comparative gaze of the naturalist. The eye that observes, compares, and contrasts is itself rarely visible. In this context, it is worthy of note that the published version of one of Smeathman's sketches of "turret nests" (*Termes atrox*) omits a miniature vignette of an observer—presumably, the naturalist himself—which was part of the original drawing (fig. 6.7). Written faintly in pencil on the original sketch are the words, "This group and the figure not to be engraved." We are tempted to attribute this editorial intervention to Joseph Banks, who had assumed the presidency of the Royal Society in 1778. Whether this was actually the case is hardly the point: there was only room for one presiding genius.

If the details of Smeathman's own biography and his career as a naturalist have slipped from the view of most historians, his sketches of tropical termitaries have taken on a life of their own. In particular, his representation of the habitations of *Termes bellicosus,* combining the composed picturesque scene, the dissecting analytical eye, and the synoptic landscape view within a single frame has been a lasting presence in the field of entomology. Hence, in a recent scientific paper celebrating "two hundred years of termitology," the *Philosophical Transactions* engraving was reproduced in a double-page illustration.[54] Copies and reworkings of Smeathman's cross-sectional views may today be found in numerous entomology textbooks and museum displays around the world.[55] The very sketches that were supposed to substitute the empirical for the symbolic have themselves become iconic representations of tropical nature. Where images of tropicality are concerned, pictures often speak louder than words.

⋆ 7 ⋆

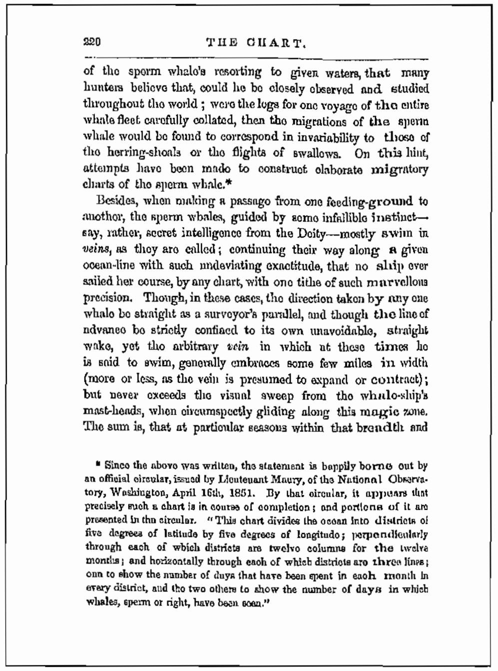
Matthew Fontaine Maury's "Sea of Fire": Hydrography, Biogeography, and Providence in the Tropics

D. GRAHAM BURNETT

Let me begin with a footnote. Sometime in the summer of 1851, Herman Melville inserted a last-minute addendum into the manuscript of his sprawling saga of man against beast—the book known variously as *The Whale, The White Whale,* and finally and forever, as *Moby-Dick.* This footnote fell in a key chapter, entitled "The Chart," where Melville takes on a (possibly the) central implausibility in his tale: How is it that Captain Ahab proposes to reencounter a single cetacean (albeit very large and strangely colored) in the vasts of the world oceans? What are the chances? This is no small matter, dramatically speaking: after all, the whole point of *Moby-Dick* is to tell the story of Ahab "chasing" the white whale. Yet this presents a serious problem: Just how, exactly, can one chase a whale?

Melville takes on the reader's skepticism in "The Chart." And his answer there casts the book's notorious protagonist in a curious new light. For in "The Chart," Melville shows us that Ahab, despite his surging, demonic passions, is a creature of incisive rationality, of methodical and empirical mind—in fact, this monomaniacal figure is, we discover, nothing less than a student of the physical geography of the sea and its denizens, a practitioner of some of the most sophisticated natural science of his day. I quote from the opening of the chapter:

> Had you followed Captain Ahab down into his cabin after the squall . . . you would have seen him go to a locker in the transom, and bringing out a large and wrinkled roll of yellowish sea charts, spread them before him on his screwed down table. Then, seating himself before it, you would have seen him intently study the various lines and shadings which there met his eye; and with slow but steady pencil trace additional courses over spaces that



220 THE CHART.

of the sperm whale's resorting to given waters, that many hunters believe that, could he be closely observed and studied throughout the world; were the logs for one voyage of the entire whale fleet carefully collated, then the migrations of the sperm whale would be found to correspond in invariability to those of the herring-shoals or the flights of swallows. On this hint, attempts have been made to construct elaborate migratory charts of the sperm whale.*

Besides, when making a passage from one feeding-ground to another, the sperm whales, guided by some infallible instinct—say, rather, secret intelligence from the Deity—mostly swim in *veins*, as they are called; continuing their way along a given ocean-line with such undeviating exactitude, that no ship ever sailed her course, by any chart, with one tithe of such marvellous precision. Though, in these cases, the direction taken by any one whale be straight as a surveyor's parallel, and though the line of advance be strictly confined to its own unavoidable, straight wake, yet the arbitrary *vein* in which at these times he is said to swim, generally embraces some few miles in width (more or less, as the vein is presumed to expand or contract); but never exceeds the visual sweep from the whale-ship's mast-heads, when circumspectly gliding along this magic zone. The sum is, that at particular seasons within that breadth and

* Since the above was written, the statement is happily borne out by an official circular, issued by Lieutenant Maury, of the National Observatory, Washington, April 16th, 1851. By that circular, it appears that precisely such a chart is in course of completion; and portions of it are presented in the circular. "This chart divides the ocean into districts of five degrees of latitude by five degrees of longitude; perpendicularly through each of which districts are twelve columns for the twelve months; and horizontally through each of which districts are three lines; one to show the number of days that have been spent in each month in every district, and the two others to show the number of days in which whales, sperm or right, have been seen."

FIGURE 7.1 A page from *Moby-Dick* (Rare Books and Special Collections, Princeton University Library, Princeton, NJ)

> before were blank. At intervals he would refer to piles of old log books beside him, wherein were set down the seasons and places in which, on various former voyages of various ships, sperm whales had been captured or seen.

Melville gives us to understand that Ahab pursues the white whale by calculation, using the tools of ocean biogeography: collating the data of previous voyages and correlating the patterns with the fluxes of the ocean system. Coming to the crux of the chapter, Melville continues:

> Now, to anyone not fully acquainted with the ways of the leviathans, it might seem an absurdly hopeless task thus to seek out one solitary creature in the unhooped oceans of this planet. But not so did it seem to Ahab, who knew the sets of all the tides and currents; and thereby calculating the driftings of the sperm whale's food; and, also, calling to mind the regular, ascertained seasons for hunting him in particular latitudes; could arrive at reasonable surmises, approaching almost to certainties, concerning the timeliest day to be upon this or that ground in search of his prey.

