounts of sounding and dredging ropes.[173]

At Simon's Bay on the Cape of Good Hope in October of 1873, the crew built an enclosure on the upper deck, henceforth referred to as the deck house, from which the scientific staff did much of their initial sorting and analysis.[174] The space was described in the following manner in the published *Narrative*, "Abaft the screw well was situated a deck house, 7 feet fore and aft, by 8 feet athwart ships, built after the departure of the ship from England, in order to give increased accommodation to the naturalists. The work connected with the preservation of birds, mammals, fish, deep-sea deposits, and the examination of tow-net gatherings, was usually conducted in this

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[171] Tizard et. al., *Narrative*, p.2.
[172] Tizard et. al., *Narrative*, p.3.
[173] Tizard et. al., *Narrative*, p.3.
[174] Tizard et. al., *Narrative*, p.282, At the Cape of Good Hope: "At Simon's Bay the ship was refitted, a deck house built for the convenience of the Naturalists, and the necessary stores taken on board for the Antarctic trip".

house".[175] The deck house is described as having sash windows that spanned the width of its walls, and underneath the large windows sat a broad "dresser" which served a number of purposes. It had three large holes which contained "glass globes" into which the collected materials from the surface nets would initially be emptied as well as several racks to hold smaller specimen bottles. The dresser also had a clamp to hold the Hartnack microscope the naturalists used for initial observations. The rest of the house had several table surfaces for specimen work including bird skinning and microscopic analysis and additional storage space for specimen collection. The roof of the house had both nets and hooks to hold collected birds, and the publication notes that "there was excellent light in this house and the microscope could be used satisfactorily in all kinds of weather".[176] Of its utility the staff noted: "A deck house such as this, where all the rougher work of the naturalists can be carried on, should be provided in every vessel expressly fitted for researches similar to those carried on in the *Challenger*".[177]

One level below the upper deck was the main deck, otherwise known as the gun deck, from which the guns had been removed, replaced by the major scientific workrooms and the traditional captain's cabin. In a symmetrical design which could be seen as something more than simply symbolic, the after (or the rear) part of the main deck which would have traditionally been for the sole use of the ship's Captain, was divided into two, providing identical cabins for the Captain (George Nares) and the Director of the Civilian Staff (C. Wyville Thomson).[178] Just beyond the Fore Cabin which attached these two cabins sat two identically sized workrooms: one

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[175] Tizard et. al., *Narrative*, p.3.
[176] Tizard et. al., *Narrative*, p.4.
[177] Tizard et. al., *Narrative*, p.4.
[178] Tizard et. al., *Narrative*, p.5.

designated for the use of the naturalists under Wyville Thomson and the other a chartroom designated for the use of the ship's surveyors under Captain Nares. In space previously occupied by the naval ship's guns HMS *Challenger* housed a zoological laboratory, a chemical laboratory and a photographic workroom.[179]

The zoological laboratory is described in the published accounts in great detail, and is accompanied by an oft-circulated woodcut image of the room.[180] Interestingly, the language used in the *Narrative* is not only descriptive, but also prescriptive, often suggesting amendments and alterations which would improve on the design for future (hypothetical) scientific expeditions. The room was intentionally well lit with both windows and skylights from the upper deck. The main part of the room was taken up by a large work table, but the *Narrative* notes that the microscopes could only be used on the end of the table near the port windows, given the light source, and that the opaque windows were a hindrance. "Those of the *Challenger* laboratory might certainly have been improved in this respect had the matter received attention when they were constructed. Plate glass windows in iron frames would probably be best".[181] The microscopes, table and almost all other equipment was fastened down in some capacity to prevent any damage or disruption from the movement of the ship, and even the scientific staff was considered: "the simple oval-topped wooden stools occupied by the microscopists were also screwed to the deck on each side of the window. They were so placed, and of such a height, that the sitter, by jamming his knees against the frame of the securely fixed table, could hold himself firm and motionless".[182] The laboratory had specially-designed cabinetry that

[179] Tizard et. al., *Narrative*, p.5
[180] Tizard et. al., *Narrative*, p.6.
[181] Tizard et. al., *Narrative*, p.5.
[182] Tizard et. al., *Narrative*, p.5.

was fitted with "air-tight zinc linings" and wooden lids that made them "air-tight and damp proof" for the preservation of plants and other collected materials,[183] and a pipe was fitted from a holding tank on the upper deck which contained the preserving spirit down to the laboratory. The tap was secured under lock and key, "under special charge, especially at night, as a precaution against danger from fire," however it was also noted in personal journals that this was to prevent any of the ship's crewmembers from attempting to imbibe the spirits themselves.[184] It is also noted that the zoological laboratory held "common fish globes" which contained living specimens as well as a slate and plate-glass aquarium which ultimately proved an unsuccessful container given that the movements of the ship made it impossible to render watertight.[185]

The chemical laboratory was smaller than the zoological laboratory and situated on the starboard side of the ship in the centre of the lower deck. The space was dominated by a four-foot long teak workbench alongside a smaller mahogany table and a blowpipe table that supported the spirit lamp for glass blowing. The main workbench contained a small sink as well as a large glass bottle, later replaced by an earthenware equivalent when it broke in rough water, which held distilled water.[186] As with the zoological lab, the chemical one also had specially-designed drawers and shelves to house the bottles, flasks, and other required equipment. The lab was stocked with unique apparatuses, many of which were adjusted over the course of the expedition to suit the work of Buchanan, the chemist.

Directly across the deck from the chemical laboratory was a photographic workroom. The *Narrative* does not mention this space beyond the statement that it

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[183] Tizard et. al., *Narrative*, p.5
[184] Tizard et. al., *Narrative*, p.5
[185] Tizard et. al., *Narrative*, p.6.
[186] Tizard et. al., *Narrative*, p.13.

was “specially fitted for the purpose for which it was intended, under the immediate superintendence of those members of the civilian Staff who were to use them”.[187] This is interesting in that while it seems that artist J.J. Wild, who was considered part of the civilian staff, may have used the camera to some extent, the three crew members noted as being entrusted with camera were all naval men and not part of the scientific staff. At the initial launch the camera was the responsibility of an unnamed “Corporal of the Royal Engineers, an experienced photographer [who] accompanies the Expedition in that capacity, and is provided with all necessary apparatus”[188], although today the photographs are most commonly associated with Scottish photographer James Horsburgh who took at least some of the photos and who was entrusted with the negatives at the conclusion of the expedition.[189]

Understanding the role of the ship in the work of the expedition also highlights the material constraints encountered by the scientific staff. The ship, like the ocean, was a physical space that enabled and constrained certain behaviours, practices and routines. The practical challenges of a moving ship were certainly of concern to the scientific staff. In addition to suffering the ill effects of storms and rough conditions, the naturalists were constantly worried about the state of their specimen collections. The description of the zoology laboratory included in the *Narrative* includes note of accommodations to secure specimens, “from injury at a moments notice,” and to prevent “specimens being lost owing to a sudden lurch of the ship”.[190]

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[187] Tizard et. al., *Narrative*, p.10.
[188] [no author], ‘Her Majesty’s Ship Challenger’, *The Times* (London, England), Thursday, Dec 05, 1872; pg. 3; Issue 27552.
[189] [no author], *Catalogue of the Photographic Negatives Taken During the ‘Challenger’ Expedition 1872 – 1876 and entruste for Publication by HM Stationery Department to J. Horsburgh, FRSSA, FGSE, Artist & Photographer*, 131 Princes Street, Edinburgh, 1885.
[190] Tizard et. al., *Narrative*, p.6.

The Tale of Bathybius

In 1868 Thomas Huxley published a short piece in the *Quarterly Journal of Microscopical Science* entitled *On Some Organisms Living at Great Depths in the North Atlantic Ocean* in which he identified and named the substance *Bathybius Haeckelii*.[191] The specimens observed by Huxley had originally been collected by crew on board HMS *Cyclops* in 1857 during a mission to determine the 'nature of the ocean floor' in an area of the North Atlantic that had been identified as a potential location for the laying of submarine telegraph cables, and which had come to be known by 1868 as the Telegraph Plateau. As noted by Huxley, the specimens were collected by Captain Dayman and his crew from the *Cyclops* and then sent to London for examination. In 1868, eleven years after the initial collection, Huxley "had occasion to re-examine specimens of Atlantic mud, which were placed in spirits in 1857, and have since remained in [his] possession". He noted specifically that in his new observations he, "ha[d] employed higher magnifying powers than he formerly worked with".[192] From this re-examination Huxley discovered *Bathybius*, which he suggested was an organic protoplasm (the *Urschleim* that his German colleague Ernst Haeckel had previously theorised) belonging to the class of *monera* which were some of the smallest living organisms in Haeckel's classification system. Although Huxley specifically stated that in this article he wanted to keep "questions of fact and questions of interpretation" separate, soon after this publication he and others began to speculate as to the significance of this newly found substance.

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[191] Huxley, 'On Some Organisms', p.203.
[192] Huxley, 'On Some Organisms', p.203.

As Philip Rehbock has argued the possibility of an organism such as *Bathybius* was anticipated by, and maintained through, the notion of abiogenesis, the evolution of organic life out of inorganic matter. That the discovery of *Bathybius* supported the theory of abiogenesis meant it was an important contribution both to Haeckel's mechanistic *Weltanschuung*, or worldview, and Darwin's evolutionary theory which had, up until this point, provided a mechanistic explanation for the diversity of species but avoided the question of the origins of organic matter.[193] *Bathybius* had the potential to be the answer to the great question of the origin of life.

In the late 1860s and early 1870s *Bathybius* became part of the general research of many well-known naturalists interested in the ocean. In 1870 *Nature* summarised a German-language article published by Ernst Haeckel in which he:

> Treats fully of the deep-sea life brought to life by the dredgings of Drs. Wallich, Carpenter, Wyville Thomson, Huxley, and others, describing the Bathybius, Coccoliths, Globigerina, &c. He confesses himself unable to solve the problem of the origin of the immense quantities of protoplasm that form a bottom to the sea, but is disinclined to regard it as consisting of the mycelium of sponges, an opinion advanced by Wyville Thomson.[194]

Bathybius had fast become an ontologically stable object which easily integrated into the scientific enquiries of some of Europe's most established naturalists.

In the same year as Huxley's original announcement, zoologist William Carpenter published his *Preliminary Report* from a dredging expedition in the North Atlantic aboard HMS *Lightning*. While merely one of the many publications that discussed *Bathybius* specimens following Huxley's original pronouncement, Carpenter's *Report* exemplifies the type of researches that followed the discovery of this protoplasm. Furthermore, and arguably more importantly, the *Report* elucidates

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[193] Rehbock, 'Huxley, Haeckel, and the Oceanographers', p.506.
[194] [no author], 'Scientific Serials', *Nature*, 2, 35 (1870), pp.177-178.

the network of relationships that existed within this community of naturalists and contributes to a clearer understanding of the personal and professional negotiations that played out. By the 1860s, Huxley was a well-respected naturalist, an active participant in the growing debates around evolutionary theory and the origins of life, and a central figure in the X Club, a group of influential members of the Royal Society.[195] Huxley was well acquainted with both Carpenter and Wyville Thomson, and their successful petitioning for funds for deep-sea exploration was no doubt partially attributed to Huxley's favourable view of their work. It was however unmistakable that Huxley's public personae was better known and respected.

The *Preliminary Report* was written by Carpenter, who in the following years would come to use the findings and results of the HMS *Lightning* voyage, along with those of its sister-ship HMS *Porcupine*, to advocate for a full global circumnavigation deep-sea dredging expedition. He was supported, both at sea and in writing the report, by Wyville Thomson. In the *Report* Carpenter not only confirmed new findings of *Bathybius* but he also dedicates ample space to investigating the specific nature and origins of the new organism. Carpenter notes in his general results, that Huxley himself examined the collection of dredged specimens and was able to offer a first-hand confirmation of the existence of *Bathybius* within these collected specimens. That Huxley had access to, or in Carpenter's words, "was good enough to [examine]", the *Lightning* specimens was in keeping with practices of the day, where experts who had no direct connection to the initial maritime expedition would still have access to specimen collections when they were returned to land. Beyond Huxley's confirmation however, Carpenter contributes many of his own microscopic observations of the

[195] See Ruth Barton, 'An Influential Set of Chaps: The X-Club and Royal Society Politics 1864 – 85', *British Journal for the History of Science*, 23, 1 (1990), pp. 53–81.

specimens in attempting to answer the 'perplexing problem' of *Bathybius*'s constitution. Although he is able to identify many of the component parts that appear in the protoplasm, Carpenter finally concludes that he cannot determine whether it was animal life itself or vegetable life which sustained animal life within its ooze, however he confidently asserts that either way it should be considered one of the lowest, and therefore oldest, living life forms. Furthermore Carpenter notes, "As Prof. Huxley has proved the existence of *Bathybius* through a great range not merely of *depth* but of *temperature*, I cannot but think it probable that it has existed continuously in the *deep seas of all Geological Epochs"*.[196]

In acknowledging Huxley's contribution to this report, it is perhaps unsurprising that Carpenter so confidently confirms Huxley's discovery. Beyond this however this report and others like it make evident that the British naturalist community was confident in the potential further research that *Bathybius* could offer to the broad fields of natural history. The discovery of *Bathybius* marked the advent of a new wave of research which attempted to write the evolutionary history of the deep sea and its known specimens. *Bathybius* was not merely another deep-sea specimen but was the foundation of an evolutionary natural history of the ocean. Given this, the relatively quick reversal of position that Huxley adopted after his correspondence with Wyville Thomson seems even more peculiar.

But so it was that in just seven years, after numerous articles and reports on the promise of *Bathybius* and theorisation about its true nature, Huxley published a short piece in the journal *Nature* entitled *Notes from the Challenger*, in which he publicly admitted that he was mistaken in his discovery of *Bathybius* and the

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[196] William B. Carpenter and Charles Wyville Thomson 'Preliminary Report of Dredging Operations in the Seas to the North of the British Islands, Carried on in Her Majesty's Steam-Vessel 'Lightning'', *Proceedings of the Royal Society of London*, 17 (1868), p.191.

specimen which he had believed to be an organic protoplasm was in fact an inorganic precipitate of lime.[197] The structure of this public pronouncement deserves some attention, because it helps to explain how and why Huxley abandoned his concept of *Bathybius* and how this admission may have been received by his colleagues.

Huxley begins the piece with a long quotation from a letter dated June 9, 1875, which he received directly from C Wyville Thomson on board HMS *Challenger.* Huxley's article in *Nature* was published August 19, 1875, highlighting the relatively short time period in which this event took place, of course noting that the letter would have had to travel from the Pacific, where the *Challenger* was then located, back to Huxley in London. The selection from the quoted letter concerns specific observations made by the *Challenger* naturalists but is not directly related to the subject of *Bathybius*. Interestingly much of what Thomson discusses in the quotation seems to support and further work done by Huxley and others in the naturalist community. It is only after the extended quotation that Huxley addresses the topic of *Bathybius*. In the final three paragraphs of the report Huxley adds:

> Prof. Wyville Thomson further informs me that the best efforts of the *Challenger*'s staff have failed to discover Bathybius in a fresh state, and that it is seriously suspected that the thing to which I gave that name is little more than sulphate of lime, precipitated in a flocculent state from the sea-water by the strong alcohol in which the specimens of the deep sea soundings which I examined were preserved…Prof. Thomson speaks very guardedly, and does not consider the fate of Bathybius to be as yet absolutely decided. But since I am mainly responsible for the mistake, if it be one, of introducing this singular substance into the list of living things, I think I shall err on the right side in attaching even greater weight than he does to the view which he suggests.[198]

[197] Huxley, 'Notes from the "Challenger"', p.13.
[198] Huxley, 'Notes from the "Challenger"', p.15.

The humility demonstrated by Huxley was intentionally constructed,[199] and appeared to have the desired impact on his colleagues. Soon after his publication Huxley's friend and colleague Michael Foster remarked in a letter 'By the bye, you did that *Bathybius* business with the most beautiful grace – I wish you would sell me a little morsel of that trick',[200] and it is this sentiment which has dominated the few short publications in the history of science that have focused on *Bathybius*. Most scholars are inclined to see the case of *Bathybius* as a small error in Huxley's otherwise illustrious career.[201]

Bathybius had perplexed Wyville Thomson's staff almost from the beginning. They were hopeful to find further specimens during their voyage in order to learn more about its general nature. But from their earliest dredges, the substance proved elusive. As Willemöes-Suhm noted in 1873, " How about Bathybius? Nobody has ever seen it in the work-room except in alcohol. But this negative statement vague as it is would never do for publication. We must show in a positive manner that when the mud is fresh a regular Bathybius does not exist by giving the results of many mud-investigations which must be noted down. I am however not going to do so, but I think one of my learned colleagues could very well".[202] Constructing an appropriate message to Huxley must have proved challenging, as the scientific staff deferred raising this topic with him until 1875, in the letter Huxley referred to in his publication.

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[199] Just a week before Huxley's publication he told his friend Michael Foster that with regard to his admission, "I shall eat my leek handsomely, if any eating has to be done." M. Foster to T.H. Huxley, Correspondence, August 11 1875, Letter 86, *Medical History Supplement*, 28, (2009).

[200] M. Foster to T.H. Huxley, Correspondence, September 14, 1875, Letter 87, *Medical History Supplement*, 28, (2009).

[201] See McGraw, 'Bye-Bye Bathybius'.

[202] Diary of Rudolf von Willemöes-Suhm, 1872 – 1875, 12, Murray Collection, Section 1, NHM, London, UK.

A closer reading of the letter beyond Huxley's summary sheds more light on the savviness of Wyville Thomson and his staff as well as on the negotiations which occurred around the *Bathybius* controversy.

> There is another matter on which I have some little hesitation in writing at present because I feel that our information is imperfect, but yet I think as it is one which has been given undue importance of late, and bears upon a question in which you are officially mixed up you should be told exactly how it stands. None of us have ever been able to see a trace of Bathybius, although it has been looked for throughout with the utmost care …Murray who has worked at it most carefully, and Suhm & Moseley who are well up to the use of the microscope all deny that such a thing exists. I have gone over Haeckel's papers & all the other notes we have on board about it and I think so also, but I do not feel absolutely certain yet as to the constitution of the flocculent precipitate. It seems to me possible that a trace of organic matter may combine with the lime sulphate to give it that very peculiar form, and as there will certainly be a vigorous discussion about it I am inclined to check any hasty publication.[203]

The tone of humility and the continual reluctance to make finite statements was surely a performance of respect and political savvy rather than of any real uncertainty in the findings. Although it was the more junior staff members who had made this un-discovery, importantly all communication went through Wyville Thomson. The assertion that they had collectively come to agreement on this issue was, I believe, an important point in convincing Huxley of its truth. The letter concluded with:

> Murray and Buchanan are anxious to bring it out at once for they expect the question to arise at the British Association and they would rather have the first word. I told them, or rather I told Murray, that I would not sanction a paper being sent home till I had written to you, as you took a fatherly interest in the beast? and got your answer.[204]

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[203] Charles Wyville Thomson to Thomas Henry Huxley, 9 June 1875, 27.312, Box Number 27, Series 1t, Thomas Henry Huxley Collection, Imperial College London Archives, London, UK.

[204] Vol. 27, MSS 315-317, Huxley Papers, Imperial College London, London, UK. As cited in Rehbock, 'Huxley, Haeckel, and the Oceanographers'.

This final statement, with the allusion to future public discussion, hints at the pressure that Huxley must have faced in light of the *Challenger* observations: either he had to quickly and publicly proclaim his own mistake in the matter or risk having the junior *Challenger* scientists, namely Buchanan and Murray, publicly discredit his discovery.

In fact, despite Wyville Thomson's prediction, there appears to have been very little ongoing interest in Bathybius once Huxley made his public pronouncements. In 1877 John Murray noted, "Some of our German friends, I notice, still cling to Bathybius; but I believe Bathybius will soon disappear from German text-books, as it has from those of this country".[205] Although it should be noted that this comment was made in a public lecture in which he described the entirety of Bathybius' short life, indicating that there was at least some ongoing interest by the general public ten years later. When the official *Narrative* was published in 1885, the *Bathybius* incident received a mere mention embedded within a broader discussion of the nature of the ocean floor in the introduction.

