VIRGINIA'S CONTRIBUTION TO SCIENCE.

BY LYON G. TYLER.

It is probable that no one doubts the conspicuous part played by Virginia along certain important lines of activity. In government she took a leading part in the American Revolution, and was the capital of the Southern Confederacy. In politics, she was the headquarters for many years of the great Jeffersonian party, and though a slave State, she was for years the strongest exponent of the democratic principle. In war her population has shown a remarkable military spirit and the names of Washington, Scott, Taylor, Lee, Johnston, and Jackson easily stand preeminent among American generals. And in colonization not only were her presidents foremost in the extension of the national domain, but the South and West teem with the millions who are descendants of the early Virginia pioneers. Her association with Science and scientific men is not so well recognized.

There is a reason for this. Science—practical science—especially loves the crowded centers, where its activity may receive adequate reward, and rural occupations and a scattered population are not supposed to be conducive to scientific pursuits. Now, Virginia has been a land of counties and not of cities and towns.

Nevertheless, her records are not a sealed book. It may be readily admitted that science as a profession has not flourished, but in the knowledge which has come down to us there have been indications of a spirit in Virginia leading to invention and research which promises better things when population be-

comes denser and more compact. Especially in the case of the great immortals, who hold first place in the temple, her contribution to science has, I think, been in no degree mean or contemptible.

At any rate, I opine, a rapid review of the evidences of the scientific spirit in the history of Virginia, which is the object of this paper, may possibly not be without some interest or value to those who like to delve in the mysteries of the past.

Not so much is to be expected of the first century of settlement when the attention of the people was absorbed in the mere necessities of living. But in the latter part of the 17th century the inquiring spirit began to manifest itself especially along the lines of natural history. The new era begins with John Banister—a man whom I consider as the pioneer scientist. He was born in England, emigrated first to Jamaica and settled near what is now Petersburg, Virginia, as early as 1678, where he officiated as minister of the Church of England for the Parish of Appomattox, afterwards Bristol Parish. He was an ardent naturalist, and compiled a catalogue of Virginia plants, which is published in Ray's "*Historia Plantarum.*" He also contributed various papers to the *Philosophical Transactions* of the Royal Society. Among them "Observations on the Natural Productions of Jamaica," "Insects of Virginia," "Curiosities in Virginia," "On Several Sorts of Snails," and "Description of the Snake Root," in which he was probably the first to call public attention to the medicinal qualities of that plant. We know little in addition to his private history, except that he came to his death by a fall while engaged in pursuing his favorite researches in botany. His grandson, Col. John Banister, was one of the prominent Virginians of the American Revolution.

Contemporary with John Banister, but coming to Virginia at a later date was John Clayton, minister at Jamestown from 1684-1686. He was probably

a graduate of Oxford University, as there are several John Claytons among the Oxford matriculates which might be taken for this man. In May, 1686, he was rector at Cröxton at Wakefield in Yorkshire. He was a member of the Royal Society, and was a friend of Hon. Robert Boyle, the celebrated chemist, to whom he wrote from Jamestown, describing a remarkable instance of animal electricity and the fly called the fly-fly or "lightning bug." He was very fond of scientific studies and his reflections on Virginia, published in the *Transactions* of the Royal Society on his return, might have been made more valuable, but for his loss on the way thither, as he states, of all his "books, chymical instruments, glasses and microscopes." As it is, we are under great obligations to him for his description of Jamestown Island and of the climate, soil, animals and inhabitants of the colony. Some of his philosophic suggestions as to physical phenomena are rather amusing in the light of our present superior knowledge. In commenting upon the diseases in September, which were then very prevalent, and are now all but disappeared, he attributes them not to the troublesome mosquito, but to the change from summer to fall. Thus he writes: "That by the exhausting Heat and Ferment of the Blood raised too high and the Tone of the stomach relaxed, when the Weather breaks the blood falls, and like over fermented liquors, is depauperized, or turns eager and sharp, and there is a crude digestion, whence the named distempers may be supposed to ensue." Thunder in those days seemed to be considered a primal fact, and lightning was one of its qualities or attributes, and Dr. Clayton suggests to the learned Society for which he is writing that thunder, with its lightning, was probably identical with "a sulphureous, inflammable spirit," which he had often distilled from coal, by which I suppose he meant kerosene oil.