Now what are we to make of this? Literary license? A liberal greasing of a sticky spot in the plot? Some elaborate Melvillian allegory?[1] Enter the footnote of mid-1851 (fig. 7.1): "Since the above was written, the statement is happily borne out by an official circular, issued by lieutenant

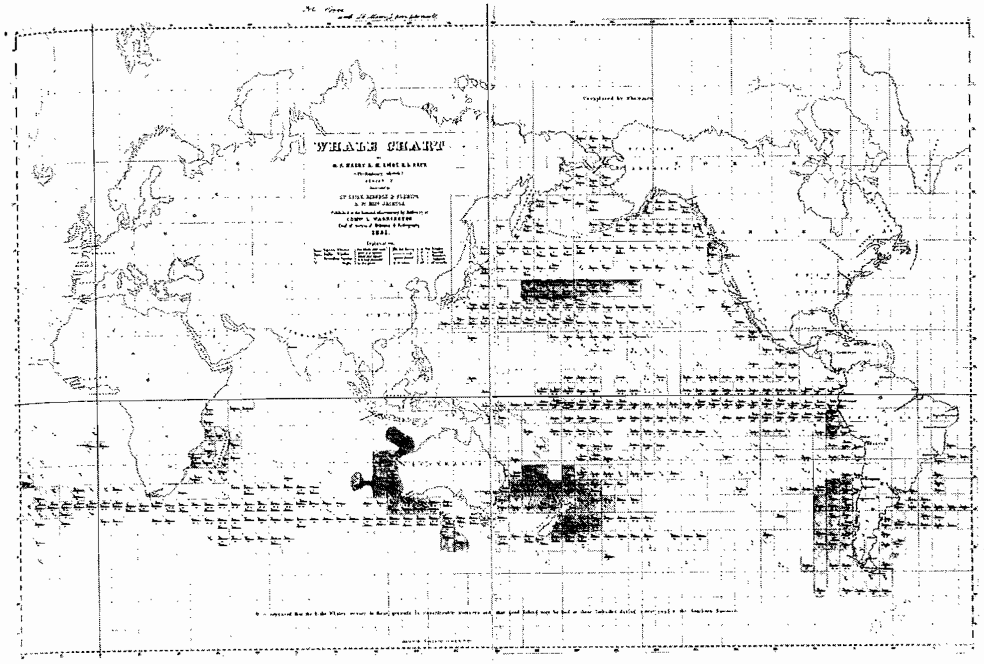


FIGURE 7.2 M. F. Maury, *Whale Chart (Preliminary Sketch)*, 1851 (Library of Congress, Washington , DC)

Maury, of the National Observatory, Washington, April 16th 1851. By that circular it appears that precisely such a chart is in course of completion; and portions of it are presented in the circular." Here, as elsewhere in *Moby-Dick*, fact and fiction perform an engrossing pas de deux. For this circular, and the maps it announced, were very real indeed. Figure 7.2 and plate 8 (a detail), reproduced from the collection of the Library of Congress, show the "Preliminary" Maury *Whale Chart* published later that year, 1851.[2]

I will return to these charts at the conclusion of this chapter, with the aim of showing not only how they were made but also what surprising relevance they have to the study of the tropics in the nineteenth century, to the history of Victorian exploration, and to the science of whales—cetology—in the period. But to get to these questions, I propose that we follow up on the footnote: Who was this "Lieutenant Maury," made immortal in the small print of the great American novel? In the next two sections, I take up the answer, offering an introduction to the life and work of Matthew Fontaine Maury, while sketching the significance of his scientific investigations. While these sections primarily review an existing biographical and critical literature, I go on to suggest the need for a

FIGURE 7.3 *Portrait of M. F. Maury*, ca.1853, Bendann Studio (Frances Leigh Williams, *Matthew Fontaine Maury: Scientist of the Sea* [New Brunswick, NJ: Rutgers University Press, 1963])

revised reading of Maury's accomplishments in light of recent work in the history of nineteenth-century science. In the third and closing section, I take up Maury's understanding of the earth's tropical zones. What meaning did he attach to this distinctive social and geographical space? This final investigation will, I hope, allow us to return to the whale charts with new eyes.

MATTHEW FONTAINE MAURY: THE LIFE

Matthew Fontaine Maury is, as it turns out, considerably more than an historical footnote, particularly in the history of science (fig. 7.3, portrait circa 1853).[3] In fact, he was probably the single most decorated American man of learning in the nineteenth century—feted by European scientific societies and a familiar of their royal patrons from London to Paris, Brussels to St. Petersburg. For what? For his work, over three decades, in the naval sciences, in meteorology, and—most important—in the nascent discipline that Alexander von Humboldt called (in a letter to Maury praising his innovative publications) "The Physical Geography of the Sea." Maury borrowed the coinage as the title for his synthetic and best-remembered book, published in 1855, and this landmark volume went though eight U.S. editions in six years, staying in print in England though perhaps nineteen editions, stretching well into the 1880s; in the meantime the book had been translated into most major European languages.[4] *The*

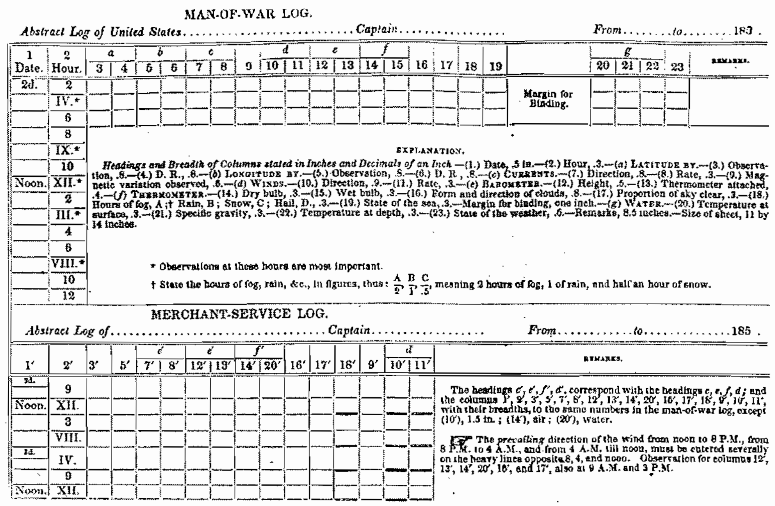
FIGURE 7.4 Naval observatory, ca.1845 (Charles Lee Lewis, *Matthew Fontaine Maury: The Pathfinder of the Seas* [Annapolis, MD: U.S. Naval Academy, 1927])

Physical Geography of the Sea has won for Maury an obligatory nod in any history of oceanography, a science that not infrequently invokes him as its "founding father"—particularly in the United States.

But the Virginia-born Maury, who hailed from a fallen-on-hard-times branch of a distinguished American family, was emphatically not a university man (pace his honorary degrees from Cambridge and elsewhere). Rather, Maury first investigated the winds, stars, and seas during his teenage years as a midshipman in the U.S. Navy in the 1820s, shooting lunar distances from the deck of one of the young nation's six frigates, his naval commission taken up in flight from hardscrabble farming in the hills of Tennessee. A country boy and autodidact, Maury's more sophisticated hydrographic interests grew with (and, to a degree, resulted in) his impressive suite of naval promotions: from sailing master to lieutenant, from there to superintendent of the Navy's Depot of Charts and Instruments, and finally to his most illustrious post, as the first superintendent of the U.S. Naval Observatory in Washington D.C. (fig. 7.4).[5] On his way up through the tumultuous rank-politicking of the peacetime post-1812 navy, Maury authored a significant treatise on the theory and practice of navigation, a text that became, by 1843, the standard reference work and teaching tool for both the navy and the merchant marine in the United States.[6] In addition, he published a several articles on navigation and instrumentation that appeared in the emergent American scientific periodicals of the nineteenth century.[7]