> The samples of 'Atlantic ooze' procured from the greatest depths of that ocean by the sounding rods of the telegraph ships were eagerly examined by the leading European and American naturalists. The ooze was found to consist largely, in some cases almost wholly, of the shells of Foraminifera and the siliceous skeletons of Radiolarians and Diatoms. The question soon came to be whether all the Foraminifera naturally lived on the bottom or whether it was only their dead shells that collected there, the animals living and dying on the surface, or at some intermediate depth. This question was exceedingly difficult to settle from the data possessed by the disputants prior to the *Challenger* and other exploring expeditions. In the preserved samples of the ooze it was believed that there was evidence of the existence of sheets of living protoplasm – a shell-less Rhizopod named Bathybius – covering the bottom of the ocean everywhere. The Naturalists of the *Challenger* failed to detect Bathybius in freshly procured samples of the ooze, and have shown that the protoplasmic appearance arose from the great excess of alcohol used in the preservation of the samples of the ooze, producing a gelatinous-like precipitate of calcium sulphate.[206]

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[205] Murray, 'The Cruise of the Challenger. (second lecture)', p.138.
[206] Tizard et. al., *Narrative,* p.xliv – xlv.

With this, the *Bathybius* episode concluded. While *Bathybius* has become a mere anecdote in the history of science, its reputation belies the peculiar circumstances of its undiscovery. Huxley, a man of good standing within the powerful scientific community in London's metropole, was quickly converted in his thinking by a set of junior naturalists circulating the globe on an isolated and disconnected ship in the middle of the ocean. All cultural and social indicators of scientific networks of the Victorian era would suggest that Huxley could have maintained and pursued his *Bathybius* idea beyond the initial findings of the *Challenger* naturalists, but as we know, this was not the case. Instead, a substance which was once presumed to cover the entirety of the ocean floor was proved non-existent by its absence in very specific locations of the ocean. From the available correspondence it does not appear that any of the actors in this engagement entertained the idea that *Bathybius* existed elsewhere in the ocean and was as yet to be re-discovered; rather the *Challenger* naturalists' conclusion stood on its own.

HMS *Challenger*, with its unique accommodations and design established a moving space of authoritative knowledge production. Its legitimacy as a scientific laboratory combined with its unique capability to continually move to its locations of study, reconfigured the processes of exploratory natural history at the end of the nineteenth century.

History of Science and Colonialism

Previous narratives of the *Bathybius* controversy have situated the story centrally within the metropole of Britain.[207] While it is not initially apparent that the *Bathybius* story is a colonial one, reading it through the bodies of work on science and empire, and more specifically on the circulation of knowledge, reframes the narrative in a way which highlights the significance of colonial locality and imperial interactions.[208] Additionally, by turning our attention to the role of the *Challenger* within the controversy, the *Bathybius* case can contribute to a revised understanding of the role of colonial localities in the circulation of knowledge.

The history of science has debated models of colonial science since the publication of George Basalla's article *The Spread of Western Science*[209] in 1967. In this article Basalla introduced his three-phase model of colonial science. In the first phase of his model, "nonscientific societies" become a resource of information and natural objects for western science. In phase two, we see the development of what Basalla coined "colonial science", a term intended to identify the early stages of a scientific culture established within previously nonscientific societies. Notably, colonial science in Basalla's conception is entirely dependent on the institution, practices and funding of Western nations. In phase three the final transplantation, as Basalla refers to it, occurs thereby solidifying an independent scientific tradition in the colonial location. Notably, while Basalla explicitly refers to this as a model, he is

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[207] See Rehbock, 'Huxley, Haeckel, and the Oceanographers', and McGraw, 'Bye-bye Bathybius'.

[208] See Richard Harry Drayton. *Nature's Government: Science, Imperial Britain, and the 'improvement' of the World*, Yale University Press, New Haven, 2000; Jim Endersby. *Imperial Nature: Joseph Hooker and the Practices of Victorian Science*. University of Chicago Press, Chicago and London, 2008; David Philip Miller and Peter Hanns Reill, eds. *Visions of Empire: Voyages, Botany and Representations of Nature*, Cambridge University Press, Cambridge, 1996; and Alex Soojung-Kim Pang, *Empire and the Sun*: *Victorian Solar Eclipse Expeditions*, Stanford University Press, Stanford, 2002.

[209] George Basalla, 'The Spread of Western Science', *Science*, 156, 3775, (1967), pp. 611-22.

also clearly referencing the specific historical case of the transfer of modern Western science from Europe to the Americas.

Since its conception there has been considerable critique of this diffusionist model of science. One of the most important responses has been the turn towards a model which emphasises the circulation of knowledge. Where the diffusionist model suggests a one way transfer of knowledge from the metropole out to the peripheries, circulation of knowledge models suggest at least a multi-directional movement of knowledge. Additionally, much of the work on the circulation of knowledge aims to show how what has come to be seen as modern science was not merely a European development but instead a result of colonial co-construction. While this tradition still promotes the importance of metropoles and peripheries as localities it aims to complicate the relationship between the two. As historian Mark Harrison notes, "The most one can say about recent literature on colonial STM [science, technology and medicine] is that much of it is characterised by a nuanced rendering of the relationship between colonial 'periphery' and imperial 'metropole,' stressing mutual interaction and the continual circulation of knowledge".[210] Most radically, some scholars have also pushed the theme of circulation further in order to problematise the distinction of metropoles and peripheries all together. While the *Bathybius* controversy is not centrally focused on colonial relationships, it can help to ask new types of questions that are central to understanding the interplay between colonisation and scientific knowledge production. It is this tradition focusing on the circulation of knowledge – including the work of Bruno Latour, Kapil Raj and Roy Macleod – in

[210] Mark Harrison, 'After Empire: Searching for A New Synthesis', in *Historical Studies in the Natural Sciences*, 39, 2 (2009), pp. 258-268.

which the *Challenger* narrative must be situated and to which it can contribute possible reconfiguration and revision.[211]

In Latour's centres of calculation model[212] he suggests that universal knowledge is produced through cycles of accumulation, where Europeans travel to the colonies, collect and produce inscriptions of the colonial world and then bring them back to the metropole, where they are organised and combined in order to produce knowledge. This knowledge is then used by the Europeans on every proceeding trip, so that the colonies are *known* before they are experienced. In Latour's visual schematic of this model knowledge circulates in multiple cycles but it is only accessible to those from the metropole.[213] This process of knowledge production hinges on the concept of immutable mobiles and in fact that the immutability of the object makes it mobile. The artefacts and specimens from the colonies must be stabilised in order to travel uncorrupted over time and space. In this way movement is not central to Latour's model but instead is something that must be overcome and explained. Kapil Raj takes up this exact point in his critique of Latour's model, stating:

> If most science studies scholars, when following the peregrinations of materials acquired in the field to the laboratory, and then of machines, instruments, printed (or written) results from their site of invention to other places on the globe, do not actually take for granted the supposedly immutable nature of both input and output, they do not deal with their mutations in the course of these displacements.[214]

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[211] See Bruno Latour, *Science in Action,* Harvard University Press, Cambridge, MA, 1987; Kapil Raj, *Relocating Modern Science: Circulation and the Construction of Knowledge in South Asia and Europe, 1650 – 1900*, Palgrave Macmillan, New York, 2007; and Roy MacLeod, 'On Visiting the "Moving Metropolis": Reflections on the Architecture of Imperial Science', *Historical Records of Australian Science*, 5, 3 (1980), pp.1-16.
[212] Latour, *Science in Action.*
[213] Latour, *Science in Action*, p.220.
[214] Raj, *Relocating Modern Science*, p.20.

In Kapil Raj's work the notion of circulation of knowledge is used to emphasise the contributions of local practices to universal knowledge. In his book *Relocating Modern Science*, Raj challenges the diffusionist model of colonial science by emphasising the role of colonial encounters.[215] He argues that encounters between Britons and South Asians not only produced new knowledge but also modified existing knowledges from both localities. It is his contention that what has come to be known as modern science cannot be understood as a Western conception, because it only develops through the negotiations and reconfigurations that occur through colonial interactions. Elsewhere Raj uses the notion of circulation to suggest that scientific knowledge of both India and Britain were co-produced from local practices in each place.[216] Raj argues that by distinguishing between knowledge on the one hand and practice on the other we can see how they map onto a universal/local dichotomy. He posits that the survey data and maps produced in the colonial period of both the British Isles and the Indian subcontinent, what he refers to as 'universal knowledge', could not have been created without the methods of surveying and measurement that came from each locality —which he distinguishes as 'local practices'.[217] What we see in Raj's model is a circulation of knowledge both within the production of knowledge but also within the enrolment and utilisation of that knowledge. While Raj's multi-directional concept of knowledge circulation de-centres the traditional metropole/periphery model, it simultaneously reinforces the importance of these two localities as the place of knowledge production.

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[215] Raj considers these colonial interactions as a "contact zone" in the tradition of Mary Louise Pratt's use of the term in *Imperial Eyes: Travel Writing and Transculturation,* Routledge, London, 1992.

[216] Kapil Raj, 'Colonial Encounters and the Forging of New Knowledge and National Identities: Great Britain and India, 1760-1850', *Nature and Empire: Science and the Colonial Enterprise*, *Osiris* 15, 1 (2000), pp. 119-134.

[217] Raj, 'Colonial Encounters', p.133.

In fact, Raj explicitly employs the notion of circulation in order to promote the significance of location in narratives of scientific knowledge production. He argues:

> This shift in attention to circulation does not, however, imply that localities lose their meaning. On the contrary, each chapter seeks to ground the circulation of knowledge and knowledge-related practices in specific localities…Indeed, it is one of the main contentions of this book that localities constantly reinvent themselves through grounding (that is, appropriating and reconfiguring) objects, skills, ideas, and practices that circulate both within narrow regional or transcontinental – and indeed global – spaces.[218]

What becomes apparent in both scholars' work, and what is articulated explicitly by Raj, is that looking at the circulation of knowledge allows them to focus on the destinations of movement. Both Raj and Latour see movement as the function of knowledge production, but that production itself is still located in specific (and stable) localities. While knowledge moves, the act of movement itself appears to be inconsequential to the specific formulation of that knowledge. Movement is something to be explained in the story, but it is never used as an explanatory factor itself.

MacLeod's article "On Visiting the Moving Metropolis" examines the moving metropole however he is primarily interested in the results of movement rather than the process. In this article he suggests that by the late nineteenth century the location of knowledge production had expanded from the traditional metropole of the imperial centre of London to the peripheral settler colonies like Australia. When MacLeod uses the term moving metropolis he is pointing to the fact that the types of institutions and other characteristics which mark the metropolis as the authoritative place of knowledge production are expanding outwards towards the settler colonies, so that by

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[218] Raj, *Relocating Modern Science*, pp.21.

the early twentieth century these peripheral localities are places of scientific knowledge production – they have been transformed from peripheries to metropoles.

All three scholars emphasise the product of movement. To build on their work, we must shift our lens from the product of movement to the process itself. In this way the *Challenger* becomes a particularly useful mode of analysis, because it both represents and frames movement as a process.

Conclusion: Spaces of Empire, Spaces of Science

While the constantly moving ship neither brought Britain to the colonies nor the colonies to Britain, it did, in a very significant way, reformulate the role that distance played in the relationship between metropoles and peripheries. The story of Huxley's discovery, including the initial collection, preservation and examination of specimens conformed to all conventional knowledge of the day on how best to produce knowledge of natural specimens. The preservation of the sedimentary specimens in alcohol was the most widely accepted practice for overcoming the distance between the site of collection and the site of analysis. In this way, the initial story of the *Bathybius* discovery fits well into the Latourian model of knowledge production. But as Raj noted, Latour is interested in immutable mobiles, and the *Bathybius* specimens were mutable mobiles; the process of preservation actually produced the object of study.

John Murray summarised the episode:

> The mistake happened thus: When the first soundings were being made in the North Atlantic, the naturalists instructed the officers in charge to put any mud or ooze that came up at once into a bottle, and to fill the bottle up with strong spirit, and as there is always a good deal of sea water mixed up with this mud or ooze, the spirit precipitated the sulphate of lime. This, from the abundance of spirit, remained in the gelatinous condition, and gave portions of the mud a

> mobile gelatinous-like appearance…When the naturalists at home examined this mud they found that it contained some organic matter, they noticed its jelly-like condition, and they found that portions of it (the gelatinous sulphate of lime) coloured in a peculiar manner in carmine solution – much the same as some animal substances colour. Their conclusion was natural. They said this was protoplasm – a low form of animal life of indefinite extent, living at the bottom of the sea.[219]

The ability of the naturalists on board HMS *Challenger* to bring a resolute end to the question over *Bathybius*' existence, their "superior advantages" to return to Murray's phrase, rested on their ability to make immediate analysis of collected specimens at the site of collection. With the laboratory spaces on board the ship, the naturalists were able to make scientific (microscopical and chemical) observations and analysis of natural specimens in the exact site of collection. That HMS *Challenger* was able to produce authoritative scientific knowledge by collapsing the time and space that previously existed between collection and analysis is only evident by examining the process of movement rather than the product.

Literatures that focus on the circulation of knowledge emphasise locality in specific terms because focusing on the product of movement rather than the process requires all knowledge production be attributed to particular localities. What we see in Latour, Raj and MacLeod's work, and which is apparent in much of the literature on the circulation of knowledge, is that while space is a central focus, time is not. The emphasis on specific localities promotes space and distance as analytical categories – particularly the distance between localities – and simultaneously subjugates the category of time. MacLeod points out that the translation of distance into units of

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[219] Murray, 'The Cruise of the Challenger. (second lecture)', p.138.

time is a modern practice itself implicated in colonial history.[220] The story of the *Challenger*'s role in the *Bathybius* controversy shows that the *Challenger* reconfigured the relationship between the metropole and the periphery, which we now see stand in for the site of analysis and the site of collection respectively, by illuminating the distance *and* time between the two. In this way the role of distance in colonial knowledge production, and the analytical significance of general localities rather than specific ones, is only evident by the reconfiguration of time.

The resolution to the case of *Bathybius* cannot, and should not, be attributed to a singular location, either at land or sea; Thomson and his naturalists brought closure to the debate only by taking seriously the role of movement in their practices. This episode is evidence that histories cannot sufficiently explain the production of knowledge in late nineteenth-century Britain without constantly and consistently multiplying the localities taken into consideration, with the effect that movement always needs to be present. In allowing the site of collection to become also the site of analysis, the *Challenger* recast the relationship between London and its expansive peripheries, and in doing so established an entirely novel space, one that could be anywhere, through which authoritative knowledge production occurred. The moving centre of calculation allowed all spaces of the empire the potential to become spaces of scientific knowledge.

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[220] Roy MacLeod, 'Passages in Imperial Science: From Empire to Commonwealth', *Journal of World History*, 4, 1 (1993), pp. 117-150.

IV. "WHAT WE GET AND HOW WE GOT IT": SCIENCE AND IMAGERY ON THE *CHALLENGER* EXPEDITION

Introduction

From the early modern era, visual representation was a primary function and purpose of maritime exploration. The *Challenger* was deeply embedded within this long tradition which prioritised visual imagery as one of the dominant media for communicating knowledge of the ever-expanding globe back to Europe. Historians and scientists have documented the prolific productivity of the *Challenger* expedition participants.[221] The scientific staff produced thousands of documents recording, reflecting, and representing all aspects of the expedition, its results and ultimately its scientific and historical legacy. In addition to the official *Narrative* and fifty-volume *Scientific Reports*, the expedition resulted in several personal journals and diaries later published, and a vast number of scientific and naval logs which recorded the activities of the ship and the expedition.

The material legacy of the *Challenger* expedition is to a considerable extent a visual one. The volumes of archival materials that resulted from the expedition include various published and unpublished visual media. The expedition produced thousands of visual reprographics, including watercolour paintings, sketches, engravings, and photographs, which, along with ship logs, narrative journals and other texts, played a significant role in the constitution of scientific knowledge of the deep sea at the end of the nineteenth century. But from this wealth of images there are very few that depict the underwater world and specifically the deep-sea environment. The expedition was fundamentally a scientific investigation of the deep sea. Given

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[221] See Helen Rozwadowski, *Fathoming the Ocean: The Discovery and Exploration of the Deep Sea*, Belknap Press, Cambridge, MA, 2005.

this, along with the strong visual legacy of the expedition, it seems almost paradoxical that the deep sea remained a visually unrepresented space even after the end of the expedition. What at first appears to be a curiosity was in fact a result of the novel application of scientific visual imagery to previously unknown space. Ultimately the lack of underwater images reflects the ways in which modern scientific knowledge of the ocean was constructed.

As an ambitious and large-scale maritime voyage, the *Challenger* expedition was a well-funded, well-organised and highly anticipated event. There were extensive preparations made before the ship set sail in 1872 including stocking the ship with the various equipment needed to conduct marine-based research.[222] The staff was also supplied with large amounts of stationery with which to record all of their work and observations. Many of their materials were pre-printed notebooks and forms which helped to standardise record keeping of the routines and activities of both the scientific staff and the naval crew.[223] These provided the foundation for organising the large amounts of data into readable, transportable, and translatable charts and tables.

The scientific staff juggled high expectations with a literal abyss of unknowns. The objectives and mandate of their mission were exhaustively instructed, and comprised a broad number of disciplinary practices, methods of investigation and questions to be answered.[224] The choices made by the scientific staff in how to

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[222] Murray, *A Summary of the Scientific Results*, pp.1-20.
[223] Murray Collection, MSS, Box 93, NHM, London, UK.
[224] Tizard, T.H., H.N. Moseley, J.Y. Buchanan, and John Murray. *Report of the Scientific Results of the Voyage of HMS Challenger during the years 1872 – 1876 under the Command of Captain George S. Nares, R.N., F.R.S. and Captain Frank Turle Thomson, R.N. Prepared under the Superintendence of the Late Sir C. Wyville Thomson, Knt., F.R.S., &c. Regius Professor of Natural History in the University of Edinburgh, Director of the Civilian Scientific Staff on Board and now John Murray, One of the Naturalists of the Expedition: Narrative of the Cruise of HMS Challenger with a General Account of the*

approach the ocean would establish new norms of practice for its scientific study. But from their masses of research and resulting data the scientific staff could not visualise the deep sea in the same way Victorian sciences visualised other spaces.

At the time of the *Challenger* expedition, scientific visualisation was a well-established and far-reaching component of scientific practice, particularly within the field of natural history. The expedition's scientific staff was confronted with the challenge of applying traditional standards of natural history to the mostly unknown environment of the deep sea. Their methods of observation, analysis, and collection which came from the study of terrestrial and littoral spaces, could not easily be transferred to the deep sea. The staff found themselves with a space which could not be replicated and represented under the standards of practice of nineteenth-century natural history. Instead the naturalists on board HMS *Challenger* found themselves establishing new norms of practice from within the day-to-day constraints with which they were confronted, which ultimately resulted in new types of representation of the ocean.

In the eighteenth and nineteenth centuries natural history primarily consisted of methods of collection, display, and representation in order to demonstrate the diversity of nature from around the world. The main challenge for expedition naturalists of the eighteenth and nineteenth centuries was how to transfer knowledge of the natural world from the site of observation back to the imperial, and scientific, centre. Over time the standards of practice and representation which dictated this process evolved, such that by the mid-nineteenth century it was achieved through the combined acts of specimen collection and first-hand witnessing. These dual facets

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Scientific Results of the Expedition, Parts I and II, Her Majesty's Stationery Office, London, 1885*,* Appendix A, pp.21-33.

allowed naturalists to transfer knowledge and information across the globe. This tradition of practice however was firmly established through terrestrial, and sometimes coastal, terrains. Whereas terrestrial environments could be recreated, re-observed, and reconstituted through description and imagery, the ocean was not reproducible in the same way.

