THE LIFE AND PHILOSOPHY OF MATTHEW FONTAINE MAURY, PATHFINDER OF THE SEA[1]

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Let us now praise famous men, and our fathers that begat us. Ecclesiasticus 44:1.

"There is a river in the ocean: in the severest droughts it never fails, and in the mightiest floods it never overflows; its banks and bottom are of cold water, while its current is of warm; the Gulf of Mexico is its fountain, and its mouth is in the Arctic Seas. It is the Gulf Stream. There is in the world no other such majestic flow of waters. Its current is more rapid than the Mississippi or the Amazon, and its volume more than a thousand times greater." From The Physical Geography of the Sea by Matthew Fontaine Maury.[2]

It is a rather poorly understood fact that many of the founding fathers, of what we know today as modern science, were individuals who believed the natural world was understandable because the Creator endowed it with order and thus evidences the handprint of design.[3] *The accomplishments and philosophy of Matthew Fontaine Maury "pathfinder of the sea" and "father of modern oceanography" are little known today even in creationist circles. However, in the middle of the last century he was considered by many to be the foremost scientist in North America; and there was hardly a civilized country untouched by his work and reputation.*

The purpose of this paper is to document the life and work of Matthew Fontaine Maury, demonstrating that his allegiance to Scripture and his theistic world view were the basis for his outstanding achievement which revolutionized the science of oceanography and meteorology and significantly advanced astronomy.

Early Years

Born of staunch Huguenot ancestry in Spotsylvania County, Virginia, in 1806, Matthew Fontaine Maury was destined to become one of the world's foremost scientists of the last century. Early in life he was taught a deep and abiding respect for the authority of Scripture, a view which was to directly influence his life's work and color his future writing.

Fulfillment of his boyhood dream of following in his brother's footsteps as a Naval officer came true in 1825 when, as an acting midshipman, he was assigned to the new 44-gun frigate *Brandywine* being prepared on the Potomac for her maiden voyage. It was a memorable trip, not only because it was his first, but also because the ship's first assignment was to carry a very famous guest to France—the General Marquis de Lafayette.

This part of the mission completed, the *Brandywine* sailed for Gibraltar to join Commodore Rodger's Squadron, taking advantage of the relative calm of the area to ride out the winter. During this time the midshipmen were supposed to begin formal training as professional naval officers. Of this attempt however, the 19 year old Maury wrote that the teacher ". . . was well qualified and well disposed to teach navigation, but not having a school room, or authority to assemble the midshipmen, the cruise passed off without the opportunity of organizing his school. From him, therefore, we learned nothing."[4] It was from disappointing experiences such as this that Maury would later effectively argue for formal training of naval officers on either a teaching ship or a land-based naval school.

The ship returned to New York that spring and early in the fall set sail for South America, rounded Cape Horn, and took up patrol duties from its station at Callo Way, Peru.[5] Maury was soon transferred to the *Vincennes* also on patrol in the area. For the next two years his ship cruised the West Coast of South America. Again, formal training aboard the ship was a total failure, the school master finally being kicked off the ship as a nuisance.

Maury did not let the lost opportunity for formal education deter him from his quest for knowledge. The ship's library had a number of volumes on navigation and he set to work mastering them. For example, even while on duty he took advantage of spare moments to work problems in spherical geometry and often chalked them on the cannon balls stored in racks on the deck, thus considering the solutions as he paced back and forth.

After several years of patrol duty the Vincennes was ordered to strike west, visiting a number of small islands (including the Marquesas and Hawaii) on its way to Canton, China. It then sailed into the South China Sea, through the Sunda Straits and into the Indian Ocean on a course designed to bring it around the tip of Africa and thence home to New York. Arriving home on June 8, 1830, the Vincennes was the first U.S. sloop of war to circumnavigate the globe.

In 1831 Maury went before the Naval Examination Board to pass on his qualifications to become a warranted midshipman. Several of the candidates had prevailed on Maury to tutor them as they recognized his superior grasp of the theoretical and practical aspects of navigation. These individuals ranked high in the test, but Maury himself stood 27th in a field of 40. The reason was that instead of merely memorizing formulas for navigational problems posed by the mathematics professor on the board, Maury derived the solution using spherical trigonometry which the professor could not follow. In order to save face the professor declared the solution incorrect and a hastily called conference with his colleagues resulted in the board supporting the professor.[6] The result was that Maury passed the exam, but at such a low level that future promotion in major rank was delayed.

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Maury's next order from the Navy attached him to the sloop of war *Falmouth* as "acting sailing master." This position placed him second under the ship's commander and gave him direct responsibility for navigation, course steerage, sail trim, as well as a number of other supervisory tasks. Taking his newly assigned position seriously, Maury attempted to find information regarding winds and currents which the ship would encounter in her voyage to the West Coast of South America via Cape Horn. Finding to his amazement that such data did not exist, he determined to keep extensive and accurate observations on the upcoming voyage which might be of use to others. In rounding Cape Horn and encountering the usual furious weather in that vicinity, Maury noted the dramatic instability of the barometer and its uselessness in that region in forecasting approaching storms. Based on these observations he wrote the first scientific paper entitled " On the Navigation of Cape Horn", which was published in the *American Journal of Science and Arts.*[7] While on duty with the squadron patroling the Pacific coast of South America, Maury began his initial notes which were to become a textbook, replacing the time-honored, but poorly-written and out-of-date *New American Practical Navigator* by Bowditch,[8] introduced 30 years before.

Returning to the states in 1834, Maury married Ann Herndon. They made their home in Fredericksburg while he was awaiting further orders for sea duty. At that time it was not uncommon for a Naval officer to spend considerable time ashore between orders—in this case almost 2 years. During this period, with excess time on his hands, he pressed on in writing his book which was published in 1836 as *Treatise on Navigation.*[9]

The book received high praise from many individuals including Alexander Dallas Bache, who was later to become one of his most dedicated opponents. It was also reviewed by Edgar Allen Poe who praised its style saying, "The spirit of literary improvement has been awakened among officers of our navy."[10] By 1844 the book had become so popular and its worth so well established that it almost exclusively replaced Bowditch by order of the Secretary of the Navy.