Maury's national and international standing probably reached its peak in the middle of the 1850s, during the watershed years of the steam-ship era, when he attained significant trans-Atlantic stature as a naval hydrographer-diplomat: his pioneering investigations of the seafloor produced some of the very earliest bathymetrical charts based on actual ocean soundings, and this work earned him the company (and patronage) of wealthy projectors scheming to lay the Atlantic cable (who were hungry for pictures of the submarine world, into which they were pouring good money).[8] At the same time, the observatory under his direction was churning out elaborate global charts of wind, current, rain, temperature, and the like.[9] In this flush, in 1853, he called for and led an international meeting in Brussels that drew together a dozen representatives of the hydrographic departments of world's major ocean-going nations, who convened to draft a uniform system for maritime meteorology. This meeting, and Maury's subsequent network of correspondents, placed him more or less at the center of what he would call "the most extensive system of philosophical observations, physical investigation, and friendly co-operation that has ever been set on foot."[10] For all the truth in the boast, the phrasing was infelicitous, since this global system of observation had hardly been "set on foot"; rather, it had been set on keel. As a result of Maury's promotional and centripetal energies, hundreds of ships under the flags of half a dozen nations were, by the mid 1850s, collecting information about oceanic conditions—observing position, water temperature, prevailing winds, barometric pressure, and a host of other physical characteristics of the sea—and inscribing these measurements in "Abstract Logs" (standardized by Maury and disseminated through the work of the 1853 Brussels Conference; fig. 7.5). These were then sent to the U.S. Naval Observatory, where Maury and his staff collated the information into thematic charts, made available to everyone who participated in his expanding network. As he put it: "Rarely before has there been such a sublime spectacle presented to the scientific world: all nations agreeing to unite and co-operate in carrying out one system of philosophical research with regard to the sea. Though they may be enemies in all else, here they are to be friends. Every ship that navigated the high seas, with these charts and blank abstract logs on board, may henceforth be regarded as a floating observatory, a temple of science."[11] Maury could turn a rousing phrase, which helps account for the popular success of his books about the sea. And he certainly had a capable grasp of self-promotion.

There remains some uncertainty about the real degree of international cooperation Maury achieved under this scheme. Hearn suggests that two hundred thousand copies of the *Wind and Current Charts* (and twenty thousand copies of the accompanying volume *Sailing Directions*) were distributed free to correspondents between 1848 and 1861 and that during the fifty years after the 1863 conference some 27.5 million abstract logs


274 PHYSICAL GEOGRAPHY OF THE SEA.

MAN-OF-WAR LOG.

Abstract Log of United States.......................... *Captain*................ *From*........*to*........183 .

1 Date. 2 Hour. *a* 3 4 *b* 5 6 *c* 7 8 9 *d* 10 11 *e* 12 13 *f* 14 15 16 17 18 19 *g* 20 21 22 23 REMARKS.

Margin for Binding.

EXPLANATION.

Headings and Breadth of Columns stated in Inches and Decimals of an Inch.—(1.) Date, .5 in.—(2.) Hour, .3.—(*a*) LATITUDE BY.—(3.) Observation, .8.—(4.) D. R., .8.—(*b*) LONGITUDE BY.—(5.) Observation, .8.—(6.) D. R., .8.—(*c*) CURRENTS.—(7.) Direction, .8.—(8.) Rate, .3.—(9.) Magnetic variation observed, .6.—(*d*) WINDS.—(10.) Direction, .9.—(11.) Rate, .3.—(*e*) BAROMETER.—(12.) Height, .5.—(13.) Thermometer attached, .4.—(*f*) THERMOMETER.—(14.) Dry bulb, .3.—(15.) Wet bulb, .3.—(16.) Form and direction of clouds, .8.—(17.) Proportion of sky clear, .3.—(18.) Hours of fog, A;† Rain, B; Snow, C; Hail, D., .3.—(19.) State of the sea, .3.—Margin for binding, one inch.—(*g*) WATER.—(20.) Temperature at surface, .3.—(21.) Specific gravity, .3.—(22.) Temperature at depth, .3.—(23.) State of the weather, .6.—Remarks, 8.5 inches.—Size of sheet, 11 by 14 inches.

2d. 2, IV.*, 6, 8, IX.*, 10, Noon. XII.*, 2, III.*, 4, 6, VIII.*, 10, 12

* Observations at these hours are most important.

† State the hours of fog, rain, &c., in figures, thus: $\frac{A}{2}$, $\frac{B}{1}$, $\frac{C}{.5}$, meaning 2 hours of fog, 1 of rain, and half an hour of snow.

MERCHANT-SERVICE LOG.

Abstract Log of.............................. *Captain*................. *From*...........*to*.............185 .

1′ 2′ 3′ 5′ *c′* 7′ 8′ *e′* 12′ 13′ *f′* 14′ 20′ 16′ 17′ 18′ 9′ *d′* 10′ 11′ REMARKS.

3d. 9, Noon. XII., 3, VIII., 4d. IV., 9, Noon. XII.

The headings *c′*, *e′*, *f′*, *d′*, correspond with the headings *c*, *e*, *f*, *d*; and the columns 1′, 2′, 3′, 5′, 7′, 8′, 12′, 13′, 14′, 20′, 16′, 17′, 18′, 9′, 10′, 11′, with their breadths, to the same numbers in the man-of-war log, except (10′), 1.5 in.; (14′), air; (20′), water.

☞ The *prevailing* direction of the wind from noon to 8 P.M., from 8 P.M. to 4 A.M., and from 4 A.M. till noon, must be entered severally on the heavy lines opposite 8, 4, and noon. Observation for columns 12′, 13′, 14′, 20′, 16′, and 17′, also at 9 A.M. and 3 P.M.

FIGURE 7.5 Abstract log (M. F. Maury, *Physical Geography of the Sea*, 2d ed. [1855])

had been turned in by seamen, with the Germans and the British leading the way (with 10.5 and 7 million, respectively).[12] On a preliminary investigation, however, these numbers do not inspire great confidence. My sense is that the vast majority of Maury's "floating observatories" were, in fact, U.S. ships.[13]

Nevertheless, the cartographic results of Maury's oceanic observational network cannot be overlooked: more than one hundred elaborate folio-sized thematic charts, published over more than a decade, collating millions of individual observations, printed in more than one hundred thousand exemplars, and used by ships under numerous flags. Perhaps the best proof of the importance of these researches lies in Maury's ties to the deep-pocketed world of international insurance finance, the maritime underwriters from Lloyd's of London to the Tontine Coffeehouse on Wall Street. These financiers saw in Maury's thematic charts the promise of safer shipping (as well as more rational risk assessment); they would remain his staunchest allies (and patrons) even as his career unraveled in the 1860s.[14]

Before turning to look at this charting work in greater detail, let me conclude this brisk biographical sketch by tracing Maury from his apogee down the unhappy slope to his demise. Even as his navigational texts and charts were winning him international kudos in the later 1850s, rivals and detractors at home were conspiring to undermine Maury's position as the celebrated "pathfinder of the seas." Nor was this opposition without its justifications. For many in the emerging university scientific establishment in the United States, Maury had become an impediment at best and, at worst, a national embarrassment. For there, at the helm of the "national" observatory (one of a mere handful of government scientific positions) stood a man best characterized—say, from the vantage point of a chair in natural philosophy at the University of Pennsylvania or the College of New Jersey (later Princeton University)—as an "Old Salt": an energetic hand with a sextant, yes; a man who looked good in a uniform, perhaps; and someone who could appreciate a carefully engraved nautical chart, fine; but not a proper "astronomer," not an astronomer capable of making original contributions to, say, celestial mechanics, or even capable of producing a star atlas to stand beside those of Greenwich or the Paris Observatory.[15]

This galled men like Joseph Henry (the head of the nascent Smithsonian Institution) and his ilk, the nucleus of the newly forming community of professional scientists in the United States: Alexander Dallas Bache (director of the U.S. Coast Survey), for instance, and Benjamin Pierce (professor of mathematics and director of the Harvard Observatory).[16] On top of the ire of these men of science, Maury's rapid promotions (at least in the eyes of rivals; he himself thought them rather sluggish), and his active career as a naval reformer-cum-gadfly (he was continuously writing thinly veiled anonymous attacks on naval bureaucracy and deadwood officer corps) had succeeded in earning him a slate of serious enemies in the navy as well, each of whom looked forward to seeing him descended. Not least of these was the "stormy petrel" himself, Charles Wilkes, Maury's predecessor at the Depot of Charts and Instruments and, subsequently, commander of the most elaborate scientific enterprise sponsored by the U.S. government in its first seventy-five years, the U.S. Exploring Expedition, or U.S. Ex. Ex.[17]