As the *Challenger* shifted the scientific practices of natural history from land to sea, they were confronted with the inability to directly witness the deep-sea environment. This led them to reformulate their practices of natural history. Informed by the earlier approach of Alexander von Humboldt the scientific staff chose to emphasise precision measurement of an almost overwhelmingly diverse set of natural characteristics and phenomena. The data, and the ways in which they used it to construct knowledge of the deep sea and its specimens, became the dominant mode of representation. At the time of the expedition the ocean was not an epistemologically stable object of the kind that allowed for scientific study. The scientific staff learned to adapt their own skill sets to study the deep sea, thereby creating new standards of objectivity and of scientific practice as they produced knowledge of the ocean. Thereby the ocean and the methods of its study were co-constructed. Ultimately, the expedition established the ocean as an object of study. In doing so, they also defined the norms and practices that would constitute objective representation of it.

The *Challenger* Expedition's Material Legacy

Among the *Challenger*'s six scientific staff C. Wyville Thomson was the head naturalist; John Murray, Henry Nottidge Moseley, and Rudolf von Willemöes-Suhm were naturalists; John Y. Buchanan was chemist and John Joseph (J.J.) Wild was secretary and artist. Wyville Thomson's own background reflected the training and interests of many naturalists during the nineteenth century. Thomson enrolled at university initially to study medicine, but eventually dropped out without earning his degree. His personal interest in biology and geology were such that he was hired as a lecturer in botany at the University of Aberdeen in 1851 without any qualification. He lectured in both botany and zoology before becoming the Regius Chair of Natural History at the University of Edinburgh in 1870, one year after he was elected to the Fellowship of the Royal Society. John Murray similarly attended university to study medicine but left without a degree before becoming a ship surgeon. He eventually returned to the University of Edinburgh and received his degree in geology.

Wild was the second most highly paid member of the scientific staff, receiving £400 compared to the £200 offered to the other members reporting to Wyville Thomson.[225] He held numerous responsibilities, including making regular sketches of scenes, specimens, and found objects as well as covering much of the daily reporting. After the conclusion of the expedition Wild produced two very different publications as a result of his experiences. The first, *Thalassa: An essay on the depth, temperature, and currents of the ocean*, published in 1877, laid out Wild's theorisation of oceanic currents based on the scientific findings from the expedition.[226] The second, *At Anchor: a narrative of experiences afloat and ashore*, was a more traditional narrative of observations and anecdotes accompanied by numerous detailed watercolours made by Wild.[227]

Wild recorded each of the 348 Station Logs made at each sounding station over the course of their route. The forms were pre-printed on official stationery with a

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[225] Murray, *A Summary of the Scientific Results*, p.40.

[226] J.J. Wild, *Thalassa: An essay on the depth, temperature, and currents of the ocean*, Marcus Ward & Co., London, 1877.

[227] J.J. Wild, *At Anchor: a narrative of experiences afloat and ashore during the voyage of H.M.S. Challenger from 1872 – 1876*, Marcus Ward & Co., London, 1878.

standard format that accounted for the station's latitudinal and longitudinal positions, the temperatures measured at both the surface and bottom depth, the depth reached, the 'nature of the bottom', and a list of specimens collected. The structure of these forms organised the types of data in which the scientific staff were interested, and the standardisation assisted in comparing locations against each other.[228]

The productivity of the expedition participants fed into the popular legacy of the expedition itself. The resulting information and scientific knowledge found value in part due to widespread circulation. During the expedition the scientific staff had constant communication with the scientific communities in London and Edinburgh through formal and informal networks.[229] They regularly filed preliminary reports to be read at meetings of the Royal Society and other scientific societies which aided in establishing priority claims on discoveries made while at sea.[230] They also wrote personal letters to friends and colleagues which recorded both the scientific activities and more routine goings on of the voyage.[231] Newspapers in both Britain and around the globe published regular reports on their location and activities.[232] After the conclusion of the voyage additional types of publication and distribution further increased the profile of the expedition and its scientific work.

Both scientific staff and naval crew members published a variety of materials related to the expedition including, official journals, personal memoirs, and shorter

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[228] Murray Collection, MSS, Box 93, NHM, London, UK.

[229] These included regular correspondence with colleagues, and submissions to be read at the meetings of scientific societies including the Royal Society.

[230] See Minutes of the Meetings of the Royal Society.

[231] See Philip Rehbock, At Sea with the Scientifics: The *Challenger* Letters of Joseph Matkin, Honolulu, 1992.

[232] In addition to regular reporting from *The Times, The Guardian,* and other UK newspapers, newspapers in the colonies including Australia and the West Indies reported on the ship's route.

pieces in scientific journals and newspapers.[233] These were in addition to the official publications produced from the Challenger Office which was established in Edinburgh and headed by Wyville Thomson, and, after his death, John Murray. By the turn of the twentieth century over two hundred copies of the *Scientific Reports* were gifted by the British Government to foreign governments and institutions ostensibly as a sign of goodwill and general diplomacy.[234] The expansive distribution of the *Scientific Reports* ensured that the expedition's knowledge claims were widely circulated amongst the international scientific community, thereby establishing the newly minted scientific knowledge as distinctly British. By the early twentieth century, it was not uncommon for maritime expeditions to include a copy of the *Challenger*'s publications on board the ship.

Amongst all of these materials was a vast collection of visual images. Thousands of images were produced during and after the expedition through a diversity of media and for a myriad of intended purposes. Wild made dozens of watercolour landscapes, the scientific staff sketched hundreds of images of collected specimens and observed phenomena, hundreds of photographs were taken, and at the resolution of the expedition, further images were commissioned from British artists to supplement the published materials.

As purportedly one of the first British naval expeditions to have a camera issued as official equipment, the *Challenger*'s collection of photographs provides a unique view of the world during the late nineteenth century.[235] The camera was issued as part of the official equipment and well-known photographer Colonel Henry Stuart

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[233] Herbert Swire, *The Voyage of the Challenger: A personal narrative of the historical circumnavigation of the globe in the years 1872 – 1876,* London 1938; and Moseley, *Notes by a Naturalist.*

[234] List of presentations of Challenger Reports, 8 September 1899, STAT 12/34/13, National Archives, Kew, UK.

[235] Ryan, *Exposures,* p.33.

Wortley was asked to contribute photographic plates that would be suitable for the expedition. He explained, "When the Challenger was fitted out, I was asked to prepare certain special dry photographic plates to go with her. I wished to give them the sensitiveness of wet collodion and unlimited keeping qualities".[236] The plates provided by Stuart Wortley worked well under the conditions of the expedition, as Jesse Lay, one of the many crewmembers who acted as photographer over the course of the expedition, relayed to him in 1875:

> It gives me great pleasure to acquaint you that the dry plates supplied to this ship three years ago are working well, being fully sensitive, notwithstanding the great trial that they have been subjected to – extreme cold and heat. On some plates I found damp spots on the film, which stain the picture, and hence I discard them; but, on selecting plates, I travelled up 2,500 feet (where the wet process seemed impossible) and obtained perfect negatives…I am using your new developer which works well.[237]

The role of expedition photographer must have proven difficult, as at least four men took responsibility for the equipment at different times. Originally the task fell to a Corporal Hewhold of the Corps of Royal Engineers, who was "carefully trained in photography and furnished with all the necessary apparatus",[238] although he appears to have left the expedition by 1873 as did his replacement Frederick Hodgeson in 1874. The third man to take on the task was Lay, referred to as "chief photographer" by Stuart Wortley and who is known to have taken many of the pictures in East Asia.[239] By the end of the voyage Scot James Horsburgh had taken over responsibility for the camera. He is typically the photographer most associated with the expedition due in no small part to the fact that he etched his name onto many

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[236] Henry Stuart Wortley, "Photography on the 'Challenger'", *Nature*, 13, 315 (1875), p.25.
[237] As recounted in Stuart Wortley, "Photography on the 'Challenger', pp.25-26.
[238] Diary of RA Richards, 1872 – 1876, RRR/1-8, Royal Geographical Society Archives (RGS), London, UK.
[239] Contemporary photographer Gary McLeod's projects *Challenger's Japan* (1875 & 2006) and *ReChallenger* (2007-2008) use Lay's photographs of Japan as inspiration.

of the original photographic plates such that it would circulate alongside the reproduced images.[240] Photographs were sold both on board the ship and after the end of the expedition as souvenirs in order to recoup some of the costs and an official album was kept in order to show visiting dignitaries.[241] Several of the images which were included in the *Challenger* photographic collection were not actually taken by expedition participants but were purchased from naturalists and other locals they encountered over the course of their journey.[242]

The ship's crew and scientific staff also produced a trove of charts and tables, measuring and recording all aspects of their daily activities. Each member was instructed to keep a journal which was to become the property of the Government.[243] The variation in topics reflects, to a certain extent, the diverse interests of staff members; but in all cases the men wrote down daily observations, scientific data, personal anecdotes and more formal recollections of activities and pursuits. They also produced tables, graphs and charts in both bound journals and on the pre-printed stationery. Some of these were eventually transcribed for official publication. Volume II of the *Narrative* includes over seven hundred pages of tables made from this data.[244]

In addition to these tables, the *Narrative* includes nearly three hundred and fifty images across the one-thousand-page text.[245] Most of these images, many of which were also used in the separately published *Scientific Reports*, were chromo-

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240 [no author], *Catalogue of the Photographic Negatives Taken During the 'Challenger' Expedition 1872 – 1876 and entrusted for Publication by HM Stationery Department to J. Horsburgh, FRSSA, FGSE, Artist & Photographer*, 131 Princes Street, Edinburgh, 1885.
241 Ryan, *Exposures,* p.35.
242 See chapter 2.
243 In addition to the official diaries of the scientific staff which are now housed in the Natural History Museum archives, several of the officers also kept diaries which have been retained by the Royal Geographical Society archives.
244 Tizard et. al., *Narrative*.
245 Murray, *A Summary of the Scientific Results*.

lithographic plates and woodcuts made from J.J. Wild's sketches of faunal specimens.[246] Specimens were each represented specifically and individually, and the drawings were often labelled with the location and depth of the collection point. Specimen sketches were sometimes grouped together to show a single specimen from several angles. They were primarily decontextualised, without any landscape or background objects. This style of representation reflected the standard approach of natural history illustrations from this period. This visual trope was also used by the wider net of naturalists who were enrolled by Thomson and Murray to assist in the writing of the *Scientific Reports* at the completion of the voyage including Ernst Haeckel, whose sketches of *Challenger* marine specimens became some of the most iconic scientific images of the nineteenth century.[247]

The *Narrative* also included many landscape depictions. As with the specimen images, these woodcuts were primarily based on Wild's sketches and paintings. Several were based on photographs taken during the expedition, although they were not attributed as such.[248] These landscapes depicted both coastal scenery from the perspective of the ship and harbour views looking out from land. Each chapter concluded with a stylised engraved print representing some aspects of ship activities. These included sailors and scientific staff members conducting observations on the top deck of the ship, and some of the more unexpected animal "members" of the expedition including a beloved dog who accompanied the crew for the entirety of the voyage.[249] This series of images engraved by SC Pearson and based

[246] Murray, *A Summary of the Scientific Results*, p.vii.
[247] See Peter J. Williams, Dylan W. Evans, David J. Roberts, David Neville Thomas, *Ernst Haeckel: Art Forms Abyss: Images from the HMS Challenger Expedition*, Prestel, Munich, London and New York, 2015.
[248] Murray, *A Summary of the Scientific Results*, p.vii.
[249] See Tizard et. al, *Narrative,* p.331. In addition to the dog, it appears that General Balfour also had a pet cat that accompanied him on the voyage.

on paintings done by British artist Elizabeth Gulland was commissioned for the purposes of the publication.[250]

Images of the scientific apparatuses, as well as three widely-circulated images of the laboratory spaces on board the ship, were included in the early chapters of the *Narrative* accompanying descriptions of the techniques used by the scientific staff. These images were extremely detailed and covered a wide array of scientific equipment. Many of the apparatuses on board the ship were specially constructed or altered to withstand the unique environs of the deep sea. The images accompanied descriptions of their origins, use, and unique characteristics. Chapter three of the *Narrative* centred on the methods used to measure oceanic temperatures and track them at various depths. Beginning with a short background on the types of thermometers previously used to measure oceanic temperatures the , of the chapter then focused on the specific type of thermometers used during the *Challenger* expedition. In addition to their design, construction, and purpose, the *Narrative* also covers the difficulties and shortcomings encountered when using these devices. It also includes various adjustments and modifications to improve the utility and accuracy of specific thermometers. In each case, the text is accompanied by scaled drawing of the specific device.[251] These drawings are intricate and specific, down to the engraved markings on the instrument and the levels of mercury in the tubes. They are drawn and labelled in such a way to assist in the descriptions of functionality included in the text of the chapter.

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[250] Gulland's contribution appears to be the only noted participation in any professional form by a woman.
[251] Tizard et. al, *Narrative*, chapter 3, pp.83-120.

The diagrams are primarily schematic representations of faunal specimens, demonstrating specific functions or anatomical characteristics of a species.[252] They differ from other sketches of specimens in that they promote simplicity of form over any detail in order to highlight a certain aspect of the specimen's anatomy or physiology. In addition to these specimen diagrams there are also several that represent the depth of the ocean floor from the coast out to sea. These are some of the only visual images from the entirety of the text that depict the ocean in a cross-sectional view. In fact, of the thousands of images that resulted from the expedition in all of their various forms, from sketches, paintings, and photographs, less than ten depict the sea from below the surface.[253]

The illustrations of instruments and diagrams played an important role in the process of legitimising the work and practices of the expedition's scientific staff. The validity of their knowledge claims depended on the wider scientific community accepting not only their results but also their methods. To assert newfound information around the temperature of the deep sea, the staff first had to demonstrate the legitimacy of their methods of analysis. Given the distance between the expedition and its intended audience, the text and images in the *Narrative* were the primary mechanism through which these methods could be evaluated. Without the opportunity to directly witness the scientific practices, observers used the images to visualise the techniques and technologies.

In one of the only underwater depictions, the deep sea is represented in order to demonstrate the functionality of the applied technologies. In one cross-sectional image HMS *Challenger* sits on the water's surface in the upper right hand corner,

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[252] For several examples of these diagrams see chapter 4 of the *Narrative*.
[253] Examples provided: Tizard et. al., *Narrative,* pp.xxix, 77, and 777.

dwarfed by the expansive depths of the sea represented below it.[254] Several sounding lines drop from the ship, and with variant lengths and weights, they spread nicely through the depths such that the nets at the end of the rope are aligned vertically, with the longest one touching the ocean floor. The lines of the diagram are labelled in association with the description provided in the text. Aside from the ship and its equipment the oceanic space is empty. In this image the ocean is portrayed as an extremely ordered space, one in which the various ropes trail along at designated depths which geometrically align with their corresponding length. The measurements depicted in this diagram were of the utmost importance to the work of the *Challenger* naturalists. Each station at which they sounded was marked with a specific longitude and latitude. By also measuring the depth of the sounding, each specimen collected could be located to a singular three-dimensional locality on the globe. But in order to use this data, to designate the exact depth from which specific specimens were collected, the scientific staff were not only depending on the validity of this imagined apparatus but also depending on others to entrust this visualisation. The significance of each individual specimen was not simply in its collection but in the scientific staff's ability to locate that collection to a specific place. The number of fathoms published with each specimen were valid only in so far as others believed that the dredging and sounding technologies used functioned in the way depicted in this picture.

The extensive descriptions of the methods employed on the expedition make it clear that the work was rarely as straightforward as it appears in the image. Thomson noted that it took two to three hours for the ropes to fully extend downward for a dredge of 2,500 fathoms, which meant that one full attempt to bring up specimens

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[254] Tizard et. al., *Narrative*, p.77.

was typically an eight-hour mission.[255] On more than one occasion this time would pass before they realised that the ropes had either snapped from the pull, failed to unravel properly, or failed to reach the bottom. Then the winds above the surface and the currents below could, and did, complicate these attempts. But none of these complications are depicted here. This image has schematised the ocean into an ordered space in its attempt to demonstrate the technology. But in creating order, it has also voided the ocean of exactly that which the naturalists found through this process: the natural environment.

Ironically, one of the main goals of the *Challenger* naturalists was to disprove Edward Forbes's azoic theory of the ocean, which had asserted that life was not sustainable below three hundred fathoms. While the azoic theory had already been questioned by others, the *Challenger* naturalists confidently disproved the theory by trawling specimens at depths up to ten times that. But in visualising this achievement, they physically erased their findings. In essence, they depicted an azoic space in order to disprove the azoic theory.

Visualisation and Objectivity

The relationship between representation, authenticity and objectivity is not an ahistorical one. Early European travel narratives from the fourteenth and fifteenth centuries cannot be defined by contemporary notions of fiction and fact. Often these texts were written in the first person and described direct observation of far-off lands,

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[255] Charles Wyville Thomson, *Report of the Scientific Results of the Voyage of HMS Challenger during the years 1872 – 1876 under the Command of Captain George S. Nares, R.N., F.R.S. and Captain Frank Turle Thomson, R.N. Prepared under the Superintendence of the Late Sir C. Wyville Thomson, Knt., F.R.S., &c. Regius Professor of Natural History in the University of Edinburgh, Director of the Civilian Scientific Staff on Board and now John Murray, One of the Naturalists of the Expedition: Introduction to the Zoology Reports,* Her Majesty's Stationery Office, London, 1880, p.8.

but their validity as travel narratives did not depend on veracity or authenticity.[256] Inspired by the epic poems and mythologies of Ancient Greece, early modern writing used the concept of travel as a popular rhetorical device.[257] The ability to experience distant lands and cultures stood in as a metaphor for a variety of themes and tropes and these cultures were a discursive construction rather than a witnessed reality.[258] Importantly, however, these early modern writings established the dominant epistemology of the foreign and exotic for European travellers until the sixteenth century.

Historians have argued that in the fifteenth and sixteenth centuries the established European worldview of foreign lands was disrupted by the ever-accumulating experiences of travellers and explorers. As the experiences and observations of these Europeans proved different to their expectations based on early narratives, they developed a language in order to contain, and account for them within their coherent worldview. This language, best represented by the terms *wondrous*, *marvellous* and *curious*, while describing the extraordinary, did so in order to encompass these strange experiences into the dominant epistemology. That these experiences challenged well-accepted accounts of foreign lands did not result in the immediate abandonment of the older narratives. Instead the strangeness of these cultures, in relation both to their own culture and also to that which they anticipated from earlier narrative accounts, was accommodated and included in an expanding knowledge set. Dating back to the voyages of Columbus and Magellan in the early

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[256] Rod Edmond, *Representing the South Pacific: Colonial discourse from Cook to Gauguin*, Cambridge University Press, Cambridge, 1997, p.82.
[257] Joan-Pau Rubiés and Francis Bacon, ‘Travel Writing as Genre: Facts, Fictions and the Invention of a Scientific Discourse in Early Modern Europe’, *Journeys*, 1, (2000), p.7.
[258] Rubiés and Bacon, ‘Travel Writing as Genre’, p.7.

modern era, images of foreign cultures and curious natural specimens accompanied written narratives as a mode of knowledge transfer.

The early sixteenth century epistemological shift may have originated from geography but it resonated through other forms of knowledge. The geography of early modern Europeans aligned to the scholastic and humanist traditions of knowledge in other intellectual disciplines including history and cosmography.[259] Early maritime exploration in the fifteenth- and sixteenth-centuries saw Europeans encounter lands and cultures which were either not accounted for in the existing canon or indeed – perhaps even more disruptive – contradicted it. Eventually these experiences accrued to a point where the text-based authority of ancient knowledge began to deteriorate. "The discovery of the non-European world and the discovery that the ancients were not wiser than the moderns seem[ed] indissolubly linked".[260] Grafton argues that this initial deterioration eventually led to an assertive challenge from a new and opposing worldview. This new way of thinking not only accommodated a newly growing collection of experiences and knowledge of the new world but also reformulated ancient history and moral debates through a new distinctly modern way of thinking.[261]

It was from this new revolutionary paradigm which promoted first-hand witnessing and direct observation that visual depictions arose. In this period natural history books began to employ illustrations alongside descriptive text. Historian William Ashworth argues that the first to do this was German Renaissance naturalist

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[259] Anthony Grafton, *New Worlds, Ancient Texts: The Power of Tradition and the Shock of Discovery*, Cambridge, MA, 1992, p.44.
[260] Grafton, *New Worlds, Ancient Texts'*, p.126.
[261] Grafton, *New Worlds, Ancient Texts'*, p. 127.