Returning from a trip to Tennessee to visit his parents in 1839, Maury was riding on top of an overloaded stagecoach just east of Somerset, Ohio. As the stage rumbled along in the night, it encountered a newly built and still soft roadbed. The wheels on one side sank into the soft dirt, throwing the stage to the side. The frightened horses lurched ahead and the stage tipped over, throwing Maury to the ground. The result was a dislocation of the knee joint, a torn patellar ligament, and a fractured femur. It was soon painfully clear that return to sea duty was to be severely delayed, if not altogether forfeited. The anguish this brought to the budding young Naval officer so full of adventure and promise was immense. It was, however, this accident which resulted in his eventual assignment to a land-based position that was to place his name on the lips and charts of nearly every blue-water navigator in the world. It would catapult him to a position of prominence in the scientific world of which he could have scarcely dreamed.

During his convalescence, Maury turned his productive mind to writing an additional 7 articles under the pen name of "Will Watch" as a continuation of his 5 previously-published articles under the pen name of "Harry Bluff". These articles, revealing graft, corruption, and inefficiency within the navy, pressed for naval reform. Published in the popular *Richmond Whig* as a series called "Scraps From the Lucky Bag," they had immediate and wide-spread impact on the naval community, in political circles, and on the public at large.[11] The real author of these articles was soon revealed, providing fertile ground for the growth of animosity which was later to be revealed in the acts of the Navy Retiring Board.

In these articles Maury argued for an organized naval academy instead of the haphazard method then in existence for training midshipmen on board vessels using civilian instructors. He suggested that the curriculum should contain courses in chemistry, natural history, astronomy, mathematics, naval architecture, international and maritime law, gunnery, tactics, and languages. Maury's voice was not the only one calling for better training of officers and for general Naval reform, but it was clearly one of the most effective. The Navy has honored Maury as a major contributor to its effectiveness by naming a destroyer (1918) in his honor.[12] In addition, the main academic hall at Annapolis carries his name in recognition of his efforts that became a key factor in the origin of the Naval Academy.[13] Many other reforms espoused by Maury were put into effect during his lifetime, thus significantly improving the morale of seamen, the efficiency of the navy, and the state of military preparedness of the United States.

The Depot and the Observatory

Prior to 1842 the Navy Depot of Charts and Instruments was a quiet and unimaginative branch of the Navy, relatively unknown even in the U.S. except to the seamen who had direct need of its services. Thus when Maury became its superintendent in July of that year, it served a rather limited function. As a depot its job was to store the log books from every cruise of a U.S. naval ship since the Navy department was instituted. It also distributed charts for navigation—handling primarily those developed by other countries (especially England), as the depot had done little original work in this area even of U.S. shores and harbors. Its final major function was to set the time standard for both the Navy and the country at large. This was done by noting the time of the transit of the sun or stars through the field of its telescope. From this, calculations were made to determine precise time for the standard clock of the observatory; and from that, chronometers on hand were checked. The Depot acted as recipient for all navigational and meteorological instruments, including chronometers, sextants, barometers, and thermometers of navy ships returning from voyages and in turn supplied these items to ships leaving on ocean treks. While under possession of the Depot the instruments were checked for accuracy. For instance, chronometers were not adjusted because of their sensitivity; but their deviation from true time was noted, and this record was delivered along with the chronometer to departing ships. Thus, when Maury was appointed as superintendent, the Depot performed a rather routine function. Within a few short years under his direction, it was to become an institution of world-wide recognition.

Soon after his appointment Maury began to work through the piles of old log books, attempting to extract data that would be of use to navigators. Several minor charts were prepared, but the detailed and extensive charts that were needed could only be obtained by systematic collection of vast amounts of data on standard forms.

The year Maury was appointed head of the Depot, Congress appropriated sufficient funds to build a national observatory. It was completed in 1844 and the question of who should direct it became a hot political issue.[14] Maury was the natural one to head it as it was to incorporate the Depot in its function. Some argued, however, that a national observatory should be headed by a civilian. In the end Maury was chosen and the observatory became a U.S. Naval Observatory. This was another significant opportunity for Maury to advance science, and he soon took advantage of it.

Astronomical and Oceanographic Observations

One of the most famous studies afforded to the observatory was the observation of the return of Biela's comet which had just been reported by European astronomers. He instructed his aides to watch for the comet, which was soon found. A contemporary writer describes the event: "That night of January 13, 1846, he beheld the ominous and inconceivable. On its way toward perihelion, Biela's comet had split in two."[15] This significant observation, establishing the fragile and ephemeral nature of comets, was published under the title "Duplicity of Biela's Comet" in the English *Royal Astronomical Society Monthly.*[16]

Also in 1846 the Observatory produced Vol. #1 of *Astronomical Observations.* This was the first major work by an American observatory; and it produced considerable comment not only in the U.S. but also abroad, establishing the institution as equal to those in Europe.[17]

The following year the first *Wind and Current Charts* were published. These along with later volumes which were to revolutionize sailing, were published under Maury's directions. As example of their impact, the first ship to follow Maury's instruction on sailing to Rio de Janeiro was able to undertake a round trip voyage in 75 days, rather than the usual 110 days. By 1851, with the California Gold Rush at fever pitch, clipper ships were engaged in extensive commerce between New York and San Francisco by way of Cape Horn. Due to great competition between shipping companies and ship captains, the route was turned into a full-fledged race course; news of their departures and arrivals was a major topic of conversation on both coasts. With the aid of Maury's charts, their average trip time was reduced from 187½ days to 144½ days, and by 1855 to only 136 days. That year the *Flying Cloud*, using Maury's charts, was able to set a world's record for this journey of just a few hours under 90 days.[18]

By the end of 1851 over 1000 ships were turning in logbooks to Maury based on the guidelines laid down in his *Abstract Log for Use of American Navigators* in return for his *Wind and Current Charts.*

In a few short years three-fourths of the shipping of the world was carried out by captains using these charts, and they in turn provided more data for future charts. So valuable has been Maury's contribution in charting both ocean currents and winds that even today *Pilot Charts* carry the inscription "Founded upon the researches made in the early part of the nineteenth century by Matthew Fontaine Maury while serving as a lieutenant in the U.S. Navy." Maury thus soon became recognized as the world's foremost authority on ocean currents and marine meteorology.