In the end, the opposition of Maury's scientific and naval detractors played no role in his spectacular fall from grace. It was the Civil War that would be his undoing. On 19 April 1861, shortly after the bombardment of Fort Sumpter, Maury learned that the State of Virginia had seceded from the Union. That night, in anguish, he gathered his belongings from the observatory, and prepared to cross the Potomac to return to his native state. The next morning he drafted his letter of resignation from the navy, a letter that his daughter would call, colorfully, but not falsely, "the death warrant to his scientific life—the cup of Hemlock that would paralyze and kill . . . his pursuit after the knowledge of nature and nature's laws."[18]

His service to the Confederacy over the duration of the war consisted of quixotic and ultimately futile efforts to deflect the naval dominance of the Federal forces. Maury experimented with mines and torpedoes and ran the blockade to seek ships and munitions in England but, ultimately, watched from the sidelines as his state and his scientific stature slid into ruins. A wanted man, he stayed away from the United States after the war, selling torpedo-building miniseminars to foreign navies, and toadying to Emperor Maximilian in Mexico as part of an abortive effort to found a "New Virginia" colony of southern irredentists in the Cordova Valley. Surviving Maximilian's execution in a popular coup (he had the good fortune to be in England at the time), Maury lived by his pen, supporting his family by authoring a shelf of popular school geographies, while living in exile (and much diminished circumstances) in London. Though he returned to Virginia at the end of his life, his scientific career was, by 1873 (the year of his death), a distant memory.[19] With this sense of the arc of Maury's life in mind, let us turn to a more detailed examination of his scientific career at its height, as well as recent assessments of the place of that career in the history of science.

MAURY'S WORK AND ITS SIGNIFICANCE

I focus here on Maury's charting and hydrographic activities at the Naval Observatory in the crucial decade of the 1850s. Working my way through these materials I have at times been struck with the sense that the whole of Maury's cartographic opus, for all its originality and scope, could almost be deduced from a pair of biographical facts: first, his rivalry with Charles Wilkes, the man who conducted the glamorous (if controversial) U.S. Exploring Expedition, 1838–42, and second, a personal disaster—the crippling stagecoach accident (on 17 October 1839) that cost Maury the normal use of his right leg for the rest of his life and, in doing so, ensured that he would never set sail on a ship in the navy again. Added together, these two merely human factors sum to a considerable problem: How could the proud and ambitious Maury rival his adversary Wilkes's global multiship scientific exploring expedition without being able to sail? How to rival Wilkes and the U.S. Ex. Ex. without ever leaving a desk job in Washington?

It is a testimony to Maury's distinctive tenacity that he actually solved this problem. The answer lay in maps, like those represented in figures 7.6 and 7.7. On taking up his position at the Depot for Charts and Instruments in 1842, just a few months after the return of the U.S. Ex. Ex., Maury became aware of the potential value of the depot's stash of old logbooks from both naval and merchant marine vessels. These logs contained the day-by-day geographical positions and wind observations for hundreds of thousands of miles of ocean voyaging. Maury set his staff of midshipmen to the laborious task of collating the information in these

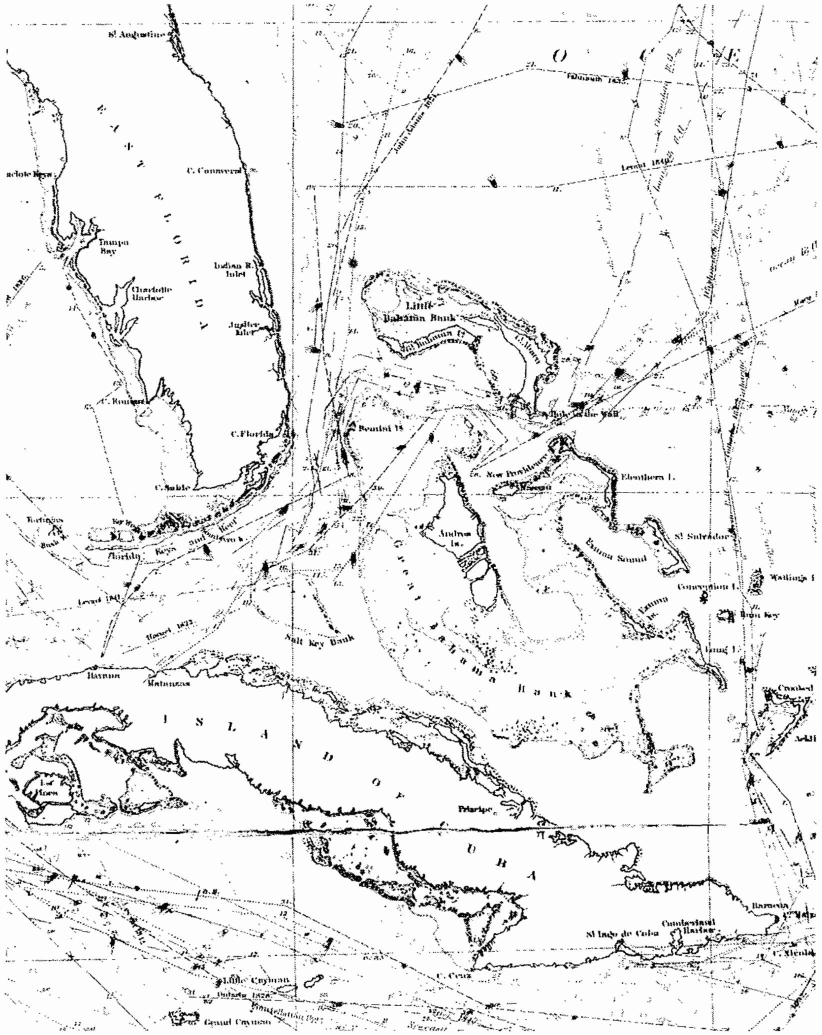


FIGURE 7.6 Detail from a track chart: Cuba and the Bahamas (Princeton University Library, Princeton, NJ)

logbooks, and the work took shape in charts like the one shown here, a detail from a much larger sheet depicting the central Atlantic.[20] It is difficult to communicate the magnitude of this operation. Over the subsequent decade, Maury's track charts, as they came to be called, spanned the entire globe in breathtaking detail—about forty large charts in all, recording the daily positions and wind observations of hundreds and hundreds of ships according to a seasonal color code; the Atlantic Ocean alone