The early part of the 18th century was contemporary with a visit to Virginia of the great English naturalist, Mark Catesby, whose sister Elizabeth was the wife of Dr. William Cocke, Secretary of State of Virginia during the administration of Governor Alexander Spotswood. He remained in Virginia seven years from 1712 to 1719, and traveled extensively, and when he returned brought to England the finest collection of natural objects which is said ever to have been brought from America to that country at any one time. Subsequently, he spent four years in the Southern colonies, and in 1726 began the publication of his natural history of Carolina, Florida and the Bahama Islands, the figures etched by himself and colored under his supervision.

More distinctly to the manor was Robert Beverley, born about 1676, in Virginia, son of Major Robert Beverley, of Gloucester County. He was an active, enterprising man, planter, historian and naturalist—mainly historian, and the only historian up to that time in any of the colonies, according to Dr. Jameson of the Carnegie Institution, who had an original American spirit about him, but none the less a scientist who had a shrewd love of observing nature. Probably the most interesting chapters in his work, "The History of Virginia," published in 1705, are those relating to the natural history of the colony.

Succeeding him should be noticed William Byrd, born in Virginia, in 1676, statesman, scholar, student of nature, Fellow of the Royal Society, and the intimate friend of Charles Boyle, Earl of Orrery, the philosopher and statesman, and nephew of the great Robert Boyle. He built the present noble brick mansion at Westover on James River, and gathered about him the finest library on the continent. He wrote several very interesting tracts upon Virginia, which, I believe, are admitted to have no equal in colonial literature for grace of style and composition. In his letters and tracts, "The Dividing Line," and

the "Land of Eden," he makes valuable comment on the mineral, vegetable and animal products of the colony in words that scintillate with wit and humor.

Another name stands high in the list at this time—that of John Mitchell—by profession a physician. He emigrated to Virginia about 1700, and resided at Urbanna on the Rappahannock River. He devoted himself to botany and other scientific subjects, and discovered several new species of plants, one of which was called by Linnaeus in his memory "*Mitchella repens.*" His articles, published in the *Transactions* and in pamphlet form, discuss botany, the origin of color in races, the yellow fever and electricity. After remaining in Virginia for nearly half a century, he returned to England, in 1744, where he was made a member of the Royal Society, published a map of Virginia, and died in March, 1768.

But the glory of colonial Virginia in this field of natural history during the 18th century was John Clayton—not the minister of Jamestown of the same name, but another and quite a different person. He was son of John Clayton, the learned attorney-general of Virginia, and grandson of Sir John Clayton of Fulham in Middlesex, England. He was born at Fulham in 1685, studied medicine, and came with his father to Virginia in 1705. He was indefatigable in botanical researches. About 1723 he became clerk of Gloucester County, and held the post till his death, December 15, 1773, at the age of eighty-eight years. His office gave him leisure for studying the soil and atmospheric phenomena affecting the vegetation of the colony. He kept a botanical garden at his home known as "Windsor" on the Pianketank river, and from this garden and other sources he amassed a great number of plants, which he dried and forwarded to Gronovius, who, in conjunction with Linnaeus, published a list and description of them in Latin in a book which was called "Flora Virginica." This

work contained the first complete enumeration of the Virginia plants, one species of which was christened in his honor by Gronovius *Claytonia*, and is occasionally met with. He was a correspondent of many learned men and was also a Fellow of the Royal Society.

In the meantime, a new era was impending in the history of science throughout the world. The iconoclasm of Voltaire and Rousseau against the dogmatism of the churches and the authority of rulers gave a stimulus to freer thought everywhere. Benjamin Franklin enthused both Europe and America by his remarkable demonstration that lightning was identical with the electric spark. In Virginia, where the church never had much influence, speculation on all kinds of questions became rife. In 1756 Franklin visited Williamsburg, the little capital near Jamestown, and received from the College of William and Mary the honorary degree of Master of Arts. In 1758, Francis Fauquier, a devotee of the sciences and a Fellow of the Royal Society, arrived as governor, and the same year Dr. William Small came to Williamsburg as professor of mathematics and natural philosophy in the College of William and Mary. Fauquier and Small delighted in the society of young men, and at Fauquier's table, where Small was a constant attendant, the youths of Virginia—Jefferson, Page, Walker, McClurg—learned their lessons in the rights of man. Dr. Small introduced in 1760 the lecture system at the College, and Jefferson, by nature a scientist himself and no mean inventor, referred to Dr. Small as the man who "fixed the destinies of his life," and John Page eulogized him as "the illustrious professor of Mathematics, the great Dr. Small, of Birmingham, the darling friend of Darwin." In 1764, after a stay of six years in the colony, Small returned to England and took up his residence at Birmingham, where he had the society of the great English philosophers, who made that city the center of their life and labors.