Since 1840 he had been working on ideas relating to deep sea sounding and recovery of bottom sediments. In 1849 he began supervision of soundings in the Atlantic. Over the next few years he was able to construct the first accurate profile of the Atlantic ocean bottom, covering the 39th parallels between America and Europe. Later studies of the bottom sediments using sampling devices developed in the Observatory allowed him to show that sediments were composed of foraminifera and a few diatoms. The shells showed no sign of abrasion and no sand or gravel was present. Maury thus concluded there were no ocean currents at great depths and noted this would be advantageous for a possible transatlantic cable.

Even as Maury was completing this report to the Secretary of the Navy he received a letter from Cyrus Field asking about the very possibility of a transatlantic cable. Following this, Field consulted with Maury extensively as the project developed. Primary information supplied by Maury related to recommendations about the best time to lay the cable in view of the intense storms often encountered in the North Atlantic, the area of the ocean best suited for the project based on his discovery of the "Telegraphic Plateau", as well as recommendations regarding the nature of the cable itself and the actual laying procedure.

Thus, Maury, along with another Christian man of science, Samuel F.B. Morse,[19] played key roles in the development of the transatlantic cable. I have not had opportunity to research the availability of documentation regarding interaction between these two scientists, but it is interesting to note that Alexander Dallas Bache of the Coast Survey and Joseph Henry, secretary of the Smithsonian, were pitted against both Maury and Morse.[20]

Francis Leigh Williams provides some tantalizing insights into the attitude of Bache and Henry toward the Observatory and its superintendent.[21] Apparently they were fearful that the reputation of the Observatory would overshadow their own organizations and remove some of the national spotlight from them. Both Henry and Bache "held belief in their mission to establish a criterion for American scientists and their determination to deny authority to those who did not meet their criterion."[22] "Bache . . . conceived a messianic role in American science for himself and his 'elite corps' of friends—an idea shared by Henry."[23] An instructive sidelight is to note that Bache and Henry played a leading role in forming the National Academy of Sciences with the ultimate purpose that it should act as a "high tribunal" of science which would sit in judgment on others.

The Quest for International Cooperation

As the work of Maury proceeded at the Observatory, it became increasingly clear that there was great need for a system of uniform observations of meteorology and hydrography, producing results to be shared by all nations. To this end he worked toward an international meeting of ten of the major maritime powers. Overcoming monumental obstructions in its formation, Maury finally brought this meeting to pass in Brussels in 1852. Maury was the keynote speaker and clearly the leading figure in the entire international conference, probably a first of its kind. The conference resulted in unanimous agreement on the kinds of observations to be made and how they were to be recorded for processing. Maury returned home from the conference triumphant, having gained international cooperation on a project so dear to his heart. During the next 35 years, over 30,000,000 abstract logs, from many nations, were turned in to the observatory for development and revision of wind and current charts.[24]

Maury was always a man with a practical bent, believing that laymen could understand science and holding that the results of science should be conveyed to the populace. To this end in 1855 he published his first volume of *Physical Geography of the Sea.*[25] It and following editions provided the first popular textbook on marine science and were in print for over 20 years in at least 6 languages.[26]

Maury had long promoted the idea of Naval reform in many aspects of the service's operation. For example, it was clear that there were numerous ineffectual officers in the navy, some of high rank. A move was abroad to remedy this situation; and Maury lent his voice the cause. A Naval commission, called the Retiring Board, was instituted and at the end of their deliberations, several hundred officers were placed on Reserved List on leave-of-absence pay—Maury ironically was one of them. The Retiring Board had amongst its members a number of Maury's enemies who saw this as a chance to settle old scores. Using his lame leg as a pretext, these vindictive naval officers claimed he was unfit for active service, in spite of the fact that he was, in the same communication, ordered to continue his work at the Observatory.[27] This tragic decision was eventually overturned nearly three years later after a continuing outcry from newspapers, fellow naval officers, politicians, and the public at large.

The Civil War

As the years immediately preceeding the Civil War moved on, Maury not only continued his work at the observatory, but also began to travel widely, speaking to numerous local and national scientific societies and other groups interested in his work. One of his favorite themes during this time was urging a system of observation stations for collecting data on land-based meteorology. Agriculture and other commercial interests had often suffered greatly at the hands of the elements, and Maury knew well that weather generated over the open sea did not stop at the shoreline. He perceived the atmosphere as a universal integrated system and argued that its pattern on land could be evaluated in a similar fashion to what he had already accomplished with marine observations.

In the months before the War, Maury spent considerable time, both in speaking and in writing, trying to cool off the impending domestic strife and urging a number of plans for reconciliation between the North and the South.[28] Maury was not in favor of separation of the Union; but as state after state seceded, it became clear that there was little that could be done to save the South. The final blow came when his native state, Virginia, seceded. Remembering its open arms to his persecuted Huguenot forefathers, his loyalty dictated that he resign his commission in the U.S. Navy, give up the magnificent Observatory and all of the promise that the future held for scientific recognition and advancement, and join his native state in her fortunes, whatever they were to be.