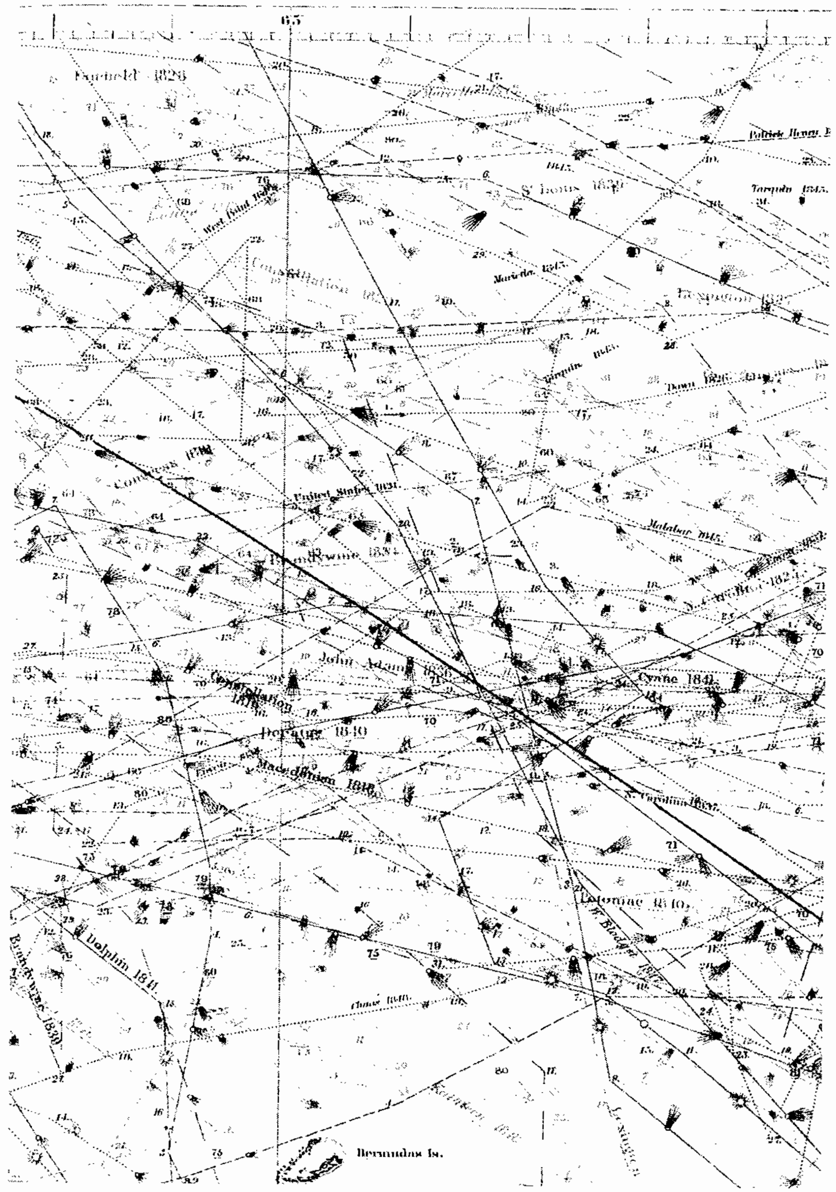


FIGURE 7.7 Detail from a track chart: Atlantic, north of Bermuda (Princeton University Library, Princeton, NJ)

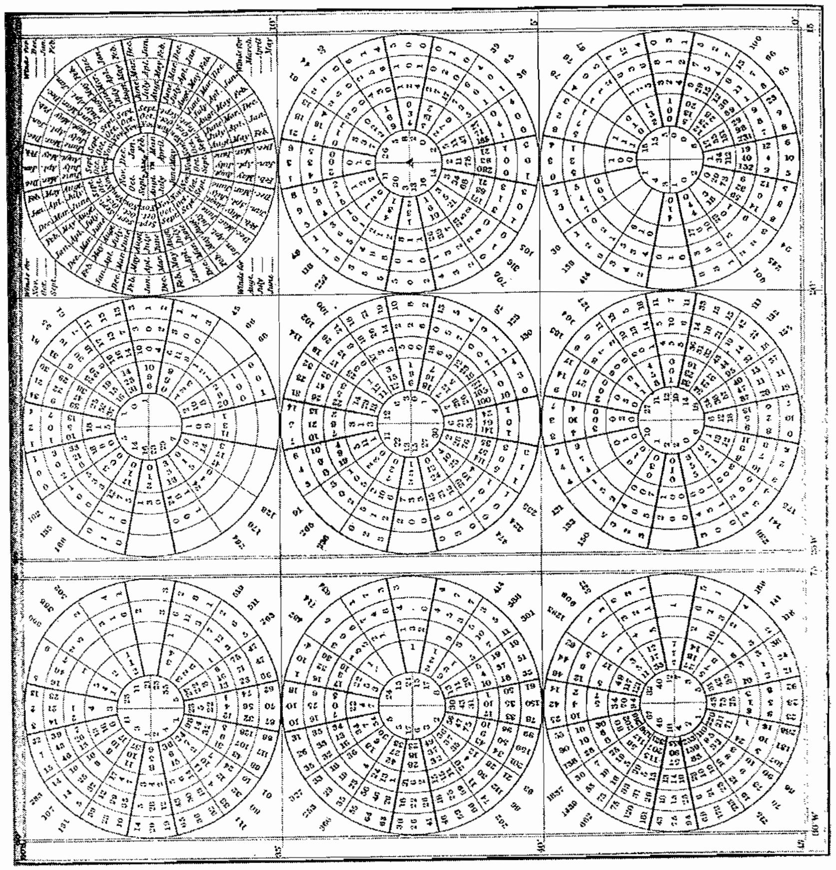


FIGURE 7.8 Example of the pilot chart (Princeton University Library, Princeton, NJ)

covered eight sheets that, if laid out, covered an area six feet high by eight feet wide. Paging through the folders of these charts offers a remarkable view of the early nineteenth-century maritime world.

This enterprise bore fruit rapidly: on completing the Atlantic coast track charts, Maury noticed that American captains running the popular New York to Rio route had a tendency to swing very wide toward Africa before picking up the Southeast trade winds and zigzagging back to the west. Rumor had it that dangerous currents and unfavorable winds hugged the eastern shore of the South American mainland, making the more direct route a perilous enterprise. Maury thought his track charts told otherwise. In 1848, Captain Jackson of the bark *W. H. D. C. Wright,* using Maury's directions, made the Rio passage in thirty-eight days from Vir-

ginia, shaving more than two weeks off the usual run. Then he repeated the feat on the return. Newspapers picked up the story, and Maury's charts became a maritime sensation.[21] Similar successes followed, particularly on the New York to San Francisco passage, which Maury claimed to have cut by almost 25 percent (from about 190 days)—no small affair in the age of California Gold rush.[22]

Maury next took on the task of codifying the wind observations included on the track charts: erasing the tracks and depicting only the winds—and in doing so abstracting the track-chart data into a kind of global wind computer. The result was what he called pilot charts (fig. 7.8). These again covered the world in extraordinary detail (about thirty charts in all, but in multiple editions, leading to probably double that number of sheets): in some regions these depict the oceans on a scale of a single degree to the inch.[23] One of the most interesting details of this series is the volvelle that Maury included on every chart as a computational aide to captains planning routes.[24] Lest this work seem arcane, it is worth recalling that Maury undertook these synthetic wind charts in the heady days of the final showdown between the power of sail and steam. The 1850s are remembered by maritime historians as the golden age of the clipper ships, those fastest of the fast sails, and the period saw numerous races staged to defend the honor of wind power on the high seas.[25] Maury was keenly aware of this rivalry and believed that his charts would save the age of canvas, writing in the first edition of the *Physical Geography of the Sea:* "The modern clipper ship, the noblest work that has ever come from the hands of man, has been sent, guided by the lights of science, to contend with the elements, to outstrip steam, to astonish the world."[26]

And Maury continued this cartographic project—squeezing the wind data—in two more documents that further abstracted and generalized atmospheric patterns: he called these the trade wind charts (or ser. B; figs. 7.9 and 7.10). Without delving into the minutiae of the B series, it is quite clear that Maury's interests in the winds and currents of the sea were growing more explicitly synthetic and, we might say, "theoretical" in the mid-1850s. Having now conducted a Wilkes-rivaling global exploring expedition of his own (one of unprecedented extent), having sailed the globe by proxy and pen for almost a decade, Matthew Fontaine Maury wanted to write up his results.[27] As he put it: "I find that the tracks of vessels are full of meaning."[28] And he took it as his mission to reveal and explain that meaning to a reading public.