Conrad Gesner in his sixteenth-century book *Historia Annimalia*.[262] The emergence of illustrations in natural history texts cannot solely be attributed to this epistemological shift; other influences, including the rise of the printing press and new methods of production and distribution, must be considered.[263] As the field of natural history expanded with the increase of European exploration, visualisation became an invaluable component of practice. Artistic portrayals became one way of accounting for new discoveries in far-off locations. The use of illustrations to reinforce direct witnessing accounts demonstrates the extent to which verisimilitude and verified authenticity came to be valued in the sixteenth century.

As a large-scale maritime expedition, the *Challenger* was situated within a long tradition of using visual imagery for the purpose of recording voyages. By the eighteenth century, sketches and paintings became a primary medium through which knowledge of the foreign and the exotic could be transferred to those back home. In particular, the practices of natural history and ethnology – the nineteenth-century science of human races and cultures – were both nexuses for the interconnection between exploratory, observation-based sciences and visual culture. In Victorian Britain, as with other empires of the nineteenth century, visual imagery of plants, animals and people were a primary vehicle for communicating the nature of far-off colonies to a metropolitan audience, and these images were of interest both within the scientific community and the general public.

Bernard Smith has argued that during Cook's three expeditions in the Pacific the role of visual imagery was transformed. Initially sketches and paintings were used

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[262] William B. Ashworth, 'Emblematic natural history of the Renaissance', in N. Jardine, J.A. Secord, and E.C. Spary, ed., *Cultures of Natural History*, Cambridge, 1996, p.25.

[263] Peter Harrison, *The Bible, Protestantism, and the Rise of Natural Science*, Cambridge University Press, Cambridge, 1998, p.81.

to complement textual descriptions and narratives of foreign people, places and things. Over the course of Cook's three voyages, Smith identifies an evolving relationship between what he calls the "descriptive sciences" of botany, zoology, and geology and artistic representations.[264] As expedition artists produced paintings and sketches that aided textual descriptions of nature, they began to develop their own stylistic techniques which eventually evolved into a style Smith identifies as "empirical naturalism". By the late eighteenth century, Smith argues, empirical naturalism, with its focus on natural environments and plants and animals in particular, had overtaken classical naturalism, with its focus on the human form, as the dominant European aesthetic.[265] In this evolution we see not only an increase in the value of visual imagery in these expeditions but a transformation in its role. Where they were initially a complementary aid to textual representations, by the end of the eighteenth century visual images had become a dominant mode of representation, and in doing so had also developed scientific and aesthetic norms governing their production. Landscapes, specimen drawings, and ethnological portraits were each produced within dominant paradigms with a set of artistic ideals. In this way, the vast majority of the images produced from the expedition aligned with the dominant tropes of expedition imagery of the nineteenth century.

By the nineteenth century, visual representations of scientific knowledge did not adhere to a singular relationship between the object and its representation. That is to say, there was no single approach to visual imagery which constituted scientific objectivity. Scientific objectivity was not determined by any single standard of artistic style; but rather by moral standards of verisimilitude and authenticity. In their famous

[264] Bernard Smith, *Imagining the Pacific: In the Wake of the Cook Voyages*, New Haven, 1992, p.51.
[265] Bernard Smith, *Imagining the Pacific*, p.51.

text on objectivity, Lorraine Daston and Peter Galison track broadly the transition in the standard of visual representation in educational atlases; from an earlier inclination towards typus and the normal or average as the exemplar of nature in the eighteenth and early nineteenth centuries to a shift in the mid-nineteenth century towards representation of the singular specimen.[266] They argue that the latter half of the nineteenth century marked the rise of mechanical objectivity, a style of representation that aspired to create visual depictions of natural phenomena as they were singularly experienced and observed. This required, and enforced, self-discipline and restraint in the application of judgment to representation.[267] Both the earlier desire to represent the typical and the later move towards mechanical objectivity were motivated by a desire to achieve the best representation of nature.[268] Representations of the typical were created to include all of the normal aspects of an observable phenomenon. Later, mechanical representation was driven by complete fidelity to the singular specimen. The natural therefore had shifted from the general to the specific.[269]

But whereas much of nineteenth-century natural history focused on representations of phenomena which could be directly observed, the deep sea was a visually impenetrable space. The deep sea was by no means the first type of scientific space to be visually recreated without a direct referent; eighteenth- and nineteenth-century geology is a prime example. Martin Rudwick tracks the emergence of a visual language in the development of geological traverse sections.[270] These were visual

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[266] Lorraine Daston and Peter Galison, 'The Image of Objectivity', *Representations,* 40 (1992), pp.81-128.

[267] Daston and Galison, 'The Image of Objectivity', p.82.

[268] Daston and Galison, 'The Image of Objectivity', p.84.

[269] Daston and Galison, 'The Image of Objectivity', p.98.

[270] Rudwick, Martin. 'The Emergence of a Visual Language for Geological Science 1760 – 1840', *History of Science*, 14, 1976, p.166. Rudwick defines a visual language as a set of standards and techniques for visual representation that are understood and agreed for production and perception, that is for both the producer and the viewer. A visual language

mappings of the earth's geological strata from the perspective of a transection of the globe. Rudwick emphasises that geological sections in general are highly theoretical constructs which employ "complex visual conventions".[271] The conventions used were variable depending on the type of map being produced. Some were intended to emphasise the mineralogical or geological makeup of the strata represented; others emphasised the relationship depth of the strata as a type of physical-historical representation of the earth.[272] Rudwick argues that it was in the early decades of the nineteenth century that geological sections became established as part of the visual language of geology. As such, their familiarity and recognisable conventionality resulted in further abstraction; sections could now be used to convey large amounts of geological information and theory without textual explanation or other qualifying notations.

Rudwick points to an interesting convergence of the visual representation of traverse sections and cliff views. He argues that the visual conventions used to represent cliffsides, directly observable phenomena, included the accentuation of main structural features and simplification of others. Additionally, geologists developed a colour palette which designated certain colours, typically "naturalistic" ones, as representative of different rock types. The result was a visual image which appeared similar to, and sometimes indistinguishable from, traverse sections. As Rudwick explains:

> Cliff views could be drawn and coloured in a formalised manner like sections, so as to emphasize the main structural and stratigraphical features; yet at the same time they were much nearer to direct observation than the necessarily speculative extrapolations that

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is a form of communication that requires coherence and which must be learned, but it can, and does, change over time.

[271] Rudwick, *Visual Language,* p.151.

[272] Rudwick, *Visual Language*, p.166.

> traverse sections required. In this way, formalized cliff views seem to have acted as a kind of conceptual bridge by which the conventions of traverse sections became acceptable and – in a sense – believable as valid representations of an unseen reality.[273]

The emergence of a visual language which encompassed both visible and non-visible phenomena altered the boundaries of objectivity and authenticity for both. Nineteenth-century objectivity attempted to eliminate subjectivity from representation and interpretation. Yet as Rudwick's example shows, objectivity was not singularly defined, nor separate from the broad set of practices and expectations that informed all other aspects of scientific knowledge.

Natural History

What historians call natural history has been traced back to Ancient Rome and Greece. The expanse of subjects and practices that fall under the mantle of natural history is almost too broad to be a useful category. As long as there have been notions of the "natural" there has been interest in defining what that is and determining how it works. Natural history as recognised by the nineteenth-century participants of the *Challenger* expedition is more accurately dated to the early modern period, originating during the period of European maritime exploration. Borne out of the traditions of Renaissance Europe, natural history in its modern form developed in the sixteenth century. This natural history was a "science of describing",[274] a practice of recording the expansive diversity of an inconceivably large world. Description was a form of knowledge construction which allowed naturalists to wholly own and possess

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[273] Rudwick, *Visual Language*, p.176.
[274] Brian W. Ogilvie, *The Science of Describing,* Chicago, 2006, p.7.

the natural objects.[275] This sixteenth-century natural history was not a science of classification or taxonomy, which did not occur until the seventeenth and eighteenth centuries.[276]

Thus natural history in the sixteenth and seventeenth centuries was focused on gathering knowledge of the natural world. This term "natural world" was in itself important in that it indicated that there was a connection between the flora and fauna of Europe and those of the rest of the world. The concept of the globe as a connected space was itself a modern construct originating in the fifteenth century.[277] The idea that individual specimens observed in far-off lands could be related in some way, however distant, to those more familiar European varieties was one of the most significant connections made in the era in which the unified worldview was evolving. It also meant that these exotic specimens could be defined in terms of the more familiar.

Natural history of the seventeenth century reflected the shifting knowledge sets of the broader natural sciences. There was a focus on collection and categorisation. This period marked the maturation of modern geography; as such, geographic, and corresponding socio-political, boundaries became naturalised. By the end of the eighteenth century, it was generally believed that the entirety of the globe had been discovered. In this new context, naturalists turned their focus towards categorisation and classification rather than simply discovery.[278] Naturalists believed that all natural specimens could be defined and organised in relation to each other,

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[275] Ogilvie, *The Science of Describing*, p.13.
[276] Ogilvie, *The Science of Describing*, p.7.
[277] Chaplin, Joyce. *Round About the Earth: Circumnavigation from Magellan to Orbit*, Simon and Schuster, New York, 2012, pp.36-37.
[278] Daniel Roche, 'Natural history in the academies', in N. Jardine, J.A. Secord, and E.C. Spary, ed., *Cultures of Natural History*, Cambridge, 1996, p.129.

creating an all-encompassing system that would unify and compare all objects regardless of their origins.[279]

Numerous historians have discussed the various classification systems that developed over the seventeenth and eighteenth centuries.[280] The emphasis on geographical origins apparent in the Linnaean classification and nomenclature system began to deteriorate by the mid-nineteenth century as evidence accumulated that many species were much more widely distributed that previously thought.[281]

By the turn of the nineteenth century natural history had experienced a fundamental shift from a focus on classification systems of natural specimens towards an investigatory interest in their internal functions.[282] This historical shift also saw the division of the field of natural history into new scientific disciplines including physiology and palaeontology. Further, the established fields of geology and chemistry began to offer new contributions to the ways in which naturalists examined and studied their specimens. By the mid-nineteenth century natural history no longer stood as a scientific discipline with a defined set of practices and standards, but instead became a mantle for the myriad of practices which were employed in order to advance knowledge of the natural world.

Parallel to this shift towards broader subject areas and more clearly defined disciplinary boundaries was the increased focus on interconnectedness and universal causes. This type of focus changed the ways in which naturalists compared and analysed natural specimens. "The search for these fundamental patterns meant that

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[279] Roche, 'Natural History in the Academies', p.127.
[280] For a useful overview see N. Jardine, J.A. Secord, and E.C. Spary, ed., *Cultures of Natural History*, Cambridge, 1996.
[281] Janet Browne, 'Biogeography and Empire', in N. Jardine, J.A. Secord, and E.C. Spary, eds., *Cultures of Natural History*, Cambridge University Press, Cambridge, 1996, p.314.
[282] Dorinda Outram, 'New Spaces in Natural History', in N. Jardine, J.A. Secord, and E.C. Spary, eds., *Cultures of Natural History*, Cambridge University Press, Cambridge, 1996, p.249.

natural history in [the eighteenth and nineteenth centuries] was a science based on *specimens*: objects of natural origin that had been prepared in ways that allowed them to be examined, compared to similar objects and described in a concise, informative manner".[283] Naturalists turned towards representations of specimens that focused on the individual details, rather than standardising and normalising images into a singular representative type. This shift in norms for natural history had particularly significant implications in relation to depicting deep-sea specimens, especially ones that had not previously been observed or recorded. The visual representations of each individual specimen became part of the species' record. The unique characteristics of each collected object became a substantive part of understanding these new-found phenomena. It was not simply that the individual characteristics demonstrated the expansive variety of a particular species, but rather that these characteristics, when viewed in combination with information about the location of its discovery, came to define these specimens in relation to the natural world. Where earlier natural history had focused on standardising visual representations of natural specimens, by the nineteenth century the distinct characteristics of each discovered specimen was not only represented but also emphasised.

The search for universal natural laws became was exemplified by the work of Alexander von Humboldt. Humboldt was by no means the first naturalist to believe that the world was controlled by a single set of forces, but he believed that the study of natural history could only reveal these forces if he collected and aggregated data points from all over the world.[284] Rather than a deductive Euro-centric view of the

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[283] Anne Larsen, 'Equipment for the Field', in N. Jardine, J.A. Secord, and E.C. Spary, ed., *Cultures of Natural History*, Cambridge, 1996, p.358.

[284] Bourguet, Marie-Noëlle. 'Landscape with Numbers: natural history, travel and instruments in the late eighteenth and early nineteenth centuries', in Marie-Noëlle Bourguet, Christian Licoppe and H. Otto Sibum, eds. *Instruments, Travel and Science: Itineraries of precision*

world, Humboldt desired to gather data from across the globe in order to identify patterns and cycles. In particular he was interested in the notion of climates and the relationship between space, height and climatic conditions.

It would be inaccurate to claim that Humboldt's scientific method was caused by the increasing feasibility of large-scale voyages and expeditions, but it was certainly informed from that tradition. Humboldt's method was facilitated by this emphasis on movement and coverage, and it allowed him to make new claims about the relationship of terrestrial environments across the globe. Just as revolutionary as the conception of the round earth and modern globe in the fifteenth century Humboldt saw connections between diverse terrains and conceived of a unifying world view that had not been fathomed previously. Importantly, Humboldt believed that nature needed to be measured, quantified, and charted in order to be known. Historian Marie-Noëlle Bourguet argues that his inclination towards numeracy and quantification was rooted in eighteenth-century French practices which were connected to the rise of naturalist-travellers' use of instruments and instrumentation. The more mobile scientific instrumentation became, the more significance naturalists placed on measurement as a means of observation. Measurement, Bourguet argues, bred precision and precision bred a deeper knowledge of nature and nature's diversity.[285] Humboldt believed that vast amounts of data could demonstrate the underlying commonalities of nature and in doing so reveal the universal laws of nature. As historian Michael Dettelbach puts it, "Out of the juxtaposition of so many measurements, 'Nature' itself was supposed to emerge, as a dynamic equilibrium of

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from the seventeenth to the twentieth century, Routledge, London and New York, 2002, p.96.

[285] Bourguet, 'Landscape with Numbers', p.116.

forces".[286] The visual impact of Humboldt's science, in both the tables and illustrations, is awesome. Perhaps the most powerful example of this is his 1807 publication *Tableau physique des Andes* ("Physical Profile of the Andes"), which includes a broad cross-sectional image of the Andes peak Chimborazo covered with an almost overwhelming number of labels indicating the location and altitude of plants and vegetation. This image is accompanied by a twenty-column table which accounted for "electrical tension and chemical composition of the atmosphere, the nature of rock formations and type of soil, humidity, the refractive power of the air, the intensity of light, the force of gravity, and more", as they varied against elevation.[287] When originally printed, this table altogether was six times the size of the quarto volume of the report to which it was attached.[288]

This focus on altitudes and climates was one of the most distinctive aspects of Humboldt's natural history. He challenged more dominant conceptions of natural history which focused on geographical location, and instead bolstered the idea of that the earth consisted of climatic strata.[289] As demonstrated by his *Tableau* Humboldt believed that each data point must be viewed with a multi-axis table; that a botanical specimen only had value in so far as it could be defined against other characteristics related to its location. Humboldt's work proved revolutionary for the *Challenger* expedition's study of the ocean. He provided them with both a figurative and literal template for how to make sense of the three-dimensional depths of the sea. The *Challenger* naturalists wanted to understand how the specimens related to their environments (meaning temperature, depth, location, etc.) and each nuance could be

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[286] Michael Dettelbach, 'Humboldtian Science', in N. Jardine, J.A. Secord, and E.C. Spary, ed., *Cultures of Natural History*, Cambridge, 1996, pp.287-304.
[287] Dettelbach, 'Humboldtian Science', p.290.
[288] Dettelbach, 'Humboldtian Science', p.290.
[289] Dettelbach, 'Humboldtian Science', p.299.

potentially meaningful in defining this relationship. This reflected the type of precision measurement that Humboldt had championed. Humboldt believed that individual terrestrial specimens only had value in so far as they were defined by the corresponding altitude and conditions at their point of collection.[290]

In lieu of direct visual observation the *Challenger* naturalists came to depend on their other forms of scientific investigation, primarily the methods of sounding which allowed them to invade and examine the ocean as a three-dimensional space. In the process of sounding, the scientific staff followed Humboldt's lead and collected a diverse and potentially interlinked set of measurements. Through these practices the deep sea came to be represented by numerical data in the forms of charts, tables and graphs. Numbers, rather than images, became the dominant method of representation. The ocean was mapped and quantified into being, but at the cost of visualising it as a natural space. The tables came to represent objectivity of the deep sea that the scientific staff found unachievable through the traditional norms of visual representation. Therefore we can see that the innumerable number of tables that the scientific staff created were not merely oceanographic measurements, but in fact defining characteristics of natural history. The scientific staff took measurements and constructed tables which covered ocean depth; water temperature; salinity; nature of the ocean floor; latitude; longitude; weather, wind force, humidity, and temperature at sea-level; and cloud formation, all with the understanding that the floral and faunal specimens, as well as the sea-water, had no scientific value unless they were accompanied by this corresponding data. The *Challenger* naturalists' adherence to Humboldtian principles resulted in a highly quantified representation of the ocean. In

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[290] Bourguet, 'Landscape with Numbers', p.116.

the absence of a visual language of the deep sea, the *Challenger* tables became the dominant scientific representation both numerically and visually.

Mermaids: Fantasy and Fact

The dominant trends of terrestrial natural history left the *Challenger* naturalists without a visual language with which to depict their experiences at sea. The naturalists' "physical attitude towards nature",[291] inspired by Humboldt, led to the creation of numerous numerical charts and tables. The convergence of these two historical moments resulted in a representation of the ocean which was numerical rather than visual. The ocean could not visually be represented as a scientific space, and therefore remained one of fantastical imagination into the twentieth century.

Of the ten or so images of the *Challenger* collection which depict the underwater environment, two include mermaids. The first, a detailed woodcut of two seductive mermaids holding small tow nets with fish inside, was included in the Introduction to the *Narrative*. The second, entitled "What we get and how we got it", is an image which came from a sketchbook from a naval crewmember of the expedition.[292] This image, described as the only one from the sketchbook with a "fanciful touch" is also the only one that represents the underwater world. This image depicts the ship in calm seas, with a single sounding line tracking underwater to the

[291] Bourguet, 'Landscape with Numbers', p.107.

[292] In 1972 The Philadelphia Maritime Museum published a facsimile volume of a sketchbook purportedly created by Benjamin Shephard who was a cooper on the *Challenger* expedition. The original sketchbook, which contained 34 watercolors made during the first two years of the voyage, went long unknown until it was re-discovered in an antique shop in Boston Massachusetts in 1968. During a trip to the archives of the Natural History Museum in 2015 I came across a copy of a letter from the Museum to a woman named Joan Weight acknowledging her loan of the "AJ Miller sketchbook"; the letter includes accompanying photographs of the contents of this book. The photographs show a number of paintings identical in style to those in the book attributed to Shephard by the Philadelphia Museum, although the paintings themselves are slightly different.

ocean floor, where there are several mermaids mischievously playing with the dredging nets. The title implies that the mermaids took part in placing the collected specimens into the nets, actively gifting the ocean's treasures to the ship's staff.

In another notable example the *Challenger* Medal, given to expedition participants and collaborators to mark the completion of the *Scientific Reports*, prominently includes a mermaid. On one side there is a knight as the central figure with the words, "Report on the Scientific Results of the *Challenger* Expedition 1886 – 1895". The other side includes the figures of Neptune and Athena accompanied by two mermaids and reads, "Voyage of HMS *Challenger* 1872 – 1876".[293] The juxtaposition of ancient Roman and Greek mythology alongside the more fantastical imagery of mermaids demonstrates quite nicely the shift in dominant representations of the deep sea at the time of the expedition.