Because of his national and international prominence, Maury was singled out by the North for special verbal attacks. The $3,000 price on his head was second only to that of Jefferson Davis.[29] A further step of mockery was taken by the National Academy of Science in January of 1864 when it passed a resolution that:

> "The volumes entitled *Sailing Direction*, heretofore issued to navigators from the Naval Observatory and the *Wind and Current Charts* which they are designed to illustrate and explain, embrace much which is unsound in philosophy and little that is practically useful, and that therefore these publications ought no longer be issued in their present form."[30]

It is difficult to imagine a statement more contrary to universally demonstrated and accepted facts, but the National Academy was clearly operating within its founding philosophy. I have not found documentation of any effect this had on the use of Maury's works; but the charts and directions were so well-founded and universally used that it is doubtful that any navigators would heed the advice of the National Academy, since their usefulness and accuracy had been such an important part of their experience on the high seas. Thus, the "high tribunal" could pass all the judgments it wanted but out on the blue water, and along unknown shores where all was at stake, navigators still turned to Maury.

During his time in the Confederate Navy he was responsible for developing the first practical electric mines (then called torpedoes) for marine warfare. However, since many of his former enemies had gone over to the Confederacy, his ability to assist the South was greatly hampered. Before the termination of hostilities, Maury was sent to England on diplomatic affairs for the Confederacy. Thus, at the end of the war he was not included in the general amnesty which excluded those who had been diplomats or agents of the Confederacy, those who had resigned their commissions to aid in the rebellion, and those who served the Confederacy above the rank of lieutenant in the Confederate navy.

During this time he used his influence with Maximilian in attempting to establish colonization of Mexico by dispossessed Southerners. He was given a cabinet post by the emperor, was made the Imperial Commissioner of Colonization, and was made Director of the Astronomical Observatory of Mexico. Seeing that the colonization efforts were destined to fail and sensing growing antagonism to Maximilian by the nationals, Maury returned to England.

When a general amnesty was issued that included Maury's circumstances, he was invited in 1868 to occupy the Chair of Physics at the Virginia Military Institute. Accepting the offer, he returned to his native state and proceeded in efforts to help rebuild the South. He produced a booklet entitled *Physical Survey of Virginia*[31] designed to aid in its reconstruction. While at the Virginia Military Institute he proposed the establishment of a polytechnic college before the Virginia Educational Association.[32] As a result, in 1872 the present Virginia Polytechnic Institute was opened in Blacksburg, Virginia. Though declining the offer, Maury was asked to become its first president.[33]

During this time Maury spoke widely; and it was due to a lingering illness produced by exhaustion from an extended speaking trip, that he died on Feb. 1, 1873. Thus closed the career of one of America's most colorful scientists of the last century.

Honors to Maury

In evaluating Maury's reputation, it is clear that in many respects he was held in higher esteem abroad than in his own country, reminding us that "a prophet is not without honor except in his own country."[34] A great many honors were bestowed on Maury. He was made an honorary member of a number of scientific societies including the Imperial Academy of Sciences of Russia, The Royal Academy of Sciences, Letters and Fine Arts of Belgium, and Associate of the Royal Astronomical Society of England as well as over 40 other societies at home and abroad. High honors of many kinds were received from a large number of countries including Denmark, Germany, Portugal, Belgium, Russia, France, (what is now) Czechoslovakia, and the Papal States. He also received the Gold Medal of Science and the Kosmos Medal from the King of Prussia. The latter medal was a source of pride to Maury as it was awarded at the request of the venerable Alexander von Humboldt, a veteran naturalist for whom the Humboldt current was named. His five-volume description of the physical universe was considered by some to be one of the world's greatest scientific writings, and there was probably no other scientist for whom Maury had a higher regard.[35]

Other honors awarded to Maury from academic institutions included LL.D's from Columbian College (now George Washington University) and the University of North Carolina and Cambridge University. During the Civil War he was offered a home, wealth, and a position of honor by Constantine, Grand Admiral of Russia. Louis Napoleon invited him to make his home in France under similar conditions.[36].

Recent vindication of Maury's competency as a scientist and of the enduring quality of his work comes in the form of the *Matthew Fontaine Maury Memorial Symposium on Antarctic Research*, published as Geophysical Monograph #7 by the American Geophysical Union. The opening address of the symposium includes these comments:

> "It is a pleasure to open this Symposium on Antarctic Research, named in honor of Matthew Fontaine Maury. It is fitting that this Symposium, based on results obtained by scientists of many countries, working harmoniously and fruitfully in Antarctica during and after the International Geophysical Year of 1957-58, should be dedicated to Maury—a pioneer in cooperative international studies on the oceans, the atmosphere, and the polar regions."

After surveying Maury's life and recounting his unsuccessful efforts to develop international cooperation in Antarctic research in the days immediately preceeding the Civil War, the speaker closes:

> "One hundred years later, sixty nations did pool their resources in a vast cooperative effort to study the Earth and its Sun and twelve of these participated in research in Antarctica. As Maury predicted, they would 'unbar the gates of the south' and each would become a '. . . fellow citizen in the great republic of human knowledge . . .' So today in this Centennial Year of Maury's proposal, as we gather here to listen to scientists of many nations describe their investigations of the atmosphere, ice, and geology of Antarctica, and the oceans surrounding this continent, let us continue with fulfillment of Maury's plea for concerted study of Planet Earth by all of its nations."[37]

Thus, in this one respect at least, Maury was a scientist clearly a century ahead of his time.