At first this project took the form of textual addenda to the charts, a kind of longish key or legend to accompany them. These appeared as a separately published booklet in 1850, under the title *A Notice to Mariners,* but

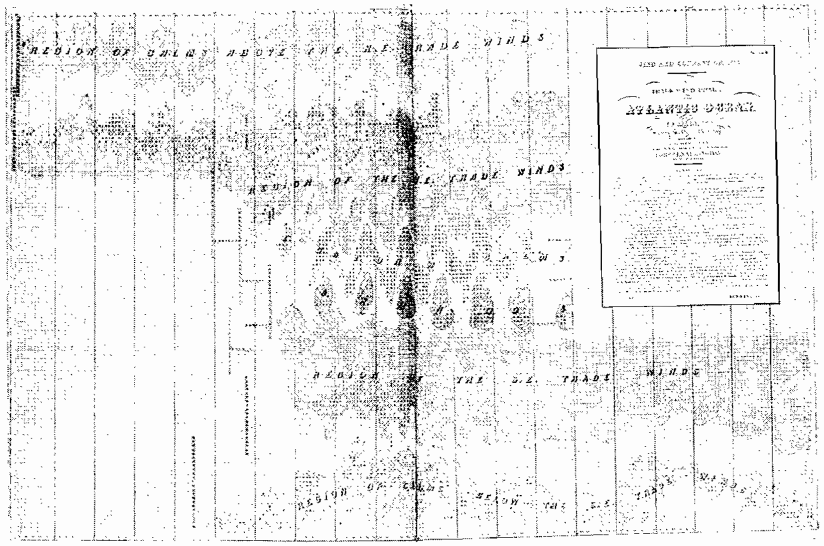


FIGURE 7.9 Detail from *Trade Wind Chart of the Atlantic Ocean,* ser. B (New York Public Library)

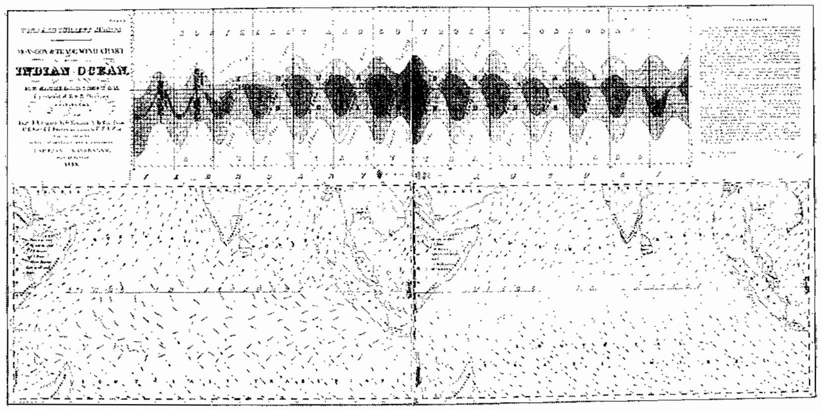


FIGURE 7.10 Detail from *Monsoon and Trade Wind Chart of the Indian Ocean,* ser. B (New York Public Library)

rapidly expanded to a 315-page book, *Explanations and Sailing Directions to Accompany the Wind and Current Charts* published in 1851, and this ballooned in subsequent editions, until by 1858 it was a two-volume, 1,300-page doorstop.

It was in these volumes that Maury tried not only to describe but also to explain the systems of global ocean dynamics that his charts had begun to show in spatialized and quantified form: the flows of currents, the sea-

sonality of winds, the fluxes of drifting tides. And it was from these books—increasingly unwieldy accretions of suggested sailing routes, physical-geographical ruminations, and hypotheses, all larded liberally with long citations from admiring correspondents—that Maury culled the material for his landmark text, the book I have already mentioned, and the book by which he remains best known: *The Physical Geography of the Sea.* This text is, when looked at closely, little more than a pruning of the best bits from the swollen *Sailing Directions.*

There are several things worth noting about this chain of textual composition and borrowing, since it is really quite remarkable that the volume widely considered foundational in the science of oceanography began life as a cut-and-paste redaction from an oversized naval almanac, itself a hypertrophied cartographic key. Part of what makes this so striking is that Maury seems to have rush-composed the shorter work that would secure his historical reputation out of anxiety that someone else would plagiarize his magnum opus to produce a profitable popular book on the seas; Maury wanted to beat them to the punch.[29] Historians of science have grown increasingly attentive in the past few years to the place of print culture in knowledge formation, and Maury's *Physical Geography of the Sea* offers a rich case study for an examination of these issues, linking as it does, print piracy, popular science, and discipline formation.[30] That his foray into science popularization became his most significant legacy, and thereby helped to define a field of scientific inquiry, dramatizes the danger of treating Victorian popular science as merely attenuated seepage from a well-defined domain of properly scientific activity; that the very success of the book eventually helped draw him away from scientific institutions, and into the life of a writer who made his living by the pen, reflects the complex conditions that birthed professional science and professional writing as twin offspring of the mid-nineteenth century, joined (perhaps) at the hip.[31]

Maury himself sought explicitly to marry the knowledge of nature and the knowledge of the masses. To understand how, we need to return to the program of his increasingly ambitious charts: What happened when he began to try to "make sense" of what his elaborate cartographic collations revealed? What was the "meaning" that he had (as he put it) "threshed" from the logbooks?

In brief, in those lines on the chart, in the wakes of the navy cutters, Maury found—God. Maury's "physical geography of the sea" fit firmly within the established tradition of natural theology, the project that exhorted the suitably devout natural philosopher to "look through nature up to nature's God."[32] For Maury—who worshiped regularly at St. John's Episcopal Church in Washington, D.C., but who embraced a Campbellite nonconformist brother and penned a fluttering, impassioned private devotion for sustenance in adversity—teleology and biblical apologetics retained a central place in the proper investigation of nature.[33] As he put it in *The Physical Geography of the Sea:* "The theory upon which this work is conducted is that the earth was made for man," and it followed from this that nature manifested divine intelligence in all its elements, from the stem of a snowdrop flower to the meridian transit of a bright star.[34]

Maury powerfully extended this familiar interpretive framework to the vast expanses of the open ocean.[35] He attacked this formless, empty, recalcitrant space, with the intention of showing that it was a precisely calibrated and complex machine, infinitely more intricate and better-regulated than the finest chronometer, with its own compensators, mainspring, cogs, and jewels.[36] And he exemplified this brilliantly, narrating with considerable poetry the fragile-yet-powerful, steady-yet-changing dynamics of the sea, the continuous circulations caused by variations in temperature, density, and chemical combination, the providential systems that supported the great "chain of being" dwelling in the depths. As he wrote toward the conclusion: "Now we do know that . . . [the sea's] adaptations are suited to all the wants of every one of its inhabitants—to the wants of the coral insect as well as to those of the whale."[37]

It is important to note that just because Maury made sense of nature according to the framework of teleological natural history (old-fashioned by 1858, even quaint), this in no way means that he was blind to quite sophisticated physical, chemical, and biological connections in the natural world—the sort of balances and webs we now think of as "ecological." In fact, if anything, Maury was predisposed to seek out such delicate and improbable global systems precisely because their very delicacy and improbability bespoke the glory of the "Architect of Creation." It might be worth underlining this point, since it has real relevance to any broader effort to assess Maury's place in the history of science—which turns out to be quite a contested matter. A brief detour into the historiography may be of use here.