In 1895, nearly twenty years after HMS *Challenger* had returned to Portsmouth England at the conclusion of its circumnavigation, the last of the *Scientific Reports* was published. By this time head naturalist C. Wyville Thomson had passed away and oversight of the publications was entrusted to expedition naturalist John Murray. Many years earlier Thomson had decided to engage a large and diverse group of international naturalists to assist in analysing and describing the many natural specimens collected over the course of the expedition, and this type of collaborative approach meant that more than a hundred men had contributed to the official *Scientific Reports*. While each contributor was gifted with a copy of the *Reports* and a small honorarium, Murray desired to also include a "souvenir" to mark

[293] Challenger Medal, MEC2807, National Maritime Museum Archives (NMM), Greenwich, UK.

their participation.[294] When he was unable to secure funding from the Treasury to create the *Challenger* Medal, he designed and produced them at his own cost. Over the next two years Murray distributed replicas of the Medal to one hundred and twenty contributors to the expedition and its *Scientific Reports* including all living scientific staff members and many of the ship's officers.

The significance of the medal, and Murray's decision to use the mermaid imagery on it, cannot be ignored. The fantastic nature of the mermaid represented both the ongoing mystery of the sea and perhaps the notion of it as a still unknown space. However, the presence of the mermaid at all indicated that this type of imagery did not conflict or compete with other types of visual representation of the oceanic space. The importance of this symbolism is not in the depiction of the mythical and mythological figures underwater – this had been a theme in artistic imagery of the underwater worlds for hundreds of years and would continue to be – but in that these images were used to commemorate the completion of the scientific results of the expedition. The sea was not scientifically represented with visual images, and therefore the fantasy of the mermaids remained a dominant trope. The fantastical images of the deep sea were able to commensurably remain within the *Challenger* materials because it did not clash with any other dominant style of visualisation.

Conclusion

The *Challenger* expedition has maintained a powerful visual legacy since the time of its launch nearly 150 years ago. The sketches, paintings, woodcuts, and photographs from the expedition have been reproduced and circulated through a

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[294] Challenger Medal Description, MEC2807, NMM, Greenwich, UK.

diverse set of networks and for various purposes, helping to promote the *Challenger* expedition as an important historical event. Yet for an expedition concerned with the deep sea we find a paucity of images which represent that space. The deep sea was an entirely new space of which the scientific staff wanted to make order. They needed to establish the means of studying it, in order to construct knowledge of it. While they focused on creating a visual record of their expedition, the traditional forms and practices of natural history visualisation, specifically direct observation and representation, proved impossible for this new and inaccessible subject. But they were successful in measuring the deep sea in the tradition of Humboldtian science which emphasised precision and comprehensive data collection. Ultimately the tables and charts that resulted from their Humboldtian measurements became a visual replacement for the lack of illustrations.

V. RESEARCHES ON LAND AND SEA: ETHNOLOGICAL OBSERVATIONS DURING THE *CHALLENGER* EXPEDITION

Introduction

The legacy of the *Challenger* expedition is tightly intertwined with the origin story of contemporary oceanography. In previous chapters I have demonstrated the various ways in which the scientific staff's pursuits blurred any discrete boundaries between contemporary scientific disciplines. The unique and completely unknown challenges of studying the deep sea saw the expedition naturalists adapt and integrate traditional scientific practices from a variety of disciplines to suit this new type of scientific pursuit. Traditional methods of specimen collection combined with near-immediate microscopical and chemical analysis brought about new understandings of the ocean as a scientific object, and led the expedition's staff to new types of scientific conclusions about the natural world.[295] The work done during the expedition has previously been discussed through its continuing contribution to current scientific understandings of the ocean and the way it is studied. This however belies a more complex and historically complicated story of scientific interests and practices on board the ship. While it may now be perceived to be revolutionary, at the time the expedition was similar in form and function to many other large-scale maritime expeditions of the nineteenth century. This is most evident in the diverse and fully integrated set of practices and activities with which the participants were engaged, both at sea and on land.

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[295] See Chapter 3.

One of the most important aspects of the expedition has been almost completely erased from its historical legacy – that of ethnology. The science of ethnology was arguably the archetypal science of Victorian Britain. Historian of anthropology George Stocking describes mid-century ethnology as, "the most general scientific framework for the study of the linguistic, physical, and cultural characteristics of dark-skinned, non-European, 'uncivilized' peoples".[296] Or as the nineteenth-century ethnologist Ernest Dieffenbach described:

> We may expect from the Science of Ethnology not only important results as regards to the origin and education of man, the causes of the varieties of the physical and mental development of nations, the origin and difference of languages and religious ideas, but we may be able to collect the colours of the prism, each of them rich and beautiful, into the pure ray of light, and confirm by inductive science the cherished unity of mankind.[297]

Cultural historians and historians of science have demonstrated the interconnected histories of eighteenth and nineteenth-century ethnology and British imperial exploration.[298] Knowledge of foreign cultures, and the development of a scientific classification system of these cultures were of prime interest for Imperial Britain in this period of extensive maritime exploration. Stocking argues that the transition from the science of ethnology to that of modern anthropology occurred mid-century, at least due in part to the newly revolutionary understanding of geological time, which also famously contributed to the rise of Charles Darwin and Alfred Russel Wallace's

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[296] George Stocking, *Victorian Anthropology*, New York, 1987, 47.

[297] Ernest Dieffenbach, "The Study of Ethnology," in the *Journal of the Ethnological Society of London*, 1 (1848), 17.

[298] See George Stocking, *Victorian Anthropology*, New York, 1987; George Stocking, *The Ethnographer's Magic and Other Essays in the History of Anthropology*, Madison, WI, 1992; George Stocking, ed., *Colonial Situations: Essays on the Contextualization of Ethnographic Knowledge*, Madison, WI, 1991; Nancy Stepan, *The Idea of Race in Science: Great Britain 1800 – 1960,* London, 1982; and *Man in Early Nineteenth-Century Britain*, Amsterdam, 1999.

conceptions of evolution.[299] Fuelled by the investigation of traveller naturalists, late-Victorian anthropology was the ultimate observation-based, applied science of natural history theories developed a century earlier.

Why is it then that histories of the *Challenger* have often failed to include accounts of the expedition's ethnological work alongside its oceanographic work? I believe that there is something distinct about our historicisation of Victorian sciences. Their continuities and proximities with contemporarily practiced sciences make them difficult to distinguish; but their epistemological differences challenge the social and cultural continuities we can easily see. Put another way, the sciences are too similar to dismiss as completely archaic but too out dated, and often politically problematic, to link with current practices. This is evident with a whole host of quintessentially Victorian sciences including early telegraphy, electricity, and infrastructure sciences, but is most prescient with ethnology and anthropology due to its highly problematic lens on race and race science.[300]

In previous chapters I have argued that the *Challenger* expedition constitutes an important moment in the construction of modern science. It literally and figuratively provided a new space through which a diverse set of scientific questions and practices were contained, thereby reconfiguring scientific inquiry. I have shown that the contemporary demarcations between natural history, oceanography, and ethnology that many scientists are inclined to see in the *Challenger* narrative were not subscribed to by the scientific staff themselves. These practices were not only integrated but were integral to the overall project and methods that the expedition encompassed. To understand the expedition as a modern phenomenon, it must be

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[299] Stocking, *Victorian Anthropology*, p.76.
[300] For a good overview of typical Victorian sciences see Bernard Lightman, ed., *Victorian Science in Context*, University of Chicago Press, Chicago and London, 1997.

viewed in its entirety. The expedition itself, the voyage, its history and the scientific knowledge which it produced is not modern because it gave birth to modern oceanography, but instead it is modern for the ways in which it organised, configured and embodied scientific knowledges and practices in the late nineteenth century. And although perhaps counterintuitive to any contemporary scientist today, this includes ethnology.

What is at stake in acknowledging (or not) the role of ethnology in the expedition? Primarily, to ignore the ethnological questions that the scientific staff were asking, to edit out the extensive writings dedicated to ethnological observations, would be to portray an incomplete narrative of the ship's time at sea. Further it would cause us to see an incomplete picture of what the world's first large-scale oceanographic expedition looked like. Just as we acknowledge that the scientific practices of the expedition and its participants cannot be isolated from their cultural context, the types of scientific engagement cannot be discretely separated from each other. Similarly, the organisation of the natural world, and the way in which nineteenth-century naturalists categorised and classified its contents also differed from present-day notions. Nineteenth-century natural history established modern demarcations of the natural world, of men from animals, animals from plants, and plants from protozoa, but did so through coherent and consistent methods of study and investigation; the science of natural history applied coherent and consistent practices to studying all types of life forms. Ethnology, in its most fundamental form, was the natural history of man. And in the tradition of Victorian natural history, many of the observational, descriptive, and comparative techniques that naturalists used to construct knowledge of flora and fauna also applied to humans.

It is perhaps appropriate to ask what indications do we have of the relative significance of ethnological researches to the expedition's scientific staff and their mission given that it has played only a small part in the *Challenger's* history? Beyond acknowledging that ethnology was a typical interest for natural history maritime expeditions in the nineteenth century, there is ample evidence of the central role of ethnology in the scientific staff's pursuits. Firstly, there is its extensive presence in their personal journals and research notes.[301] More prevalent and regular than sporadic, ethnological observations were made at almost every opportunity. These often coincided with corresponding photographs or drawings, which together reflect a distinct perspective of these cultures. This work carried through to the published results, the materials which together represent the public record of the expedition.[302] In addition to descriptive ethnological work in the various personal narratives and accounts of the voyage, even the *Scientific Reports* include ethnological research. The twenty-ninth volume of the *Zoology Reports*, situated between volume 28 on cirrepedia, a class of crustacea that includes barnacles, and Volume 30 on polyzoa, a type of invertebrate marine animal, addresses human skeletons with a primary focus on skulls.[303] This report is a strong reminder that the ethnological work went well

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[301] Including Diary of J.J. Wild, 1872 – 1876, Murray Collection Section 1, 6 – 9, NHM, London, UK; Diary of Charles Wyville Thomson, 1872 – 1876, Murray Collection Section 1, 10, NHM, London, UK; Diary of R. von Willemöes-Suhm, 1872 – 1875, Murray Collection Section 1, 12, NHM, London, UK; Journal of botanical and zoological observations made during the voyage HMS Challenger made by Henry Nottidge Moseley, 1873 – 1875, MSS MOS, NHM, London, UK.

[302] John Murray, *Report of the Scientific Results of the Voyage of HMS Challenger during the years 1872 – 1876 under the Command of Captain George S. Nares, R.N., F.R.S. and Captain Frank Turle Thomson, R.N. Prepared under the Superintendence of the Late Sir C. Wyville Thomson, Knt., F.R.S., &c. Regius Professor of Natural History in the University of Edinburgh, Director of the Civilian Scientific Staff on Board and now John Murray, One of the Naturalists of the Expedition: A Summary of the Scientific Results: Historical Introduction,* Her Majesty's Stationery Office, London, 1885.

[303] William Turner, *Report of the Scientific Results of the Voyage of HMS Challenger during the years 1872 – 1876 under the Command of Captain George S. Nares, R.N., F.R.S. and*

beyond recording and observation. Within the published and unpublished work there is a significant amount of theorising. The gaze, language and analysis are all imbued with dominant racial and ethnological theories of the nineteenth century. Most importantly it is not the race science in itself but the use of race science along with other analysis of geography and oceanographic thinking to theorise about the natural world. The research of the scientific staff demonstrates the interconnected thinking between ethnology and other natural sciences. These sciences were not practiced or understood in isolation, but instead were all variations of an all-encompassing epistemology which aimed to explain the natural world.

While ethnological research occupied the scientific staff throughout the course of the expedition, there was particular interest in the relatively isolated and lesser-known Pacific Islands encountered halfway through the expedition as the ship continually headed east on its circumnavigation. The time spent at the Admiralty Islands north of Australia are a rich and engaging example of the type of work undertaken by scientific staff members. In this chapter I first provide an overview of late nineteenth-century ethnology before describing the ethnological interests and practices of the expedition's staff. I will then turn towards the Admiralty Island case study to examine the ways in which their work was conducted, depicted and understood.

Captain Frank Turle Thomson, R.N. Prepared under the Superintendence of the Late Sir C. Wyville Thomson, Knt., F.R.S., &c. Regius Professor of Natural History in the University of Edinburgh, Director of the Civilian Scientific Staff on Board and now John Murray, One of the Naturalists of the Expedition: Zoology Part XXIX, Her Majesty's Stationery Office, London, 1884.

Race Science in Context

Nancy Stepan, George Stocking and other historians have traced the long history of the concept of race and race science.[304] While one can find discussions of differences in human appearance and behaviour dating back to at least the early modern period, the predecessor for what historians of science would consider "race science" – rather than simply philosophical questions of human difference – emerged in the enlightenment period of the eighteenth century. Natural philosophers including Prichard, Blumenbach, Buffon, Herder and Kant theorised race as a typological approach to various individuals and cultures observed beyond the European continent. Blumenbach's major contribution was his conception of the five races of man which, while highly debated over the course of the nineteenth century, laid the foundation for the dominant approach to racial thinking in this period. Blumenbach argued that all of humanity could be categorised into five types: Caucasian, American Indian, Malay, Oriental and African.[305]

Ethnology was borne of imperial interests across Europe, and British interest in this science expanded alongside the growing borders of the British Empire. By the Victorian era the British Empire covered vast expanses of the globe; and this period saw the emergence of new kinds of understandings of the relationship between the imperial centre and its colonial peripheries including ethnology. As Ernest Dieffenbach, one of the pre-eminent ethnologists of the nineteenth century explained, "England encircles the globe in glorious enterprise…no nation, therefore, has such opportunity for investigating the history of races, - for no nation is it so essential to be

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[304] See Nancy Stepan, *The Idea of Race in Science: Great Britain 1800 – 1960,* Macmillan, London, 1982; George Stocking, *Victorian Anthropology*, The Free Press, New York, 1987; and George Stocking, *The Ethnographer's Magic and Other Essays in the History of Anthropology*, University of Wisconsin Press, Madison, 1992.

[305] Stephen Jay Gould, *The Mismeasure of Man*, New York, 1996, 406.

well acquainted with these races".[306] Understanding foreign cultures was as much a project of British identity making as it was a scientific pursuit. As famously asserted by scholar Edward Said, eighteenth century enlightenment Britain was preoccupied with identifying and reifying cultural boundaries between the British and "Other".[307] By the late nineteenth century British national identity gave birth to the concept of *Greater Britain*, one made famous by historian JR Seeley in his 1883 text *The Expansion of England*[308] but developed by numerous other scholars. The concept of Greater Britain evidenced the rise of a national identity that was inextricably linked with Britain's imperial project.

At the heart of Seeley's conception of Greater Britain was a distinction between British and Other. Greater Britain, he argued, consisted of Britain and its dominion colonies, those occupied by white British emigrants and their descendants. As historian Duncan Bell argues, "Greater Britain was more important because it was seen as *British*: the settlement colonies were an extension of the British (or more commonly English) nation, constituting an 'empire of liberty' that was to be transmuted into a single postimperial global formation".[309] This figurative expansion of Britain necessitated strong boundary making around what was to be included and excluded. Strengthening racial boundaries in the definition of what constituted Britons allowed for the relaxation of other boundaries like geography; and vice versa. Ironically, this move towards strengthening the notion of a British national identity also contributed to notions of global connections, and universal commonalities. The

[306] Dieffenbach, 'The Study of Ethnology', p.16.
[307] Edward Said, *Orientalism*, Pantheon Books, New York, 1978.
[308] John Robert Seeley, *The Expansion of England, Two Courses of Lectures*, London, 1883.
[309] Bell, Duncan. *The Idea of Greater Britain: Empire and the Future of World Order, 1860 – 1900,* Princeton University Press, Princeton, 2007, p.24.

development of a coherent racial science was therefore necessary for and necessitated by this period of literal and figurative British expansion.

The history of racial thought was, in broad terms, defined by the debate between monogenist and polygenist theories. Monogenism held that all racial types developed out a single origin, whereas polygenism held that at the source racial difference came from separate origins. Both theories, while based on the question of human origins, had far reaching social and political implications in Britain in the nineteenth century. Monogenists attributed racial difference to a myriad of natural and cultural causal explanations and argued that a shared human origin showed that race was malleable and changeable. If humanity had previously shared uniformity, then perhaps with the right conditions it could again. Polygenists argued that racial difference amongst people from different cultures was inherent and inherited from the beginning. Despite variance within the polygenist view, most polygenists asserted that inherent racial difference implied fundamental differences of character and of nature. Significantly, however, as historian Nancy Stepan highlights, monogenist beliefs were not necessarily non-racist.[310] Both monogenist and polygenist theories aimed to explain racial difference, and with that difference was intertwined a complicated collection of cultural, moral and philosophical understandings of Britons' place in the world and their relationship to other peoples. While there were strong proponents for both theories throughout this period, there was a marked shift in British scientific communities from predominant monogenist theories to polygenist theories around the mid-century mark.

One significant aspect of racial theory was the pursuit of understanding the relationship between bodies and their environments, which, for the British, was

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[310] Stepan, *The Idea of Race in Science,* p.44.

connected to imperial ambitions and the state of the British Empire. Specifically, the conception of race in this period was deeply intertwined with the ideological distinction between settler colonies and other colonial territories such as India. Historian Mark Harrison suggests that in order to understand the connection between theories of race and cultural and political perceptions of India versus the settler colonies, one must look back to notions of climate and acclimatisation, the theory that bodies adapt to particular climates over time, from the eighteenth century. Harrison argues shifts in racial thinking and shifts in British colonial strategies in India were co-constituted in the late eighteenth and early nineteenth centuries.[311] One of his main assertions is that the rise in belief in inherent racial characteristics and discrete boundaries between different races coincided with a shift in British colonial policy in India where acclimatisation was no longer seen as an achievable goal.

Harrison's history of "climatic determinism" shows that in the eighteenth century the British believed that there was a close relationship between bodies and climate, and that individual bodies could acclimatise to new environments. The shift that Harrison identifies at the turn of the nineteenth century did not eliminate this relationship between bodies and climate entirely, but instead suggested that bodies as a category, rather than as individuals, were affected by environment. It was not until the last decades of the nineteenth century that that which has come to be known as *race science* truly took form, and it was in relation to the solidification and popular acceptance of racial difference as an inherent and fundamental characteristic.

The environmental explanations of difference that dominated the first half of the nineteenth century began to wane by the second half. Notions of adaptation and

[311] Mark Harrison, *Climates and Constitutions: Health, Race, Environment and British Imperialism in India 1600 – 1850,* New York, 1999.

acclimatisation fell away, as British colonials continued to move and settle in tropical environments, a tradition that originated in the seventeenth century. While the factors that led to the move away from environmental explanations of difference are numerous, a few can be highlighted here. Firstly, some scholars pointed to evidence that colonials had settled in foreign lands for generations (like Dutch colonials in South Africa or the British in Australia) without any racial or physiological change as proof that environmental adaptation of humans was false. Additionally, as colonials began to settle in these lands as a form of imperial control, notions of acclimatisation became more problematic, as there was a desire to reinforce notions of difference between the coloniser and the colonised. In this way a strengthened identity outside of the colony, and outside of the colonial environment, became essential to the formation of colonial rule.

The shift from these earlier conceptions of race to the establishment of what is considered race science occurred through a confluence of intersecting conceptual, disciplinary, and social changes in the mid-nineteenth century. This period marked the beginning of the shift from natural history, which placed man as separate and unique within the natural world, to biology which placed man on a spectrum of the natural world alongside, but superior, to animals. The practices of ethnology considered both physiological and cultural differences of populations in the categorisation and classification of different races. In parallel, both scientific and cultural factors contributed to what constituted a shared British national identity. No longer was culture the singular definition of identity. The stabilisation of a racial science which promoted the notion of fundamental difference embedded race as a defining characteristic of nineteenth-century British national identity.

It was also in this period that the discipline of ethnology was institutionalised. The Ethnological Society of London began in 1843, and at its first official meeting Dieffenbach outlined a prescription for its aims, thereby also indicating where he believed the field should be headed.