Maury's Writing Style

Maury's writing style was not universally appreciated either by his contemporaries or present day critics. Nevertheless Coker, in his introductory oceanography and marine biology text, *This Great and Wide Sea*, states:

> "The rhetorical aspect of his book . . . has been the occasion of comment, and perhaps sometimes disparagement. Although it is now the fashion in scientific writing and textbooks to be sparing of rhetoric (and sometimes, it would seem, to be wary of clarity), it can hardly be questioned that Maury's style of expression, combining rhetoric, clarity, and piety, was one of his most effective implements of trade."[38]

Of his *Physical Geography of the Sea* Coker continues:

> "His book is still well worth reading as a whole with the understanding that the facts and conclusions in many cases are not now acceptable in the light of subsequent and precise observations and of a far better understanding of many oceanic phenomena. A glance at the list of contents gives some indication of the comprehensive scope of his

work, as we see chapters upon the Gulf Stream, the atmosphere, the currents of the sea, the depths of the ocean, winds, climates, drifts, storms, etc."[39]

With regard to his writing style it should be noted that Maury did not write his *Physical Geography of the Sea* exclusively for academic scientists, but for the layman in general, perhaps with specific thought to young midshipmen. Scientific writing need not be dull and boring, but with some attention can be made to sparkle with life. Maury was clearly a master in this arena.

The Moral Influence of his Work

Modern scientific writing on any subject related to origins, both technical and popular, usually has, as an underlying motif, obeisance to the evolutionary hypothesis and its attendant moral and philosophical implications. The underlying theme of Maury's work was quite different. In speaking of his own work, he said:

"As great as is the value attached to what has been accomplished by these researches in the way of shortening passages and lessening the dangers of the sea, a good of higher value is, in the opinion of many seamen, yet to come out of the moral, the educational influence which they are calculated to exert upon the seafaring community of the world."[40]

The following excerpt of a letter to Maury from Captain Phinney of the ship *Gertrude* in 1855 illustrates the impact his writings had on one indiviudal.

". . . I am happy to contribute my mite toward furnishing you with material to work out still farther toward perfection your great and glorious task, not only in pointing out the most speedy routes for ships to follow over the ocean, but also of teaching us sailors to look about us, and see by what wonderful manifestations of the wisdom and goodness of the great God we are continually surrounded. For myself, I am free to confess that for many years I commanded a ship, and, although never insensible to the beauties of nature upon the sea or land, I yet feel that until I took up your work, I had been traversing the ocean blindfolded. I did not think; I did not know the amazing and beautiful combinations of all the works of Him whom you so beautifully term, 'the Great First Thought.' 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. I am grateful for this personal benefit."[41]

The *In Memoriam* published by the Virginia Military Institute upon Maury's death in 1873 evaluates the life of Maury as follows:

"The benefits conferred upon mankind by Maury cannot be measured by any estimate of their pecuniary value, great as that value may be. If we include the general gain to civilization, by increased facilities of communication between widely separated parts of the earth, we shall not then have the measure of his work. Ranking higher than these are the moral results of his teaching. The directions by which seamen were enabled to apply the principles and laws which his genius had wrought out of the the vast mass of material which, from all parts of the world, they spread before him, were accompanied by other teachings. Passionately devoted to the study of natural phenomena, seeing in all the guiding hand of the Creator, profoundly conscious of a Ruling Providence, he strove to convey to others knowledge of those things which filled him with admiration and joy—singing ever a song of praise; and by the power of this master mind was there awakened in the sea world a spirit of observation and research, a love of Nature, and a respect for God in His works and Majesty, which those unfamiliar with the sea and its affairs, may hardly be expected to understand."[42]

Design in Nature

Maury's philosophy of nature and his recognition of Scriptural authority and accuracy in those areas of natural science upon which it touches, is best seen by examining his work. Thus, the remainder of this paper will draw heavily upon his original material.

The concept of design and harmony in nature was prominent in Maury's thought, His speeches and writings, especially his *Physical Geography of the Sea* are liberally laced with frequent allusions to this subject. For example, in addressing the Virginia Historical Society regarding his experience in astronomical studies at the Observatory, he said:

"To me the simple passage through the transit instrument of a star across the meridian is the height of astronomical sublimity.

At the dead hour of the night, when the world is hushed in sleep and all is still; when there is not a sound to be heard save the dead beat escapement of the clock, counting with hollow voice the footsteps of time in his ceaseless round, I turn to the Ephemeris and find there, by calculation made years ago, that when the clock tells a certain hour, a star which I never saw will be in the field of the telescope for a moment, flit through and then disappear. The instrument is set;—the moment approaches and is intently awaited;—I look;—the star mute with eloquence that gathers sublimity from the silence of the night, comes smiling and dancing into the field, and at the instant predicted even to the fraction of a second, it makes its transit and is gone! With emotions too deep for the organs of speech, the heart swells out with unutterable anthems; we then see that there *is* harmony in the heavens above; and though we cannot hear, we feel the 'music of the spheres.'"[43]

In commenting on the unique proportions of the surface of the earth given over to land, sea and air, he suggests:

". . . if the proportions and properties of land, sea, and air were not adjusted according to the reciprocal capacities of all to perform the functions required by each, why should we be told that *He* 'measured the waters in the hollow of His hand, and comprehended the dust in a measure, and weighed the mountains in scales, and the hills in a balance?' Why did He span the heavens but that He might mete out the atmosphere in exact proportion to all the rest, and impart to it those properties and powers which it was necessary for it to have, in order that it might perform all those offices and duties for which He designed it? Harmonious in their action, the air and sea are obedient to law and subject to order in all their movements; when we consult them in the performance of their manifold and marvelous offices, they teach us lessons concerning the wonders of the deep, the mysteries of the sky, the greatness, and the wisdom, and goodness of the Creator, which makes us wiser and better men. The investigations into the broad-spreading circle of phenomena connected with the winds of heaven and the waves of the sea are second to none for the good which they do and the lessons which they teach. The astronomer is said to see the hand of God in the sky; but does not the rightminded mariner, who looks aloft as he ponders over these things, hear His voice in every wave of the sea that 'claps its hands', and feel His presence in every breeze that blows."[44]