In the early 1960s, several distinguished historians of science and geography took a look at Maury and reappraised his significance, considerably downgrading his stock in the history of the ocean sciences.[38] Schoolbooks might call him the founder of oceanography, they noted, but it was not at all clear that he merited the title: he was a popularizer at best, and an inferior student of the sciences of earth, sky, and sea. There is clearly some truth to this cold-eyed review of Maury's contributions to science in general and American science in particular, and it served as a necessary corrective to a line of Maury apologists and enthusiasts who tended to overstate his achievements, decking him out as a kind of Confederate Newton.[39] But at the same time this reassessment was rooted in a style of history of science particularly concerned to establish and trace the genealogy of the right answers to the hard questions about the natural order. Maury, to be sure, got most of the answers wrong: he thought magnetism was somehow involved in the circulation of the atmosphere, he thought that air streams "crossed" in the doldrums, and he thought winds did not really cause ocean currents. Moreover, to historians of science of a certain generation, Maury's extravagant natural theology went a long way toward demonstrating that he was not a true scientific innovator, that he was nothing like, for instance, everyone's favorite example of a mid-nineteenth-century scientific hero, Charles Darwin (who was Maury's almost exact contemporary—in fact, they quite literally "passed like ships in the night" off the Falklands in March of 1834).

But the past forty years of scholarship in the history of science have shifted our approach in a number of ways, enabling us to see Maury afresh, without resort to either Dixie hagiography or wheat-from-chaff threshing. Work like that of Susan Faye Cannon, Nicolaas Rupke, and Michael Dettelbach, for instance, has given us a better sense of the importance of Alexander von Humboldt in the first half of the nineteenth century, and there is certainly much to be said about Maury as an American Humboldtian (see chap. 1).[40] Equally important is a revised view of the durability, complexity, and significance of natural theological thought in the history of the sciences of matter, motion, and life.[41] The old story (crudely) was that the sustained study of the laws of nature—real science—emerged out of the progressive extirpation of "backward" and "blinkered" god talk: the less God, the more science. Such accounts—of conflict, maturation, and the overcoming of superstition—have now seen considerable reworking across a wide range of periods, places, and enterprises. In fact, looking more closely at certain contexts, it sometimes seems that, in profound ways, the emergence of something like science may well be entirely contingent on such god talk: facilitated by it, not hampered. How? Take Maury as an example: by the old view, Maury fails as a "real" proto-oceanographer to the degree that he indulges in natural theological reveries. But couldn't we argue precisely the reverse? By situating God at the helm of a vast sea-machine (precisely calibrated, meticulously regulated), Maury folded the oceanic environment into the realm of order and law. And this is no small thing, particularly in light of the deep Western tradition of depicting the ocean as the very opposite of order and reason, as a zone of darkness and chaos, a space behind God's back.[42] Taking this into account, we might say that only once the sea has been posited as a realm of divine beneficence, as a manifestation of God's rational plan for the cosmos, does it become possible to investigate it "scientifically," with some expectation of revealing its immanent logic.

In this view Maury's natural theological vision of the sea is not a blind ally in the history of oceanography but a legitimate, significant, and even, potentially, a constitutive episode in the history of the sciences of the sea. We can perhaps go even further, since Maury not only extended a metrical, collative natural theological framework to the dark spaces of the sea, he also extended a system of enlightening scientific observation to sailors, a notoriously benighted population.[43] Seen this way, it's possible to read Maury's *Physical Geography of the Sea* not as the failed theoretical overreaching of some sort of scientist manqué (very much the tone of several of the assessments from the 1960s) but, rather, as an extremely successful program for the moral reformation of the world's sailors through science. These tars and their officers would learn that the sea was a godly realm, and they would learn this through participating, by means of the careful use of instruments on board their ships, in nothing less than the collaborative revelation of divine order. Maury's network would transform them, turning them from hardened men of the bilge into what he called "contemplative" and "right-minded mariners."[44] If I am right about this, then *The Physical Geography of the Sea* has been significantly misunderstood, since by my argument it must actually be read as an extension of Maury's life-long work of naval reform. Improbable? Wrote one captain from the coast of Chile in 1855: "I feel that, aside from any pecuniary profit to myself from your labors, you have done me good as a man. You have taught me to look above, around, and beneath me, and recognize God's hand in every element by which I am surrounded."[45]

THE MEANINGS OF THE TROPICS

Let me turn then, in conclusion, to the questions that link *The Physical Geography of the Sea* to the theme of this volume and that will draw us back, in an ocean gyre, to *Moby-Dick*. What did Maury have to say about the tropics, and what were the implications for the history of exploration and the science of whales in the nineteenth century?

Maury was no stranger to the tropics. In his circumnavigation as a young midshipman in the U.S.S. *Vincennes*, 1827–30—traveling with among others, Herman Melville's cousin, Thomas—Maury ran down the Pacific line, with stops in Manila, Java, Sumatra, the Marianas, Macau, Hawaii, and perhaps most significantly, the Marquesas Islands, where he had a chance to inquire after his then-deceased older brother, John, who had lived for more than a year as a beachcomber on Nuku Hiva Island, the same island where Herman Melville, a few years later, would jump his whaling ship and live out the tropical romance that would lead to the novels *Typee* and *Omoo*. Maury thus lived the first American age of tropical adventurism, but what did he think about this region, what place did it have in his vision of the oceanic-atmospheric system? An important place, it turns out, and one that nicely illustrates the theme I have addressed in the previous section: Maury's maritime natural theology.

Take, for instance, this quote from *The Physical Geography of the Sea:*

> Modern ingenuity has suggested a beautiful mode of warming houses in winter. It is done by means of hot water. The furnace and the caldron are sometimes placed at a distance from the apartments to be warmed. It is so at the Observatory. In this case, pipes are used to conduct the heated water from the caldron under the superintendent's dwelling over into one of the basement rooms of the Observatory, a distance of one hundred feet. These pipes are then flared out so as to present a large cooling surface; after which they are united into one again, through which the water, being now cooled, returns of its own accord to the caldron. . . . Now, to compare small things with great, we have, in the warm waters which are confined in the Gulf of Mexico, just such a heating apparatus for Great Britain, the North Atlantic, and Western Europe. The furnace is the torrid zone; the Mexican Gulf and Caribbean are the caldrons; the Gulf Stream the connecting pipe.[46]

Maury elaborates this analogy at considerable length, but the thrust is clear and is reiterated throughout the work: the tropics serve as the furnace and caldron of the providential atmospheric-terraqueous earth engine.[47]

But the deeper meaning of this tropical cauldron lay, strangely, far to the north. To understand how, we must return to the footnote with which we began, to Maury's whale charts (fig. 7.2 and plate 8, the version of 1851; and fig. 7.11, the version of 1853). The whale charts—series F, the final set of documents in Maury's extensive cartographic enterprise—should now make more sense.[48] They were a product of the very same process—the collation of logbooks—that produced the pilot charts. Figure 7.12 is a graphic depiction of the process of logbook collation, and there is a full world map of this form, in four sheets, which is the final fruit of the F series. In this case, the logs hailed from a selection of the more than seven hundred U.S. whalers afloat around the globe, plying their trade.[49] And here, too, as in the study of the track charts, there were material advantages to be gained—Maury was quick to point out that the whaling industry not only employed thousands of American seamen but also drew up from the deep far greater value, he asserted, than all the gold of California. Better knowledge of whaling grounds was worth a fortune.