> Ethnology begins with Ethnography – with an authentic description of the physical condition of each nation: and for this purpose it will be necessary to collect every thing that will throw light on this subject. It is not sufficient that authentic skulls should be collected of all races, or casts of such; but whole skeletons. We have sufficient materials to distinguish races from the form of the skull, as there are large collections in England and on the Continent; but we are almost ignorant of Comparative Human Osteology. We have no accurate data of the relative proportions between the abdomen and the chest, amongst different races; of the number of vertebrae; of the shape and capacity of the pelvis; of the length and strength of the extremities. The muscles, the internal organs, and the organs of the voice, have been still less thoroughly examined.[312]

Maritime expeditions played an essential role in this process. Fundamentally, they provided the physical and material conditions necessary for the British to explore these expansive lands and to establish the type of direct interactions which fuelled ethnological thinking (both through direct observation and by providing written and visual records of foreign cultures for a wider population of armchair ethnologists back in Britain). But just as anthropology, ethnology and race science continued to evolve over the eighteenth and nineteenth centuries, so too did the role of maritime voyages and their participants. By the late nineteenth century, ethnology was not simply observational, nor was it merely recreational. Instead, it had developed into a specific branch of the natural sciences and accordingly required skilled men of science (almost always men) to undertake the work. In this way, the *Challenger* expedition, as a scientific expedition with a uniquely qualified scientific staff solely dedicated to

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[312] Dieffenbach, 'The Study of Ethnology', p.18.

scientific pursuits, was fortuitously timed to contribute to the ethnological movement of the nineteenth century.

The transition from armchair anthropology to exploration anthropology is a central tenet of the history of nineteenth-century anthropology and has been well documented.[313] As noted by Kuklick and others, the *Challenger* is a notable example of this transitional stage, where the work of scientific knowledge making was a collaboration between the expedition naturalists and their colleagues back in the UK.[314] The decision to enrol a large number of expert naturalists from the UK to analyse the collections and contribute to the *Scientific Reports* was not a foregone conclusion, and was heavily debated by Wyville Thomson and representatives of the British Museum and government representatives.[315]

Admiralty Islands

As previously discussed, the expansive mandate of the expedition was not solely concentrated on the deep sea. Included within the multi-page directive outlined by the Committee of the Royal Society entrusted with oversight of the expedition is the stipulation that:

> Every opportunity should be taken of obtaining photographs of native races to one scale; and of making such observations as are practicable with regard to their physical characteristics, language, habits,

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[313] See Stocking, *Victorian Anthropology*, and K.R. Howe, *Nature, Culture and History: The 'Knowing' of Oceania*, University of Hawai'i Press, Honolulu, 2000.

[314] Henrika Kuklick. 'Islands in the Pacific: Darwinian Biogeography and British Anthropology', *Journal of the American Ethnological Society*, 23, 3 (1996), pp.619.

[315] Charles Wyville Thomson, *Report of the Scientific Results of the Voyage of HMS Challenger during the years 1872 – 1876 under the Command of Captain George S. Nares, R.N., F.R.S. and Captain Frank Turle Thomson, R.N. Prepared under the Superintendence of the Late Sir C. Wyville Thomson, Knt., F.R.S., &c. Regius Professor of Natural History in the University of Edinburgh, Director of the Civilian Scientific Staff on Board and now John Murray, One of the Naturalists of the Expedition: Introduction to the Zoology Reports,* Her Majesty's Stationery Office, London, 1880, pp.25-27.

> implements, and antiquities. It would be advisable that specimens of hair of unmixed races should in all cases be obtained.[316]

These instructions were in keeping with the anthropological and ethnological interests of the scientific community at large, and consistent with those delivered to many other European expeditions of the period. A close examination of one specific terrestrial expedition from the voyage demonstrates exactly how these instructions were implemented in practice. By February 1875 HMS *Challenger* had been at sea for almost two and a half years and was slowly wending its way east through the South Pacific on its way back to the UK. The first week of March was spent conducting what would turn out to be some of their most productive ethnological work in the Admiralty Islands, an archipelago north of modern-day Papua New Guinea. Focusing on the scientific researches the scientific staff conducted over this one-week period helps to highlight their distinct ethnological approach to the Pacific Islands, and other territories less well known to British and European naturalists.

The Admiralty archipelago consisted of 18 islands. According to the *Challenger*'s *Narrative* the Islands were first encountered by Europeans during Jaques Le Maire and Willem Corneliszoon Schouten's seventeenth century voyage for the Dutch East India Company.[317] Over the course of the next century, they were visited by several other large-scale European expeditions, including one led by Bruny D'Entrecasteaux in the late eighteenth century who had been directed there on an

[316] T.H. Tizard, H.N. Moseley, J.Y. Buchanan, and John Murray. *Report of the Scientific Results of the Voyage of HMS Challenger during the years 1872 – 1876 under the Command of Captain George S. Nares, R.N., F.R.S. and Captain Frank Turle Thomson, R.N. Prepared under the Superintendence of the Late Sir C. Wyville Thomson, Knt., F.R.S., &c. Regius Professor of Natural History in the University of Edinburgh, Director of the Civilian Scientific Staff on Board and now John Murray, One of the Naturalists of the Expedition: Narrative of the Cruise of HMS Challenger with a General Account of the Scientific Results of the Expedition, Parts I and II,* Her Majesty's Stationery Office, London, 1885, p.30.

[317] Tizard et al., *Narrative*, p.697.

unsuccessful mission to find out what had happened to La Perouse's famous shipwreck earlier in the century. By the nineteenth century the Islands were not unfamiliar with visits from European and American vessels, including some Pacific whaling ships.[318]

The Pacific region represented a place of possibility within the European scientific imagination. Although the notion of a Terra Australis had faded by the nineteenth century, the region still held the promise of new types of undiscovered phenomena, not the least of which included primitive cultures. There was much to be learned about the Pacific region, and much of this was tightly intertwined with theories of the greater natural world. Readings of published materials, private journals, and personal notes from the expedition indicate that the natives of the various Pacific Islands were of distinct ethnological interest for the expedition's scientific staff. Despite a number of voyages in the preceding centuries and colonial settlement in Australia, New Zealand and additional smaller islands, the South Pacific still sheltered some of the least explored locations for Britons in the late nineteenth century, and one can surmise that these cultures were some of the least known, and least recorded, for British naturalists.

The published *Narrative*, which was written in chronological order and organised by geographical location, integrates ethnological descriptions of peoples throughout, but becomes noticeably focused on ethnology in its chapters on the Pacific Islands. This is even evident in the chapter outline for Chapter 18, covering their time on the Islands. Typically, the chapter subsections are organised around geographical movement, or a particularly notable scientific find. However in this case the Admiralty Islands chapter is divided into: The Admiralty Islands; History of their

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[318] Tizard et al., *Narrative*, p.697.

Discovery; Description of Nares Harbour; General Appearance of the Islands and Botany, Natives, Their Houses, Habits, Customs, Ornaments, Weapons, and Implements; Zoology; and Polynesian Races. What follows is an in depth descriptive chapter which covers the history of European contact with the Islands; physiological, behavioural, cultural, and racial observations of the Islands' inhabitants; and a general theoretical exploration of the Islanders' place within the racial classification system of ethnology.

Despite this detailed account, it is noted that:

> The following account of natives of the Admiralty Islands is largely taken from a paper on the subject published in 1877 by Mr. Moseley, to which the reader is referred for further details as to the language and other matters. It must be remembered that the stay of the *Challenger* at the islands lasted only a week, and that the period during which the natives and their customs could be studied was very short.[319]

Rather than reading this as simply a caveat to their findings, this should be noted as an indication of their audience. Shifting from a period in which many scientific "observations" and conclusions could be made from second-hand materials and mere speculation, the *Challenger's* scientific staff seem to be speaking to an audience of colleagues who would expect a certain amount of in situ observation. A week's emersion into the culture and environment of the Admiralty Islands may have seemed a relatively short amount of time from which to make any significant findings, and of course the *Challenger* staff was not in a position at the time of publication to speculate as to the impact or longevity of their work in this regard. However, it is also clear that a week's time was more than enough to engage the staff in a myriad of cultural and scientific questions around the nature of Admiralty Islanders and their

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[319] Tizard et al., *Narrative*, p.697.

environment, and the relatively short trip did not curtail the vast amount of writing and speculation they produced from it.

Foremost in the staff's interests was the physiological nature of the Admiralty Island locals. The observations made of the islanders were methodical and detailed. Descriptions adhered to traditional ethnological hallmarks, including notes on body parts, hair and complexion, and details were remarkably consistent amongst the notes made by various staff members. In one strikingly curious example, three of the six scientific staff members each recorded a particular instance of anthropological investigation in their own personal research journals. In J.J. Wild's account he describes the measurements of four men from the Admiralty Islands, an archipelago north of present-day Papua New Guinea. The men, simply identified either "adult male" or "young male", were measured from head to toe. The measurements included: height; girth of chest; penis size; size of buttocks; and length of foot, of hand "to tip of middle finger," of arm, and of forehead. Wild concludes his notes with the following: "These natives were measured and weighed on the main-deck, in the afternoon, March 10th 1875".[320] In Moseley's more succinct record, he provides a similar list of measurements to Wild's for what appear to be the same four men. He also notes that there was a photograph taken of one of the men. His data is labelled as "taken down and partly made by myself".[321] In Willemöes-Suhm's account he noted on the 10th of March 1875, "I measured some women and men and got the following results:" before detailing the averaged measurements of four women and nine men. He also mentions, "From the houses, where they were suspended (either inside or

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[320] Diary of J.J. Wild, 1872 – 1876, Volume 3, page 47, Murray Collection Section 1, 8, NHM, London, UK.
[321] Journal of botanical and zoological observations made during the voyage HMS Challenger made by Henry Nottidge Moseley, 1873 – 1875, MSS MOS, NHM, London, UK.

outside) I procured 12 skulls, one of them with lower jaw which will furnish very valuable materials for an anthropological inquiry into the subject."[322] In the scientific report on the human crania, it is noted:

> The skulls from the Admiralty Islands were the most valuable part of the craniological collection, as apparently no Europeans had landed on these islands prior to the visit of HMS *Challenger*, and skulls of natives were unknown in our museums.[323]

These observations were ultimately published in the *Narrative* in a detailed table accompanied by the following explanation:

> The men average about 5 feet 5 inches in height, and the women about 5 feet and 1 inch. They contrast at once with the natives of Humboldt Bay, in being far thinner and lankier. Three men who were weighed, averaged only nine stone (127 lbs.) in weight. Only one native was observed that was at all fleshy, although such were not uncommon at Humboldt Bay. Food is perhaps not so abundant here as on the New Guinea coast, and the natives have not, like the natives there, the advantage of bows and arrows to kill game with.[324]

This concluded with the remark:

> Measurements in inches of Natives of the Admiralty Islands, taken by the late R. von Willemöes Suhm, being of Natives of Wild Island, except those Nos. 6, 7, 8, 9 which were taken on board the ship by R. von Willemöes Suhm and H.N. Moseley.[325]

What does it mean that these three men, whose personal notes and journals indicate very little overlap in scientific interests, all found this encounter with the natives of the Admiralty Islands notable enough not only to record it, but to record it as a first-person observation? In part, I believe, it reflects the semantic conventions around ethnological observations which, as I noted earlier, placed significant value on

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[322] Diary of R. von Willemöes-Suhm, 1872 – 1875, Murray Collection Section 1, 12, NHM, London, UK.
[323] Turner, *Report on Human Crania*, 51.
[324] Tizard et al., *Narrative*, p.707.
[325] Tizard et al., *Narrative*, p.707.

first-hand accounts. Further, it seems that the novelty of these Islanders, not only to the naturalists but to the greater British scientific community would have made these sightings and measurements more valuable than those of cultures and peoples more familiar to ethnologists.

The detail and specificity of the measurements and observations mirror those taken of oceanic specimens throughout the expedition. Just as Humboldtian notions of climatic and zonal relationships between fauna and their environments informed the staff's study of animals, so too did it for the study of humans. The specific data, along with the details of locality, and even the context of the measurements, reflect the similar style of data collection. There is no clear explanation for why all three naturalists took such a keen interest in these specific men from the Admiralty Islands. It is perhaps indicative of the apparent novelty and value of observational data of the Admiralty Islanders that all three men thought it noteworthy to record this specific event, but this is merely speculation.

George Stocking marks the turn from ethnology to anthropology in the 1850s. He suggests that the same contributive factors which fostered the rise of Darwin's theory of evolution, primarily the expansion of geological time, also changed the collective evidence which had supported the dominant monogenist theory of race that had developed from the first half of the nineteenth century.[326] The distinctions between ethnology and anthropology, as articulated by Stocking, are not dogmatic. Stocking argues that the armchair theorisation that underlay the ethnological thinking of James Cowles Prichard and his contemporaries began to buckle under the accumulating material artefacts collected by voyages and expeditions. This in turn promoted the new science of anthropology which prioritised comparative anatomy

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[326] Stocking, *Victorian Anthropology*, 69.

rather than the book-based linguistic study of cultures. Others however have argued that voyaging naturalists including Charles Darwin, Alfred Russel Wallace and late nineteenth-century contemporaries of the *Challenger* scientific staff were still participating in the science of ethnology through to the end of the nineteenth century. While the transition from ethnology to anthropology may not be as clear as Stocking asserts he and other historians have identified two distinguishing characteristics between them. First, the race science of ethnology adhered to, in fact was predicated on, a temporal understanding of civilisation with the oldest and least civilised cultures on one end, the barbarians, and the modern most civilised cultures on the other. Secondly, modern anthropology was a more material-based science, which aimed to do comparative analysis of various anatomical and physical characteristics.

Physiology was not the only consideration in nineteenth-century race science however. Behaviour, countenance and demeanour, were all understood to be inherent to particular cultures, races and people of certain geographical areas. Charles De Paulo, a historian of Charles Darwin's ethnography, suggests that Darwin's ethnographic approach was strongly informed by his interest in Humboldt's anthropological writing from the first half of the century. Humboldt's anthropology mirrored his naturalist practices: he was strongly devoted to embedded observation, detail-oriented data collection, and starting with specific examples and working outwards. De Paulo argues that Humboldt's writings on race and ethnology had the most significant scholastic influence on Darwin during his time aboard the Beagle, specifically Humboldt's book *Personal Narrative of Travels to the Equinoctial Regions of America during the Years 1799 – 1804.*[327]

[327] De Paolo, Charles. *The Ethnography of Charles Darwin: A Study of His Writings on Aboriginal Peoples*, McFarland & Co., Jefferson, NC, 2010, p.18

> [Humboldt] prefers studying the physical constitution of the people and, in an ethnological spirit, decides to use 'the analogy of language' as a means of categorizing tribes, of tracing 'their distant migrations,' and, most important, of communicating with native people. He believes, moreover, that the primordial unity of mankind could be revealed if one observes primitive societies closely, and especially 'those family features by which the ancient unity of our species is manifested'. Thus, Humboldt began his ethnological journey, not with artificial classifications of human groups emphasizing their diversity and separateness but, rather, with the conviction that the native inhabitants of the equinoctial region of America were simply a remote variety of mankind, having discernible heritages and physical characteristics.[328]

De Paulo notes that Humboldt's starting point was to identify physical features and to highlight the distinctions amongst different groups of people. He also paid attention to their facial expressions.[329] This type of thinking clearly influenced Darwin's own ethnological observations made during his time on the Beagle expedition which would strongly inform his ethnological work over the next several decades resulting in the publication of his book *The Descent of Man, and Selection in Relation to Sex* in 1871.

This text, which presents Darwin's evolutionary thinking on the human species, has provided historians of science with almost endless questions and thought-provoking challenges. As I noted earlier, the interconnection between problematic race science and nineteenth-century evolutionary thinking, which of course lays the foundation for twentieth-century biology, has been an ongoing challenge for historians and scientists alike. Darwin's theory of evolution, which today is so fundamental to biological thinking, also strongly informed Darwin's understanding of

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[328] De Paolo, *The Ethnography of Charles Darwin*, p.19.
[329] De Paolo, *The Ethnography of Charles Darwin*, p.20.

racial origins, relationships, and hierarchy, all of which are highly problematic from today's cultural perspective.[330]

At this time Darwin also produced a third smaller text which was originally conceived as a chapter to the *Descent of Man* but which came to be published as a separate tract. In "On the Expression of the Emotions" Darwin tries to understand the significance of facial features and facial expressions in categorising races and identifying the evolutionary relationship between these different categories. Importantly, it was a text, which although only published in 1872, the same year the *Challenger* expedition began, informed the *Challenger*'s scientific staff's ethnological work. As Moseley describes:

> Having studied Mr. Darwin's work, 'On the Expressions of the Emotions,' I was immediately struck on seeing the men conversing in the boat with one another, by the unusually marked development of facial expression exhibited by them. The muscles of the forehead during animated conversation, are contracted and relaxed incessantly, and in a most varied manner; the brow is strongly wrinkled, and the eyebrows are jerked up to such an extent as to remind the observer at once of the jerking up of the eyebrows of monkeys.[331]

This type of observation where physical expressions were speculatively translated into inherent behavioural characteristics was also made of the Admiralty Islanders by *Challenger* participants.

> To express affirmation, the natives jerk the head up, as at Fiji. Negation is expressed by a most extraordinary and peculiar method: the nose is struck on its side by the extended forefinger of the right hand, the motion being as if the tip of the nose were to be cut or knocked off. This sign was invariably used to express refusal of proffered barter, or that a native had not got some article asked for. It is capable of various modifications: the quick decided negative is given by a smart quick stroke on the nose; in the doubtful, hesitating

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[330] De Paolo, *The Ethnography of Charles Darwin*, p.183.
[331] Henry Nottidge Moseley, *Notes by a Naturalist: An account of observations made during the voyage of HMS Challenger round the world in the years 1872 – 1876,* London 1892, p.246.

> negative, the finger dwells on its way, and is rubbed slowly across the nose".[332]

The comparison with other races that was included in the published account is evident throughout this section of the *Narrative* as well in other publications including the *Zoological Report on Human Crania* and a separate article by Moseley entitled "On the Inhabitants of the Admiralty Islands" which was published in the Journal of the Anthropological Institute in 1877. This article includes a table focusing solely on the comparison of arm length of the Islanders (separated into men and women) with those of New Zealanders, Australians, Tahitians and Germans. It is concluded simply, "Whence it appears that the Admiralty Islanders are short armed".[333]

The report continues, "The race is of average height, but the weight is, as usual with savages, below that of Europeans; 126 lbs. (nine stone), as compared with 150 lbs., about the weight of an average Englishman. The natives contrasted at first glance with the Papuans of Humboldt Bay in being far thinner and lankier. I saw but one native that was at all fleshy, although such were not uncommon at Humboldt Bay".[334] Distinctions between the Admiralty Islanders and the locals of Humboldt Bay seem to be of particular interest. Humboldt Bay, now known as Yos Sudarso Bay, is on the northern coast of modern-day Indonesia's Papua province, just west of the national border with modern-day Papua New Guinea. The Bay is only coincidentally, although rather interestingly, named after Alexander von Humboldt, in comparison to the Admiralty Islands which are heavily marked with names associated with the *Challenger* expedition including Nares Harbour (named by Captain

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[332] Tizard et al., *Narrative*, p.706.
[333] Henry Nottidge Moseley, 'On the Inhabitants of the Admiralty Islands', *The Journal of the Anthropological Institute of Great Britain and Ireland*, 6 (1877), p.384.
[334] Moseley, 'On the Inhabitants of the Admiralty Islands', p.385.

Thomson who proceeded him) and Moseley Point, as well as Buchanan, Moseley and Murray Islands (named after three of the scientific staff members). The following excerpt is found in both Moseley's article as well as the longer *Narrative*:

> The usual colour of the natives is a black-brown, often very dark, and darker than that of the natives of Humboldt Bay…Some one or two of the young women were of a quite light yellowish brown, as was also one young man, who came from a distance to the ship to trade. No doubt there is a mixture of blood, and the light coloured natives observed belonged to the light coloured race described by Jacobs as inhabiting the eastern part of the main island, and as constantly being made war upon by the dominant black race.[335]

This type of detailed comparison was also made of discrete characteristics. In the case of the Admiralty Islanders their hair was of particular interest in the comparison to other Pacific races.