The currents of the ocean were of particular interest to him and in these he saw strong evidences of design and purpose. Speaking of the Gulf Stream, first identified by Ponce de Leon in 1513 and crudely plotted by Benjamin Franklin in 1786,[45] Maury suggests:

"If the current of the sea, with this four-mile velocity at the surface, and this hundreds of tons pressure in its depths, were permitted to chafe against its bed, the Atlantic, instead of being two miles deep and 3000 miles broad, would, we may imagine, have been long ago cut down into a narrow channel that might have been as the same ocean turned up on edge, and measuring two miles broad and 3000 deep. But had it been so cut, the proportion of land and water surface would have been destroyed, and the winds, for lack of area to play upon, could not have sucked up from the sea vapors for the rains, and the face of the earth would have become as a desert without water. Now there is a reason why such changes should not take place, why the currents should not uproot nor score the deep bed of the ocean, why they should not throw out of adjustment any physical arrangement in the ocean; it is because that in the presence of everlasting wisdom a *compass was set upon the face of the deep; because its waters were measured in the hollow of the Almighty hand; because bars and doors were set to stay its proud waves; and because, when He gave the sea His decree that its waters should not pass His command, He laid the foundations of the world so fast that they should not be removed forever.*"[46] (emphasis his)

Of the sea and marine organisms he says:

"The inhabitants of the ocean are as much the creatures of climate as are those of the dry land; for the same Almighty hand which decked the lily and cares for the sparrow, fashioned also the pearl and feeds the great whale. Whether of the land or the sea, the inhabitants are all His creatures, subjects of His laws, and agents in His economy. The sea, therefore, we infer, has its offices and duties to perform; so may we infer, have its currents, and so, too, its inhabitants; consequently, he who undertakes to study its phenomena, must cease to regard it as a waste of waters. He must look upon it as a part of the exquisite machinery by which the harmonies of nature are preserved, and then he will begin to perceive the developments of order and the evidences of design which make it a most beautiful and interesting subject for contemplation."[47]

Maury believed that even when the principle of design was not readily apparent it was nevertheless of value to look for it.

"In studying the workings of the various parts of the physical machinery that surrounds our planet, it is always refreshing and profitable to detect, even by glimmerings ever so faint, the slightest tracings of the purpose which the Omnipotent Architect of the universe designed to accomplish by any particular arrangement among its various parts."[48]

Maury also wrote:

"He that established the earth 'created it not in vain; He formed it to be inhabited.' And it is presumptuous, arrogant, and impious to attempt the study of its machinery upon any other theory; *it was made to be inhabited* . . . The theory upon which this work is conducted is that the earth was made for man; and I submit that no part of the machinery by which it is maintained in a condition fit for him is left to chance, any more than the bit of mechanism by which man measures time is left to go to chance."[49]

This does not imply that he rejected apparent stochastic processes in nature. However, even behind what appears to be random events are subtle but all pervading laws which govern the entire process.

He goes on to say:

"In observing the working and studying the offices of the various parts of the physical machinery which keeps the world in order, we should ever remember that it is all made for its purposes, that it was planned according to design, and arranged so as to make the world as we behold it—a place for the habitation of man. Upon no other hypothesis can the student expect to gain profitable knowledge concerning the physics of the sea, earth, or air."[50]

Thus, the philosophy of order and design is seen by Maury to be not only all pervading in extent, but foundational in nature for a complete understanding of physical geography, and by implication, all of science.

Use of Scripture

Maury was severely criticized by some of his contemporaries for using Scripture in support of his scientific ideas. For example, Sir David Brewster said:

"It is now, we think, almost universally admitted and certainly by men of the soundest faith . . . that the Bible was not intended to teach us the truths of science. The geologist has sought in vain for geological truth in the inspirations of Moses, and the astronomer has equally failed to discover in Scripture the facts and laws of his science. Our author, however, seems to think otherwise, and has taken the opposite side, in the unfortunate controversy which still rages between the divine and the philosopher,"[51]

Maury, however, was firm in his conviction of the appropriateness of quarrying from Scripture all of the science it had to offer. His defense of Scriptural authority in scientific matters is perhaps best seen in the keynote address at the laying of the corner-stone for the University of the South in the Sewanee Mountains in East Tennessee on Nov. 30, 1860.

"I have been blamed by men of science, both in this country and in England, for quoting the Bible in confirmation of the doctrines of physical geography. The Bible, they say, was not written for scientific purposes, and is therefore of no authority in matters of science. I beg pardon! The Bible is authority for everything it touches. What would you think of the historian who should refuse to consult the historical records of the Bible, because the Bible was not written for the purposes of history? The Bible is true and science is true, and therefore each, if truly read, but proves the truth of the other. The agents in the physical economy of our planet are ministers of Him who made both it and the Bible. The records which He has chosen to make through the agency of these ministers of His upon the crust of the earth are as true as the records which, by the hands of His prophets and servants, He has been pleased to make in the Book of Life.

"They are both true; and when your men of science, with vain and hasty conceit, announce the discovery of disagreement between them, rely upon it, the fault is not with the witness of His records, but with the worm who essays to interpret evidence which he does not understand.

"When I, a pioneer in one department of this beautiful science, discover the truths of Revelation and the truths of science reflecting light the one upon the other, how can I, as a truth-loving, knowledge-seeking man, fail to point out the beauty and rejoice in its discovery? Reticence on such an occasion would be sin, and were I to suppress the emotion with which such discoveries ought to stir the soul, the 'waves of the sea would lift up their voices' and the very stones of the earth cry out against me.