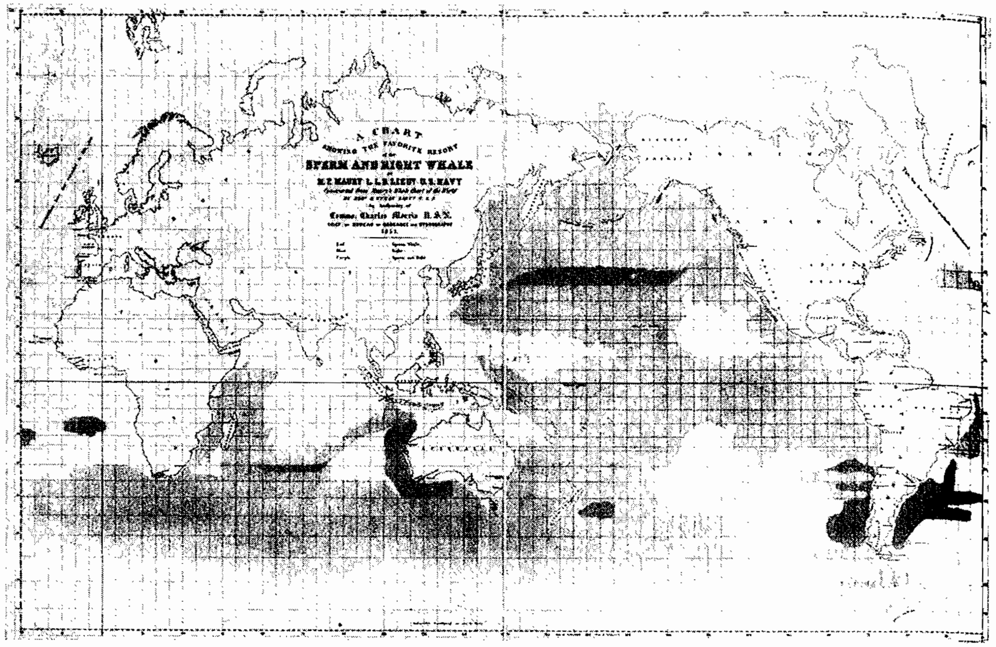


FIGURE 7.11 M. F. Maury, *A Chart Showing the Favorite Resort of the Sperm and Right Whale,* 1853 (Library of Congress, Washington, DC)

But as in the case of the track charts, there was more than merely practical knowledge to be gained from the threshing of the logs: there was hidden meaning, providential inscriptions written by the Creator in the workings of the sea system, and only legible through the painstaking cartographic collation that was the work of the observatory. Maury wrote: "Log-books containing the records of different ships for hundreds of thousands of days were examined, and the observations in them co-ordinated for this chart. And this chart . . . led to the discovery that the tropical regions of the ocean are to the right whale as a sea of fire, through which he can not pass, and into which he never enters."[50] So the tropical cauldron was apparently impassible to the right whale. Who cared? Well, this was, if true, a startling and significant discovery: after all, the pious whaling captain and man of science, William Scoresby Jr., had already shown (based on recovered harpoons) that whales struck in the North Atlantic were sometimes later taken in the North Pacific.[51] And this meant a remarkable chain of deductions could be forged: if right whales could appear on both sides of the Americas, but they could not cross Maury's equatorial "sea of fire," then, as Maury wrote, "we are entitled to infer that there is, at times at least, an open water communication between

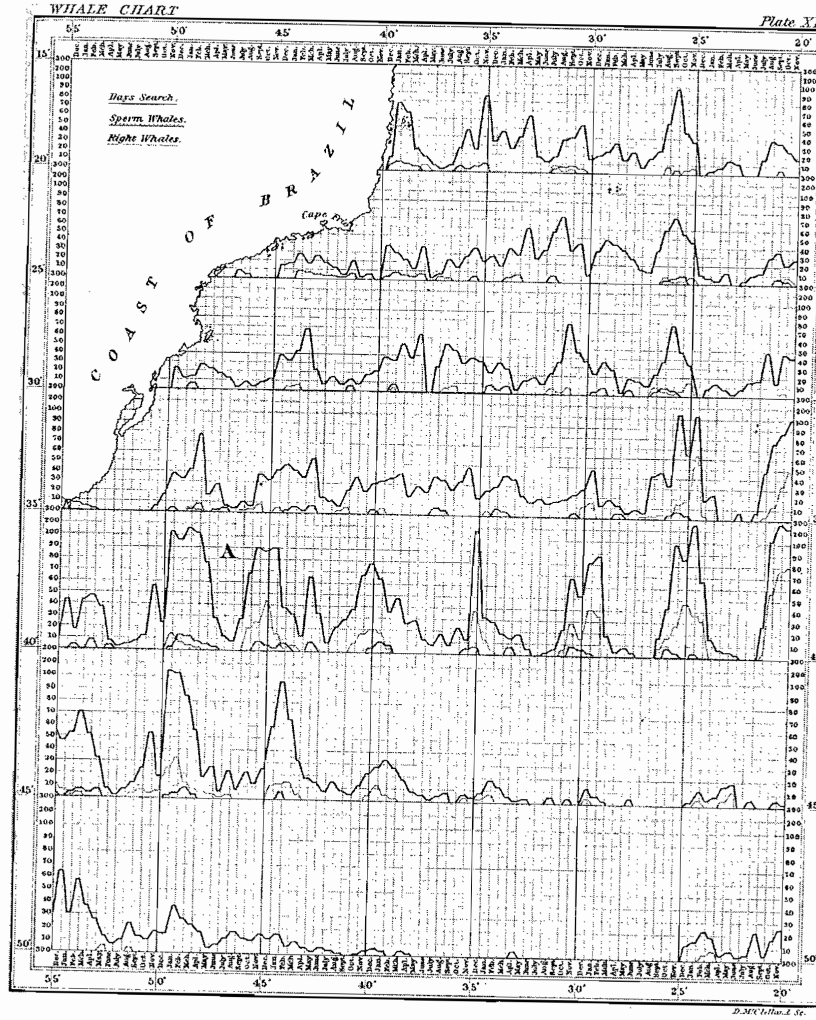
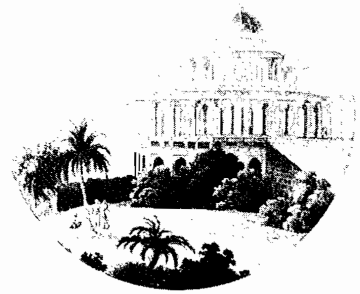


FIGURE 7.12 Whale chart, off the coast of Brazil, ser. F (Princeton University Library, Princeton, NJ)

these Straits [the Bering Strait] and bay [Baffin Bay]—in other words, that there *is* a north west passage."[52]

Here was Maury's providential geography in action, the apotheosis of his natural theological oceanic cartography. While John Franklin's bones whitened on the tundra, while his would-be savior, Robert McClure, made his ship fast to an iceberg in Mercy Bay and crossed his fingers, Matthew Fontaine Maury could claim already to have "discovered" the route they sought, discovered it by calculation, by reading between the lines of the godly sea system that he had carefully worked to plot and manifest and that he hoped would save souls in more ways than one.[53]

For Franklin, of course, it was too late, and—where souls are concerned—it is a testimony to Melville's impious genius for irony that his lost Ahab went spiritually astray hunched feverishly over a Maury-esque map of the physical and biological geography of the seas. But perhaps Maury, in the end, gets the last laugh: the logbook of Melville's own whaling voyage aboard the *Acushnet* disappeared more than a century ago, but not before it was abstracted for Mathew Fontaine Maury's whale charts. As a result, a precise record of the voyage survives, and it is now students of *Moby-Dick* who can unroll Maury's track charts and pursue the wanderings of Melville himself "in the unhooped oceans of this planet."[54]



SITES