> The hair of the head which is worn long only by the younger adult males, formed in them a dense mop, projecting in all directions 6 to 8 inches from the head, but appeared less luxuriant in growth than that of the natives of Humboldt Bay. The hair is crisp, glossy, and extremely elastic, and every hair rolls itself up into a spiral of small diameter, thus in general appearance it is fine curly, like that of Fijians. On comparing it with a very small sample of hair of the natives of Humboldt Bay taken from several native combs, the hair of the latter proves to be somewhat coarser but in other respects the two hairs are closely alike, the diameters of the spirals of the curls being the same. Some hair from a native of Api, New Hebrides, is of about the same coarseness as the Admiralty Island hair, but the curls are of much smaller diameter; the hair of the Api Islanders seems to be remarkable for the fineness of its curls. The fineness of the curl of the hair in various Melanesian races seems to be pretty constant in each race and characteristic. It might be estimated by measuring the diameter of the circles formed by the separate spirally twisted hairs, and taking the average of several measurements. No doubt a certain curve of the hair follicles corresponds with and produces the curl in the hairs, as in the case of the hair follicles of the negro as discovered by Mr. Stewart, but the amount of curve will be peculiar to each race. The hair of both head and body of the Admiralty Islanders is naturally black, that of the head being of a glossy black. The hair of the men's bodies was not at all abundant, nor by any means so plentiful as it is

[335] Tizard et al., *Narrative*, pp.708-709.

often seen to be on the bodies of Europeans, the hairiness of whom is apt to be underrated.[336]

This extended observational narrative demonstrates the various comparisons and reference points the ethnological community utilised in describing newly observed cultures and peoples. No physiological characteristic was considered too insignificant. Descriptions of both the people of Humboldt Bay and the Admiralty Islands was particularly useful for British ethnologists in this period, as questions over the uniformity and relationships between cultures which fell under the early nineteenth-century mantle of "Malay race" were being called into question.

Moseley's journal article reflects the depths of his ethnological work in the expansive set of behaviours and characteristics he analyses beyond physiological traits. Among the diverse set of categories he includes: language, emotions, diseases, population, dress, behaviours, crafts – including "technical handiness" – trade, religion, music, war, treatment of women and character. In turn, each of these categories is examined in order to paint a picture of the Admiralty Island culture as well as to situate it amongst knowledge of other primitive cultures. For example, Moseley observes that the Admiralty Islanders chew betel, which had also been observed in several other Pacific Island cultures. Later however he suggests that the ability of some of the men to restrain from chewing betel demonstrates strength of character.

The article also includes several tables and charts of the Islanders' words and numbers, contributions to which were made not only by the scientific staff but also several of the naval crew members. Moseley observes that with regard to their numbers, "the earlier numbers up to 5 correspond to some degree with the Malayo-

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[336] Tizard et al., *Narrative*, pp.708-709.

Polynesian forms, and that the word for 5 is the almost ubiquitous lima (hand); the higher numerals are peculiar, and the terms for 8 and 9 are formed by subtraction". He states that this numerical form based on subtraction has been observed in several races including in some from North America,[337] but that among all known Melanesian, Louisiade or Papuan languages, as well as the 33 languages of the Malay Archipelago described by Wallace only one small Island – Micronesia Yap which is part of the Caroline Island group – shares this form.

Moseley then returns to the topic of betel by noting that the Yap Islanders are some of the very few western Micronesians who chew the substance, and that while it is believed that they learned this behaviour from the Malays, they have a different set of language to describe it and related behaviours – language which sounds similar to that of the Admiralty Islanders, which in turn is unique in that there are very few other similarities in languages of the two Islands. Despite this detailed analysis Moseley concludes:

It is possible that the resemblances between the Admiralty and Yap languages may have no real significance, and would disappear were any but a mere fragment of the Admiralty Island language available for comparison, but it is at all events worth having attention drawn to it.[338]

This strange but seemingly typical example demonstrates the interconnected considerations that ethnologists made in working through an understanding of the relationships among global races. Language, behaviour, and cognition, combined with anatomy, physiology and geography, all contributed to the conceptual mapping and classification of human races in this period. At the conclusion of his article

[337] Moseley, 'On the Inhabitants of the Admiralty Islands', p.391.
[338]

Moseley surmises that the Admiralty Islanders are of Melanesian rather than Papuan "affinity" and that "their nearest neighbours are at present very little known".[339] While apparently simplistic this conclusion reflects a significant contribution to ethnological theory. For nineteenth-century ethnologists the Pacific Islanders proved particularly interesting, but also particularly challenging, in that they sat geographically in an undefined region of racial categorisation, and challenged the established paradigms of racial classification.[340] The reference to the Admiralty's little known neighbours indicates how few of these Islands had been studied in enough detail to definitively draw the boundary lines between the Melanesian and Papuan races, therefore determining that the Admiralty Islands should be classified as Melanesian was an important marker in ethnological knowledge making.

The contributions the *Challenger* expedition made to British ethnology continued on long after the end of the voyage. In the late nineteenth century one of Britain's preeminent anthropological museums was established by expedition naturalist Henry Nottidge Moseley. Lieutenant-General Augustus Pitt Rivers donated his collection of anthropological items to the University of Oxford in 1884 to be managed by Moseley. By the 1880s he was the Linacre Professor of Human Anatomy at Oxford. Moseley's central role in the early years of the Pitt Rivers museum were, according to historians of the institution, a natural progression from his times spent on HMS *Challenger*. "Parts of his collection [from the expedition], including a group of Melanesian and Australian spears, and pots, baskets, and fibre samples from Fiji, South and North America, and Papua New Guinea, and a number of human-hair

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339 Moseley, 'On the Inhabitants of the Admiralty Islands', p.419.

340 Bronwen Douglas, '"Novus Orbis Australis": Oceania in the science of race, 1750-1850', in Bronwen Douglas and Chris Ballard, eds., *Foreign Bodies: Oceania and the Science of Race 1750-1940*, The Australian National University Press, Canberra, 2008, pp.99-156.

specimens from various parts of the world, were given to the University Museum and later transferred to the Pitt Rivers".[341] In 1882 Moseley was appointed the Curator of the Ethnological Collections in the University Museum, who in practice was in charge of the materials which would eventually be distinguished as the Pitt Rivers Museum collection.[342] The legacy of the Pitt Rivers Museum is far too expansive to cover in adequate detail here, however its role as a centre of ethnological practice in the late nineteenth and early twentieth centuries is relevant in this broader discussion in that it helps to concretise the specific connections between the expedition and an ethnological legacy. The Museum became the central node in the British network of ethnology and anthropology at the end of the nineteenth century. Its early participants and contributors connected the most influential anthropological thinkers of the day, and it became a clearinghouse of important material artefacts reflecting their dominant ethnological interests.

Stocking draws a straight line from the *Challenger*'s natural history tradition to the anthropology of the early twentieth century. He argues that early leaders in British anthropology were directly inspired by the work of Moseley and his colleagues:

> For [British anthropologist Alfred Cordon] Haddon, 'anthropology' still had the embracive meaning it had gained in the nineteenth-century Anglo-American evolutionary tradition, and which it might also be expected to have for a field naturalist, to whom the behavior, cries, and physical characteristics of animals were all part of a single observational syndrome. Aware, however, that some areas of anthropological inquiry had developed a technical elaboration beyond the limitations of his own competence, and anxious to introduce the methods of experimental psychology to accurately 'gauge the mental and sensory capacities of primitive peoples,' Haddon took as his model the great nineteenth-century multidisciplinary maritime

[341] Chris Gosden, Frances Larson, and Alison Petch, *Knowing Things: Exploring the Collections at the Pitt Rivers Museum 1884 – 1945*, Oxford, 2007, 160.
[342] Gosden et al., *Knowing Things*, p.162.

> exploring expeditions – on the basis of one which Moseley had made his reputation and won his position at Oxford.[343]

Historian Henrika Kuklick is even more specific in locating Haddon's scientific predecessors. She argues:

> Haddon's direct inspiration was arguably the expedition of the H.M.S. Challenger in 1872 – 1876, the first major expedition mounted to study the world's oceans scientifically, although in comparison to it the Torres Straits Expedition was extremely modest. It was his work on the Challenger expedition that enabled Haddon's friend Moseley to build his scientific reputation and secure his Oxford chair; and Haddon, who wrote up some of the *Challenger* data (many of which were consigned to armchair oceanographers to synthesize for publication), must have expected his expedition to do for his career what Moseley had for his.[344]

Haddon's late nineteenth-century expedition to the Torres Strait was, Kuklick argues, a major turning point in the transformation of ethnology into a legitimate field science. It was Haddon's integration of Pitt Rivers' Darwinian understanding of anthropology with his own principles of fieldwork that led to a watershed moment in British anthropology. According to Kuklick, a Darwinian understanding of anthropology both required and explained the isolation and unique cultural establishments of the Pacific and its inhabitants. Haddon and his contemporaries believed that Darwinian notions of evolution provided a scientific explanation for the keen vulnerability to extinction of flora and fauna of the Pacific that Europeans had observed. Additionally, these concepts also made the region a place of significance for European anthropologists as it provided the uniquely controlled and laboratory-like conditions for scientific study that they desired to further their evolutionary understanding.[345]

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[343] Stocking, *The Ethnographer's Magic*, p.22.
[344] Henrika Kuklick, 'Islands in the Pacific', p.629.
[345] Henrika Kuklick, 'Islands in the Pacific', p.616.

Conclusion

The scientific significance of the *Challenger*'s ethnological work is reiterated in the concluding pages of the *Narrative*'s Admiralty Islands chapter:

> Various theories have been advanced as to the origin of the Mahoris [Maoris] or Polynesians, though none of them is perhaps entirely satisfactory. America has been regarded by some as their original home, from which they diffused themselves over the eastern Pacific in the course of the trade winds. By others Asia and the Malay race have been considered as their progenitor, and the term Malayo-Polynesian is on this view a popular ethnological designation for them. Others again, like Mr. Wallace, have accounted for both Polynesians and Melanesians on the well known theory of Charles Darwin that the Pacific is an area of subsidence, that its coral reefs mark out the position of former continents and islands, and that both races are merely varying forms of one great Oceanic race, the diversities of which are to be accounted for by the certain effects of the varying physical conditions which have resulted in the present state of the surface of the land in Oceania. But it is difficult to understand wherein such varying physical conditions could reside in islands subject to such uniform or closely allied climatic conditions as the tropical islands of the Admiralty, New Hebrides and Tonga groups, even on the supposition that they had at one time been the tops of continental mountains, so as to produce, in the two former, a black-skinned, frizzly haired, dolichocephalic stock, and in the last named a brown-skinned, straight haired, brachycephalic people. The hypothesis also which accounts for the origin of the Melanesians on the supposition that, in prehistoric times, a great south oceanic continent existed which extended from the east of Africa up to the Indian Ocean, and from which the black race spread into both Africa and the islands of the Pacific, is not satisfactory. *For the deep-sea investigations of the Challenger have thrown great doubt upon the possibility of such an extensive continent ever having had any existence in recent geological times either in the Indian or Pacific Oceans.* But from the superior civilisation and better physical development of the Polynesians there can be little doubt that they represent a later incursion into the Pacific than either the Melanesian or Australian races.[346]

Despite what may seem like entirely disparate scientific enquiries, this conclusion emphasises the fact that the scientific staff were focused on one overarching interest in the natural world and its origins. In this short extract Wyville Thomson alludes to

[346] Tizard et al., *Narrative*, 732 – 733, emphasis added.

the many types of natural factors which ethnologists believed to be connected to race and racial geography including trade winds, altitude, and climate. He then is able to assert that the new investigations of the deep sea produce new insight not only into the natural world but also to ethnology and the distribution of human races on the globe. This statement, while tucked away within the thousands of pages of the voyage's *Narrative* may not initially be seen as revolutionary science, but it is an important indication of the ways in which oceanography and ethnology were conceptually intertwined. Natural history, geology, and ethnology all contributed to an understanding of the origins of the natural world (including its inhabitants) and its change over time.

Previous histories of the *Challenger* expedition have demonstrated the ways in which the expedition's research of the ocean contributed to broader understandings of the natural world. It is my argument here that the scientific staff's work on ethnology similarly informed their oceanic and terrestrial natural history. One cannot fully contextualise their scientific knowledge of the ocean without equally appreciating their work in ethnology. Geological, geographical, and oceanic speculation around the natural evolution of the globe, and the relationship between specific localities in the Pacific, were challenged and revised based on racial science and ethnological work.

In context the expedition's time spent on the Admiralty Islands is (literally) one chapter in a much longer history. In some ways, the experiences and observations there were so typical of the broader expedition that they are often overlooked in historical accounts. However, a close reading of this episode, through archival documents, published accounts and visual representations, highlights how representative it is of the larger goals and ambitions of the expedition's scientific staff. Ethnological enquiries were not merely a recreational interest, but were a central part of their scientific work. The observations and theorising done during their time in the South Pacific became an important part of their work, not only in the science of ethnology, but in the science of oceanography as well.

VI. THE MODERN OCEAN

Introduction

In the previous chapters I have demonstrated how the work of the expedition was constituted by reconfigurations of various earlier scientific practices applied to the new and epistemologically malleable concept of the deep sea. However the dominant popular narrative is one of novelty and innovation defined by its uniqueness in relation to earlier voyages rather than its inherited similarities. In fact the *Challenger* expedition is the beginning of modern oceanography not simply because it marked the beginning of a new paradigmatic way of studying the ocean, but because it embodied practical and epistemological continuities with both the past and the future, while facilitating the appearance of a complete conceptual rupture with earlier work. This semantic shift also effectively erased the long history of the ocean which had existed through to the Victorian era. Positioning the expedition as the beginning of a modern way of knowing created the illusion of an ahistorical ocean, one which had neither a natural or human history attached.

What does it mean for something to be modern; more specifically what marks science as modern? Some historians of science have defined the term based on simple historical dates, typically locating the rise of modern science to the eighteenth and nineteenth centuries.[347] Peter Bowler and Iwan Rhys Morus suggest that modern science emerged in the eighteenth century cultivated by enlightenment thinking and marking a transition from passive observation to something akin to what is now considered the scientific method: "rigorous testing of new hypotheses by observation

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[347] David Knight, *The Making of Modern Science: Science, Technology, Medicine and Modernity: 1789 - 1914,* Polity, Cambridge, UK, 2009.

and experimentation". Interestingly, they suggest that the history of modern science followed soon after, beginning with Brit William Whewell, known as the originator of the term "scientist", and his publication *History of the Inductive Sciences* in 1837.[348] Essentially, modern science and history went hand in hand in the nineteenth century.

Historian David Knight dates modern science later than Bowler and Morus, designating the nineteenth century as the age of modern science. His book *The Making of Modern Science* maps out the institutionalisation, professionalisation, and formalisation of scientific practices over the course of the century in arguing that modern science represents the progress towards accurately representing and understanding the real world. Beyond this chronology debate there are other considerations in locating *modern science.* Colloquially modern science is typically used to reference knowledge that is still considered valid science through a present-centred lens. In Kuhnian terms this includes all practices and knowledge which fall within the same paradigm as current science.[349] There is also much debate as to whether practices and knowledge must adhere to a European tradition to be considered scientific.[350] In most cases, modern science is contextual, each individual case defined by a series of requisite characteristics – including commonalities with

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[348] Peter J. Bowler and Iwan Rhys Morus, *Making Modern Science: A Historical Survey*, University of Chicago Press, Chicago and London, 2005, p.4.

[349] Thomas Kuhn, *The Structure of Scientific Revolutions*, University of Chicago Press, Chicago and London, 1962.

[350] For a discussion of origins of modernity specifically relating to modern science see Dipesh Chakrabarty, *Provincializing Europe*: *Postcolonial Thought and Historical Difference*, Princeton University Press, Princeton and Oxford, 2000; Bayly, C.A. *The Birth of the Modern World, 1780 – 1914*, Wiley, London, 2004; Gyan Prakash, *Another Reason: Science and the Imagination of Modern India*, Princeton University Press, Princeton, 1999; Kapil Raj, *Relocation Modern Science*, Palgrave Macmillan, New York, 2007 and David Wade Chambers and Richard Gillespie. 'Locality in the History of Science: Colonial Science, Technoscience, and Indigenous Knowledge', *Nature and Empire: Science and the Colonial Enterprise*, *Osiris* 15, 1 (2000), pp. 221-240.

current practices and commensurability with a European worldview – but which can also be used to include and exclude particular practices and knowledges as valid science.[351] This, for example, is why nineteenth-century electro-magnetism is modern whereas its contemporary phrenology is not; but it can also help to explain why certain non-Western practices are not considered modern science.

This of course is an amorphous and imprecise answer. But if we ask the broader question of what constitutes the modern, a more exact understanding comes into relief. The term modern represents, in Bruno Latour's words, "a new regime, an acceleration, and rupture, a revolution in time".[352] This temporal aspect is a central tenet of modernity. In Foucaultian terms the modern age emerged due to a fundamental shift in the foundation of order of the classical age. The laws and logic that provided epistemological coherence to knowledge of the classical era broke down, laying the groundwork for a revolutionary new way of thinking: that of the modern era. As historian Harry Harootunian argued, "This sensitivity to the distinctively modern experience rooted in the present disclosed an awareness of the temporal dimensions of the present and its difference from the pasts that had preceded it".[353] Therefore modernity is a historical concept; any modern science must have a history, one that defines it in terms of similarities to the present and difference to the past. Modern science is knowledge that has commensurable continuities with current

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[351] The issue of boundary-work between science and non-science has been a central concern of Science & Technology Studies for over forty years. See David Bloor, *Knowledge and Social Imagery*. University of Chicago Press, Chicago and London, 1991; Thomas Gieryn, *Cultural Boundaries of Science,* University of Chicago Press, Chicago and London, 1999; Brian Martin and Evelleen Richards, 'Scientific Knowledge, Controversy, and Public Decision-making', in Sheila Jasanoff, Gerald E. Markle, James C. Petersen, and Trevor Pinch, eds., *Handbook of Science and Technology Studies*, Sage, Thousand Oaks, CA, 1995, pp. 506-526.

[352] Bruno Latour, *We Have Never Been Modern*, Harvard University Press, Cambridge, MA, 1993, p.10.

[353] Harry Harootunian, *History's Disquiet: Modernity, Cultural Practice, and the Question of Everyday Life*, Columbia University Press, New York, 2000, p.3.

ways of knowing as well as a revolutionary rupture from the past. In the case of the *Challenger* expedition, this rupture was semantic, the product of its own construction as modern. It became modern specifically because the expedition could be lifted out of its historical context to become a universal – and timeless – symbol of oceanography.

Oceanography's Internal History

The *Challenger* expedition's position at the beginning of a new type of science reinforces the implication of a revolutionary separation from previous studies of the ocean. The dominant history that circulates within the field of oceanography, aligns closely to historian of technology David Nye's notion of "technological origin stories". In his book *America as Second Creation* Nye argues that early Americans wove technology into the dominant narratives of American settlement; they placed technological artefacts in the centre of progressive narratives of colonial settlement, land cultivation, and social development.[354] As Nye explains, the history of early America was re-written in the nineteenth century, replacing complicated narratives of colonisation, conflict and struggle with a progressive narrative of American society, and reconstructing the early history of the American landscape as an uninhabited and untamed wilderness. The internal history perpetuated in the field of oceanography typically begins with the *Challenger*; the expedition is an essential part of oceanography's internal origin story. Further, by emphasising the technologies of the expedition, including the ship itself, this internal narrative suggests that the ocean is an ontologically stable and unchanging phenomenon which has been revealed to

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[354] David Nye, *America as Second Creation: Technology and Narratives of New Beginnings*, MIT Press, Cambridge, MA, 2003.

scientists through the work of the expedition. In emphasising discovery, this narrative implies that the ocean has a material reality outside of human understanding.

In almost all oceanographic textbooks, the expedition is the essential representation of the history of oceanography. In *Oceanography: A View of the Earth*, a textbook which has had seven published editions from 1972 to 1996, the introductory chapter on the history of oceanography presents a familiar description of the aims of the expedition and the type of scientific measurements and observations that were conducted.[355] This type of positivist history that imbues so much of oceanography's internal history portrays the expedition as the catalyst for a revolutionary break from earlier inaccurate knowledge of the ocean. It suggests that the ocean was primed and ready for technologies to reveal its true form. The text goes so far as to say that, "many delusions about the ocean were swept away by the *Challenger* results."[356] Enlightened knowledge of the natural world is revealed through the use of technology, and modern scientists improve on false knowledge from the past.