"As a student of physical geography, I regard earth, sea, air, and water as parts of a machine, pieces of mechanism, not made with hands, but to which, nevertheless, certain offices have been assigned in the terrestrial economy; and when, after patient research, I am led to the discovery of one of these offices, I feel, with the astronomer of old, 'as though I had thought one of God's thoughts,' and tremble. Thus, as we progress with our science, we are permitted now and then to point out here and there in the physical machinery of the earth a design of the Great Architect when He planned it all."[52]

His view of the authority of Scriptures in areas of science was not just academic but found practical expression in the conduct and decisions of life. For example, Scriptures appear to have played a major role in his decision to study ocean currents and winds. After months of intense study of the old log books in the Observatory, he was convinced that accumulation of detailed atmospheric and marine data would enable him to produce entirely new and greatly improved charts and sailing directions. From years at sea he had seen the truth of Psalm 107 ("They that go down to the sea in ships, that do business in great waters; these see the works of the Lord, and his wonders in the deep.") Of this Williams says:

"As he weighed the proposal he would make, Maury later told his family, that verse came often to his mind but even more frequently the words of the 8th Psalm: 'Thou madest him to have dominion over the works of thy hands . . . and whatsoever passeth through the paths of the seas.' Those words convinced Maury that he was right in his belief that there were natural paths through the seas, even as there were natural paths through mountain passes, if man would but persist until he discovered them."[53]

"As our knowledge of nature and her laws has increased, so has our knowledge of many passages of the Bible been improved. The Bible called the earth 'the round world,' yet for ages it was the most damnable heresy for Christian men to say the world is round; and finally, sailors circumnavigated the globe, and proved the Bible to be right, and saved Christian men of science from the stake. And as for the general system of atmospherical circulation which I have been so long endeavoring to describe, *the Bible tells it all in a single sentence*; 'The wind goeth toward the South and turneth about into the North, it whirleth about continually, and the wind returneth again to his circuits.'"[54] Eccles. 1.6.

"Solomon in a single verse, describes the circulation of the atmosphere as actual observation is now showing it to be. That it has laws, and is as obedient to order as the heavenly host in their movements, we infer from the fact announced by him, and which contains the essence of volumes by other men, 'All the rivers run into the sea; yet the sea is not full; unto the place from whence the rivers come, thither they return again.'

"To investigate the laws which govern the winds and rule the sea is one of the most profitable and beautiful occupations that a man, an improving, progressive man, can have. Decked with stars as the sky is, the field of astronomy affords no subjects of contemplation more ennobling, more sublime or more profitable than those which we may find in the air and the sea.

"When we regard them from certain points of view, they present the appearance of wayward things, obedient to no law, but fickle in their movement, and subject only to chance.

"Yet when we go as truth-loving, knowledge-seeking explorers, and knock at their secret chambers, and devoutly ask what are the laws which govern them, we are taught, in terms most impressive, that when the morning stars sang together, the waves also lifted up their voice, and the winds, too, joined in the mighty anthem. And as discovery advances, we find the marks of order in the sea and in the air, that is in tune with the music of the spheres, and the conviction is forced upon us that the laws of all are nothing else but perfect harmony."[55]

Again, Maury states the importance of an understanding of the Scripture in attempting to interpret scientific data:

"I will, however . . . ask pardon for mentioning a rule of conduct which I have adopted in order to make progress with these physical researches, which have occupied so much of my time and so many of my thoughts. The rule is, never to forget who is the Author of the great volume which Nature spreads out before us, and always to remember that the same Being is the author of the book which revelation holds up to us, and though the two works are entirely different, their records are equally true, and when they bear upon the same point, as now and then they do, it is as impossible that they should contradict each other as it is that either should contradict itself. If the two cannot be reconciled, the fault is ours, and is because, in our blindness and weakness, we have not been able to interpret aright either the one or the other, or both."[56]

Conclusion

Matthew Fontaine Maury was clearly one of the outstanding figures in science during the middle of the 19th century. His dedication to the highest goals in science, his ability to collect vast quantities of data, his attention to detail and his commitment to the authority and accuracy of the Scripture. not only in his personal life but in his scientific work, may well serve as a pattern to contemporary men and women of science beset on every hand by secular and atheistic philosophies.

He has left to us an heritage of outstanding achievement, not only in science, but also in the successful integration of both natural and Biblical revelation. How different might have been modern science if his ideas and philosophies had not been largely swamped out by the impending Darwinism which was soon to engulf the Western World!

Acknowledgements

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The following abbreviations are used in the bibliography:

MFM = Matthew Fontaine Maury

FLW = Frances Leigh Williams, 1963 Matthew Fontaine Maury, scientist of the sea. Rutgers University Press, New Brunswick, New Jersey. This scholarly work must serve as a starting point for any serious study of Maury. In addition to nearly 480 pages of superbly written text, this volume contains almost 230 pages of documentation evidencing the highest standards in historical research.

PGS = Physical geography of the sea.

JWW = John W. Wayland, 1930, The pathfinder of the seas, Garrett & Massie, Inc., Richmond, Virginia.

[1]The phrase, "The Pathfinder of the Sea" is taken from the book entitled The pathfinder of the seas, by Wayland, John W., 1930. Garret & Massie, Inc., Richmond, Virginia.

[2]MFM, 1855. The physical geography of the sea and its meteorology, p. 38 ed. John Leighly. The Belknap Press of Harvard University Press, Cambridge, Massachusetts, 1963. This is perhaps the most famous quote from Maury and reveals his literary style. The editor's 20-page introduction to this recent edition is so totally negative regarding the value of Maury's work that it is difficult to understand why a publisher would consider reproducing it. It is interesting to compare Leighly's caustic criticism of Maury to the highly commendatory work of FLW.

[3]For an excellent short summary of the lives of Lord Kelvin, Robert Boyle, Johannes Kepler, Michael Faraday, Samuel F.B. Morse and James Clerk Maxwell see table of contents in Williams, Emmett L. and George Mulfinger, Jr., 1974. Physical science for Christian schools. p. XI. Bob Jones University Press. Greenville, South Carolina.