A second textbook *Principles of Oceanography*, originally published in 1972 and also still in use in universities today, includes a very similar narrative. The introductory "Brief History of Oceanography" is divided into sections in relation to the Challenger expedition and explicitly situates the *Challenger* as the turning point of modern oceanography:

> This voyage and the information gathered by its scientific crew is without doubt the most famous of its kind. Not only was a tremendous supply of knowledge made available but the voyage was a great stimulus to other nations interested in similar endeavors, in the minds

[355] M. Grant Gross and Elizabeth Gross, *Oceanography: A View of the Earth*, *seventh edition*, Prentice Hall, Berkeley, CA, 1996.
[356] Gross and Gross, *Oceanography*, p.13.

> of most oceanographers, the sciences of the sea "came of age" with the culmination of the *Challenger* expedition.[357]

Similar to other texts, this one identifies the *Challenger* as a moment of transition to the beginning of modern practices. The coming-of-age language again reflects this tendency towards positivist history. It implies a notion of development and maturity; the practice of studying the ocean only became a *science* at the time of the *Challenger* expedition. This is enhanced by the passive role the ocean plays, having knowledge made available through the expedition.

While the narrative represented by both texts is a dominant and recurring one in oceanographic textbooks, we also find some technical oceanography texts that fit Nye's concept of a counter-narrative. Nye contends that counter-narratives develop alongside the dominant progressive narratives and often emphasise the potential detriment produced by technologies. In the case of the *Challenge*r counter-narrative hones in on the limitations of technology as the cause of lack of scientific development. Scientist Henry Charnock's chapter "H.M.S. *Challenger* and the Development of Marine Science," is a good example of this counter-narrative. This chapter begins, "The existence of marine science is commonly believed to date from the great *Challenger* expedition which sailed in 1872…[but] in fact…marine science has grown gradually over the centuries, at rates depending on individuals and the environment in which they found themselves."[358] This text provides much of the same background information as the narratives previously mentioned, but the overall valence is significantly different. Charnock argues:

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357 Richard A. Davis Jr., *Principles of Oceanography*, Addison-Wesley, Massachusetts 1972, p.8.

358 Henry Charnock, 'H.M.S. *Challenger* and the Development of Marine Science', in *Oceanography: Contemporary Readings in Ocean Sciences*, Third Edition, ed. R. Gordon Pirie, ed., Oxford University Press, New York and Oxford, 1996, p.32.

> The *Challenger* expedition had magnificently justified the faith that many had put into it. There was only one serious gap – the physics of the sea had been relatively neglected. None of the scientific staff was a physicist and the observation had been left to the ship's officers, to whom they were an extra obligation. Perhaps the technology of the day was not quite ready, perhaps the problem was just too complicated.[359]

Here we see that although this text works against the dominant origin story of the *Challenger* it still includes a heavy emphasis on technology as the causal explanation for scientific advancement (or in this case lack thereof). The technology itself becomes the obstacle that prevents the acquisition of knowledge of the natural world that is still waiting to be revealed. So despite the shortcomings of the *Challenger* expedition to contribute to knowledge of the physics of the sea, technology is still regarded as the cause of scientific progress.

The internal history of oceanography is structured on a particular understanding of the relationship between technology and knowledge. Technological development, beginning with the technologies and techniques of the *Challenger*, is the main agent for gaining knowledge of the ocean. The ocean is an ahistorical object of study. The *Challenger* episode is fundamental to this reading of the ocean because it provides a historical coherence with the contemporary practices and knowledge from the field of oceanography today. This positivist history explains any and all changes in the knowledge of the ocean to the technological improvements that oceanographers have made over the twentieth century since the *Challenger*. They view the *Challenger* as a technology-driven narrative, where the development of technologies and techniques on board the ship revealed the true nature of the ocean.

[359] Charnock, 'Development of Marine Science', pp.38-39.

History of the Ocean

The *Challenger*'s true mark of modernity is its complete obfuscation of the long history of practices and knowledges from which it was conceived. It is the appearance of novelty and innovation, as opposed to the reality, which defines it as modern. In fact, although contemporary retellings of the expedition suggest that the history of oceanography (if not the history of the ocean itself) began with the expedition, the participants themselves, as well as the wider community of Victorian naturalists, perceived their position much differently.

Although the ocean has played a central role in modern history, there is a telling absence of a coherent history of the ocean. The ocean itself has played a myriad of roles in various sub-fields including maritime history, military history, Atlantic studies, and the history of science.[360] It is at once a geographical feature, a location, an adjectival setting, and a conceptual space. Sometimes it is an assumed ontological object, a material reality, and other times it is a metaphorical background. All together, these histories tell us that the ocean is an enigmatic, and fluid (pun intended), concept. Even the question of its objectivity – is it a single ocean or a world of oceans? – is contested. From these pluralities it is not easy to identify clearly what then is the history of the ocean. Some have suggested that the history of the ocean has yet to be written. Historians Bernhard Klein and Gesa Mackenthun have gone so far as to argue that modern history has established the cultural myth that, "the ocean is outside and beyond history, that the interminable, repetitive cycle

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[360] For recent examples see Jonathan Scott, *When the Waves Ruled Britannia: Geography and Political Identities, 1500-1800*, Cambridge University Press, Cambridge, 2011; David Igler, *Great Ocean: Pacific Worlds from Captain Cook to the Gold Rush*, Oxford University Press, Oxford, 2013; Ryan Tucker Jones, *Empire of Extinction: Russians and the North Pacific's Strange Beasts of the Sea, 1741-1867*, Oxford University Press, Oxford, 2014; and David Reidy, *Tides of History: Ocean Science and Her Majesty's Navy*, University of Chicago Press, Chicago and London, 2008.

of the sea obliterates memory and temporality, and that a fully historicised land somehow stands diametrically opposed to an atemporal, 'ahistorical' sea".[361]

This appearance of ahistoricity, the notion of a timeless and stable phenomenon, is itself a modern conception. Early scientific studies of the ocean, including the *Challenger* expedition, overwrote earlier histories of the ocean with their own conceptual understanding of it as a scientific space. They erased the ocean's historical past and replaced it by integrating scientific epistemology into the dominant conception of the ocean. And it is this view which has dominated our understanding of the ocean over the course of the twentieth and twenty-first centuries. This was achieved specifically by writing science into the long history of the ocean. Put another way, the construction of the ocean as a scientific space was founded in a reconstruction of a *new* history of the ocean – one with science at its core.

By contrast, the *Challenger*'s scientific staff viewed the ocean through a historical lens, both a history of the natural phenomenon as well as a history of man's (primarily European men's) understanding of it. The insistence, and persistence, of twentieth- and twenty-first century oceanographers that the *Challenger* marks the beginning of modern oceanography eliminates the context in which the expedition participants very prominently placed themselves. The significance of history is evident in how the scientific staff's work presented their own narrative of the expedition. The extended *Narrative* of the expedition opens with a detailed, if myopically European, history of man's relationship to the ocean:

> The sea and the life in its waters were little studied by the learned men of the ancient civilisations, which were clustered round the nearly tideless Mediterranean. Their sea-lore consisted in great part of wildly exaggerated descriptions of the more striking marine phenomena

[361] Bernhard Klein and Gesa Mackenthun, eds., *Sea Changes: Historicizing the Ocean*, Routledge, New York, 2004, p.2.

> woven into a vague mythology…The sea was not, so far as is known, made the subject of close attention until Aristotle brought his mind to bear on it in common with other departments of natural history.[362]

The parallels to the histories of modern oceanography are hard to ignore. Both present the ocean as an unexplored space which eventually becomes the object of study, heralding a new period of oceanic knowledge; but paradoxically, the original history becomes obscured by the modern one.

The historical survey presented in the narrative is selective, to say the least. Beginning with Aristotle, it then suggests that there was no interest in the ocean until Pliny the Elder in the first century AD who was concerned with oceanic animals, the depths of the sea, and the salinity of the water. From Pliny the narrative again jumps to Robert Boyle with the assertion that, "the Science of the Sea may be said to date from the seventeenth century", with the caveat that the discovery of the Americas in the fifteenth century brought the sea into greater prominence.[363] Along with Boyle's investigations into the salinity of seawater, it also mentions Hooke's interest in the depth of the ocean and Newton's interest in phosphorescence as examples of this new age of oceanic research. It suggests however that over the course of the seventeenth century as scientific enquiry turned towards specialisation "in the modern sense" marine research was ignored. It points to the fields of chemistry, geology, natural philosophy, natural history, and even nautical astronomy, as disciplines which

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[362] Tizard, T.H., H.N. Moseley, J.Y. Buchanan, and John Murray. *Report of the Scientific Results of the Voyage of HMS Challenger during the years 1872 – 1876 under the Command of Captain George S. Nares, R.N., F.R.S. and Captain Frank Turle Thomson, R.N. Prepared under the Superintendence of the Late Sir C. Wyville Thomson, Knt., F.R.S., &c. Regius Professor of Natural History in the University of Edinburgh, Director of the Civilian Scientific Staff on Board and now John Murray, One of the Naturalists of the Expedition: Narrative of the Cruise of HMS Challenger with a General Account of the Scientific Results of the Expedition, Parts I and II,* Her Majesty's Stationery Office, London, 1885, p.xxxi.

[363] T.H. Tizard, et. al., *Narrative*, p.xxxiii.

developed and evolved over the course of the century but which in turn excluded the ocean from their research programmes.[364]

According to the *Narrative* account, the eighteenth century saw a significant increase in the interest in the zoology of the ocean which went hand in hand with more accurate depth measurements. Unsurprisingly the narrative history dedicates the majority of its attention on the nineteenth century. In 1839 the British Association appointed a committee focused on marine zoology whose membership included Edward Forbes. The *Narrative* both praises Forbes for his contributions to oceanic research while also asserting that many of his findings were no longer accurate. His most valuable contributions to the field, it concludes, are not his data but rather his methods, of which the next generation of marine zoologists have been trained.[365]

In the mid-nineteenth century efforts to extend depth measurements coincided with several important expeditions including James Clark Ross's expeditions in the Arctic which included Joseph Hooker as assistant surgeon.[366] Measurements were made beyond 4,000 fathoms and dredges up to 400 fathoms. The *Narrative* continues to summarise the research of an international array of expeditions, among them American, Swedish, French and British voyages occurring between 1850 and the start of the *Challenger* expedition in 1872. The final part of this introduction addresses William Carpenter and Charles Wyville Thomson's participation on HMS *Lightning* and *Porcupine* and their subsequent advocacy for the *Challenger* expedition.

This *Narrative* introduction highlights an historical awareness that is rarely attributed to the *Challenger* participants. The rhetoric of origination and innovation that has come to dominate contemporary tellings of the expedition are absent, and in

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[364] T.H. Tizard, et. al., *Narrative*, p.xxxv.
[365] T.H. Tizard, et. al., *Narrative*, p.xxxix.
[366] T.H. Tizard, et. al., *Narrative*, p.xli.

their place we see much more emphasis on improvement, development, and continuity. Beyond this longue-durée historical account of the ocean, the scientific staff also viewed their expedition within a tradition of earlier maritime voyages and natural history. The staff maintained an impressive reference library on board the ship made up of previous voyage narratives (including narratives for the Astrolabe, Beagle, Dolphin, Herald, Fly, Rattlesnake, Samarang, as well as Bligh's voyages to the South Seas, Cook's voyages around the Pacific and Wallace's voyages to the Malay Archipelago), an extensive collection of natural history texts, and various other scientific texts covering astronomy, geology, geography, botany and mathematics. Well-known works included Darwin's *Ciripedia* and *Geological Observations*, Mivart's work on the Genesis of Species, and Lyell's *Principles of Geology* and *Element of Geology*.[367] This collection of texts highlights the dual aspects of history with which the scientific staff engaged: human history and natural history. As noted in chapter two, Lyell's work on geology had introduced a revolutionary new understanding of time in the natural world, thereby extending and transforming historical understandings of the earth. This both informed the research of terrestrial and marine-based natural history as well as guided new fields of inquiry. As the Royal Society posited ahead of the expedition:

> The investigation of various problems relating to the past history of the globe, its geography at different geological epochs, and the existing distribution of animals and plants, as well as the nature and causes of oceanic circulation, will be greatly aided by a more accurate knowledge of the contour of the ocean-bed.[368]

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[367] List of books for HMS *Challenger*, 20 December 1872, TIZ/25/3, NMM, Greenwich, UK.

[368] Unconfirmed meeting minutes of the Council of the Royal Society, 14 November 1872, JDH/1/14/1-5, Joseph Dalton Hooker Collection, Royal Botanical Gardens (Kew) Archives, Kew, UK.

This oceanic natural history, imagined prior to the expedition, became a fully formed scientific enterprise at the end of the nineteenth century. By the end of the century, it had not only become the dominant way of knowing the ocean, but it had supplanted humanity's history of the ocean in the popular imagination.

Conclusion: The Beginning of Modern Oceanography

The popularisation of the term *oceanography* was part of this modernising process. To use the term to describe oceanic research at the time of the expedition is anachronistic; at the time of the expedition the term was just beginning to appear in English-language media including newspapers and scientific publications. In the 1860s the rare use of the term referred specifically to tides and currents. Oceanography at this point was seen as tangential to meteorology; one source referred to it as "meteorology of the sea"[369] while another noted that they were similar in treating phenomena of the same order of magnitude.[370] During the expedition, the scientific work was described primarily through its disciplinary components rather than as a single approach. The purpose of the voyage was described to the President of the Royal Geographical Society as, "chiefly natural history, but also includes the determination of currents, and what might be termed sub-oceanic geography".[371] The term oceanography began to gain momentum in the 1880s, which not coincidentally was when the formal *Challenger* publications began to appear. The first appearance of the term in *The Times* occurred in 1885 in an announcement of publication of the

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[369] [no author], *The Edinburgh Review or Critical Journal for July 1866 – October 1866*, Vol. CXXIV, Longmans, Green, Reader, and Dyer, London, 1866, p.84.

[370] Joseph John Murray, *Habit and Intelligence, in Their Connexion with the Laws of Matter and Force: a series of scientific essays*, Macmillan and Co., London, 1869, p.211.

[371] W.J. Grandy, 'Letter presented at the Third Meeting, 9th December, 1872', *Proceedings of the Royal Geographical Society of London*, 17, 1 (1872), p.56.

Challenger Reports.[372] In the same year Franz Boas wrote a letter to the editor of *Science* as part of a wider debate over routes to the North Pole in which he stated, "this is not the place to treat of modern oceanography; and I can only refer to Thomson's and Carpenter's work".[373] Also in 1885, John Murray gave a lecture at the Annual Meeting of the British Association for the Advancement of Science on the subject of oceanography; the lecture was praised as "one of the most interesting features of the Aberdeen meeting".[374] This decade saw the marriage of the expedition and the concept of oceanography. After this point, the two became closely associated, and reference to one implied reference to the other. As such, the *Challenger's* reputation as an unprecedented scientific expedition was solidified and the field of oceanography came to be viewed as a modern science beginning only in 1872 at the start of the voyage.

The adoption of this new term distinguished the work and results of the *Challenger* expedition from earlier studies of the ocean. Techniques that had been applied and honed to deep-sea research over the first half of the nineteenth century soon became associated with the term oceanography, thereby dating them to the latter half of the century. And just as oceanography transformed the work of the expedition, at least in name if not in practice, the expedition had a similar effect on the term. By the early twentieth century the term oceanography no longer connoted simply oceanic physical geography, but encompassed a myriad of other scientific aspects of the ocean including tides, climates, and natural history, all of which had come together as the science of the ocean through the *Challenger* expedition. In this literal sense, the

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[372] [no author], 'The Challenger Reports', *The Times* (London, England), Friday, May 29, 1885; p.13; Issue 31459.

[373] Franz Boas, 'Mr. Melville's Plan of Reaching the North Pole', *Science*, 5, 112 (Mar. 27, 1885), pp. 247-248.

[374] Geographical Notes, *Proceedings of the Royal Geographical Society and Monthly Record of Geography,* New Monthly Series, Vol. 7, No. 10 (Oct., 1885), pp. 667-673.

Challenger expedition did mark the beginning of oceanography. Wyville Thomson argued, "the only means of acquiring a true knowledge of the rationale of the distribution of our present fauna, is to make ourselves acquainted with its history, to connect the present with the past"[375], but in essence this is also the way in which we must understand the HMS Challenger expedition and its legacy.

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[375] Charles Wyville Thomson, *The Depths of the Sea*, Macmillan & Co, London and New York, 1873 p.6.

CONCLUSION

> I have endeavoured, ladies and gentlemen, to give you some account of the cruise of the *Challenger* – of what she was sent to do, how she did it, and what results may be expected to flow from her observations…Any one of the subjects on which I have touched would have sufficed for a single lecture…A flood of light has been thrown on a vast region of the earth's surface about which before all was doubt, guesswork and ignorance…The *Challenger* has not robbed the ocean of all her secrets, but she has made captures for almost every branch of science. She has drawn a line of observations around the world, and through the deep sea, from which all future investigations must take their start.[376]
>
> - John Murray, Naturalist

When HMS Challenger set sail in late 1872, it left as the inheritor of long historical traditions in maritime expeditions and natural history practices; however when it returned in 1876 it had become something wholly modern. The ship's circumnavigation around the globe transformed the expedition into an emblem of modern science. Charles Wyville Thomson and his scientific staff understood their own work to be an important step in the progress of scientific knowledge of the deep sea; they employed and honed skills and techniques from earlier expeditions in order to penetrate and interrogate the ocean to depths never before reached. They observed and analysed specimens just as naturalists had done for centuries previously, but with new abyssal spaces they found specimens never even imagined, and they did it on board a ship specifically outfitted to facilitate such work. They recorded information in the tradition of Humboldt and his followers, and their exhaustive circumnavigation provided global data, something unachievable on briefer voyages. In short, while all

[376] John Murray, 'The Cruise of the Challenger. (second lecture)', p.139.

aspects of their expedition had precedents, the expedition as a whole was unprecedented.

HMS *Challenger*, as a transformed floating laboratory, became a transformative space. It facilitated a circumnavigation that connected diverse and distant geographical spaces into a coherent expedition, it allowed the scientific staff to conduct scientific research in virtually any locality, and it brought together various scientific and naval practices in order to construct knowledge of the deep sea. These spatial transformations extended far beyond the bounds of the ship. The expedition's research led to new understandings of the relationship between oceanic depths and biota and contributed to contemporary debates over geographical distribution of oceanic inhabitants and human races. Ultimately, these scientific findings were in concert with grander Humboldtian debates over the organisation of the natural world and the coherence of the universe.

Just as the heterotopic nature of HMS *Challenger* highlights the various interconnected, often overlapping – and sometimes apparently contradictory – aspects of the expedition, the history of the expedition complicates more general themes of scientific knowledge, cultural legacies, materiality and historical narrative. The expedition represents a moment in modern science, one in which traditions of practice were reconfigured into something which appeared wholly new. Yet, as this thesis has demonstrated, the grand narrative of a modern scientific circumnavigation is a mosaic of traditional practices, inherited knowledges, and collaborative work. The expedition does not mark the beginning of a new paradigmatic science, rather it represents a semantic rebirth of nineteenth century science into modern oceanography. Long histories were erased, and replaced by new modern narratives. The history of the ocean was rewritten, and a new scientific narrative, a natural history, was established.

The work of the *Challenger*'s scientific staff established the deep sea as a central component in the modern understanding of natural order. In doing so, they infused scientific thinking into the long history of the ocean, and concurrently bounded the ocean as a coherent object which could be investigated, and understood, through that science.

The configurations of the expedition provided new conditions of possibility in knowledge of the deep sea and the natural world. The heterotopic ship facilitated numerous simultaneous activities, all of which combined to constitute this modern moment. It produced new ways of thinking about the oceanic environment and its natural history; it combined a multitude of local engagements and interactions into a coherent voyage; it allowed for immediate analysis of deep-sea specimens, which resulted in new understandings of their constitution; it challenged conventions of natural history visualisation by introducing the unknown environs of the deep sea; it allowed the scientific staff to observe and theorise about the relationship between humans and the natural world; and it rewrote the history of the ocean.

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