[4]MFM. May, 1940, Scraps from the lucky bag. *Southern Literary Messenger*. VI(4):315, cited by FLW, p. 56.

[5]JWW, pp. 173-183. Garrett & Massie, Inc., Richmond, Virginia. The chronology presented here is extremely helpful in sorting out the details of Maury's life. However, it is not completely accurate. For example, FLW (p. 62) provides convincing evidence that Maury sailed for Rio de Janeiro on Aug. 31, 1826 aboard the *Brandywine* rather than on June 10, aboard the *Macedonian*.

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[7]MFM, July, 1834. On the navigation of Cape Horn, *American Journal of Science and Arts*, XXVI, 54-63. Cited by FLW, p. 693.

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[11]See FLW, p. 701.

[12]JWW, p. 182.

[13]*Ibid.*

[14]See FLW, p. 157.

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[16]MFM, 1845-1847. Duplicity of Biela's comet. *Royal Astronomical Society Monthly Notices*. London, VII, 90-91. Cited by FLW, p. 702.

[17]Over the next 10 years at least 4 more volumes of this work were published, See FLW, p. 702.

[18]For a detailed account of reduction of sailing times attributable to Maury's works see FLW, pp. 190-195.

[19]For a brief account of the life of Samuel F.B. Morse see Reference 3.

[20]See FLW, pp. 167-175 and associated footnotes.

[21]*Ibid.*

[22]*Ibid.*

[23]*Ibid.*

[24]FLW, p. 221.

[25]MFM, 1855. The physical geography of the sea and its meteorology. Harper and Brothers, Cambridge, Mass.

[26]See FLW, p. 698 for complete list of reprints and editions.

[27]*Ibid*, 273-274 for the text of this letter.

[28]*Ibid*, 348-364.

[29]*Ibid*, 370.
[30]*Annual of the National Academy of Sciences for 1863-1864*, p. 60 cited by FLW, p. 472.
[31]MFM, Dec. 1869. Physical survey of Virginia. Preliminary report No. 1. W.A.R. Nye, Richmond.
[32]FLW, p. 656.
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[34]Matthew 13:57b.
[35]See FLW, p. 223 for a more detailed list of awards and the effect that Maury's reception of these honors had on Bache and Henry.
[36]Ibid. pp. 384-385, 428.
[37]Smith, Waldo, ed. 1962. *Matthew Fontaine Maury Memorial Symposium on Antarctic Research.* Geophysical Monograph #7.
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[41]*In Memoriam, Matthew Fontaine Maury,* LL.D. 1873. Proceedings of the Academic Board of the Virginia Military Institute, Lexington, Va., on the occasion of the Death of Commodore M.F. Maury, LL.D., Professor of Physics, in the Virginia Military Institute, pp. 21-22.
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[44]MFM, PGS. pp. 127-128.
[45]Tchernia, P. 1980. Descriptive regional oceanography. Pergamon marine series, Vol. 3. Pergamon Press, Oxford., p. 117.
[46]MFM, PGS. pp. 295-296.
[47]FLW, p. 261.
[48]MFM, PGS. p. 403.
[49]*Ibid.* p. 153.
[50]*Ibid.* p. 114.
[51]Brewster, Sir David (no date) *North British Review*, XXVIII, 434-435. Cited in PGS, p. XXVI.
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[53]FLW, p. 151.
[54]*The Holy Bible*, Holman's Edition, 1872. A.J. Holman and Co., Philadelphia.
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VARIATION AND THE FOURTH LAW OF CREATION

Colin Brown*

By the fourth law of creation, is meant that living beings remain within their kinds, although limited variation is allowed. Various aspects of this, one of the most important principles of biology, are examined in this article.

The law which governs the reason why species will remain within their kinds (what I mean is that descendants do not cross the boundary into a different kind from their ancestors) I have called the fourth law of creation. There are six other laws which I have been able to name and hope to discuss. The present one, while fourth in the order of things, is of such importance that it is worth discussing immediately.

The Fourth Law

When we look at the world around us we find that the plants and animals are very well adapted to their environment. How, we may ask, did this adaptation come about? Were these animals and plants first non-adapted; and did they later gradually adapt? No, these organisms had already within themselves adaptation, to a greater or less degree, to their environment.

Now consider the fossil record. Many plants and animals, represented by fossils, have also come through the corridors of time right up to the present day as living creatures; and they have changed only within their kinds, sometimes very little indeed. How and why should this be so? After all, even organisms which are well adapted to the environment cannot stop mutations from taking place. For the main sources of mutations are radiation from the sun and from the ground, and certain gases, elements, and other chemicals in the environment. (Incidentally, is there something already strange here? For, according to the usual geological time-table, mutations seem to have taken longer in the past. But according to physics the amount of radiation from radioactive minerals should have been greater in the past.)

Now these organisms could not have said: "Would you please stop the radiation? I don't need any more mutations. I am very well adapted. Thank you very much." No, the organism undergoes mutations willy-nilly; all it can do is try to cope with them. How?

As already mentioned, organisms are (and were) adapted to their environment. So only two types of mutation can take place:

(1): Mutations with lethal, or deleterious, effects, and

(2): Mutations that do not cause lethal effects in the functions of the adapted organism, but rather add to its adaptive variation.

Both of these types of mutation occur without reference to any future adaptation (i.e., they do not anticipate future needs); so any mutation, in a given environment, can be accepted only if it helps the organism in its adaptive role; and in so doing it therefore keeps the organism within its kind.

As for any damaging mutations, they are either:

(1): Removed by enzymes which remove the damaged or mutated parts and replace them with new material, or

(2): Any which get through to cause lethal or deleterious results will in time be eliminated. For the mutated line, being in an unfavourable position, will in time die out.

What if the environment changes? When the organism comes to cope with a change in the environment,

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