Besides being "the darling friend" of Erasmus Darwin, he was the intimate friend of James Watt, and it was on his advice that Watt, in 1773, left Glasgow and came to Birmingham, where he formed a partnership with Matthew Boulton, the founder of the Soho Engineering Works. For it must be remembered that in 1763 by his famous development of the steam engine, Watt furnished the key to the new era mentioned, which was one of invention and not chiefly one of observation as hitherto.

Under the expanding wings of this new departure a society for the promotion of manufactures was founded, in 1759, in Williamsburg, which was authorized by the general assembly to offer bounties for discoveries and improvements, and in May, 1773, a Philosophical Society—known as "THE VIRGINIA SOCIETY FOR THE PROMOTION OF USEFUL KNOWLEDGE" was established, of which the venerable John Clayton, of "Windsor," the botanist, was president, and John Page, of "Rosewell," was vice-president. Page, who was lieutenant-governor under Patrick Henry and afterwards governor, spent much of his time in scientific investigations. He invented an instrument, by which he measured the fall of dew and rain to the 300th part of an inch, and claimed that his invention was the first of its kind ever used in America—perhaps in the world; and at his residence on the York, he calculated an eclipse of the Sun. As early as 1779, fifty years before Michael Faraday's wonderful experiments, in a communication published in the American Philosophical Society's Transaction, he suggested the identity of magnetism with electricity. His neighbors called him John Partridge after the noted Almanac maker in Scotland. There is preserved in the Virginia Historical Society a gold medal presented to John Hobday, of Gloucester County, by this Virginia society of science, for his invention of an improved method of threshing grain by horse power.

I have touched somewhat in detail upon these early manifestations of the scientific spirit in Virginia, and the rest of my article must be of a more general character. As we all know, invention and discovery came to its flower in the 19th century, and most important in the list of the early post revolutionary characters was James Rumsey, who though a native of Maryland, was a citizen of Virginia, and spent the active part of his life in that Commonwealth. He lived at Shepherdstown on the banks of the Potomac, where he was manager of a saw mill and superintendent of the Potomac Company, of which Washington was a member. Although, as has frequently happened in other cases, there were others to precede him, these were Europeans, and as an American he was the first in the country to construct and navigate a boat by steam. In this noble experiment he also greatly improved upon his European predecessors. His first boat was fifty or sixty feet long, drawn to a point at both ends and worked by a steam engine, which forced water through a pipe out at the stern. He privately tested his boat in 1786, and gave a public demonstration of its value at Shepherdstown in 1787, when the novel sight of a boat moving through the water against the current of a river at the rate of four or five miles an hour, was witnessed by many persons, including Horatio Gates. Rumsey obtained patents for his invention from the legislatures of Virginia, Maryland, and New York, and in 1788 the Rumsey Society was formed in Pennsylvania, of which Benjamin Franklin was a principal member. He then went to Great Britain, where he demonstrated the utility of his plans to the Society of Arts in London, and procured patents from the British government for his steamboat and for various improvements in steam-engines, pumps, boilers, and mill machinery. In spite of all kinds of pecuniary embarrassments he successfully constructed a new boat of about double the length of his American steamer, and, after private

trial, made preparations for its public exhibition on the Thames. But after all the burdens borne, and on the very eve of triumph, a stroke of apoplexy intervened between him and all earthly glory. On the evening of December 20, 1792, he delivered an eloquent lecture before the committee of mechanics of the Society of Arts on the subject of hydrostatics, at the conclusion of which, while engaged in wording resolutions to be entered in the Society's book, he was taken with a violent pain in the temple. He became speechless and expired the next evening. Some few weeks later his boat was tried on the Thames, and according to the notice in the *Gentleman's Magazine* attained a speed of "four knots an hour."

Rumsey had a close second in John Fitch, who contested his claim to precedence, but as far as I can understand the evidence, it appears conclusive in favor of Rumsey. He was backed by Washington, Jefferson, Franklin, and Benjamin Rush. The last named, in 1788, eulogized Rumsey's moral character, and represented Fitch as a man "equally known for plagiarism in philosophy and a licentious opposition to our constitution"—which opinion of Dr. Rush is a delightful instance of the mingling of politics with science. Though Rumsey's steamboat never came into practical use, he paved the way for Fulton; and several of his inventions survived in one modified form or another; as for instance the tubular boiler so superior to the old tub or still boiler in the presentation of fire surface and capacity for holding rarefied steam. One of Rumsey's patrons was Thomas Jefferson, who succeeded Franklin as President of the American Philosophical Society. In the vast variety of objects which engaged his astonishing genius, philosophy held no insignificant place, as is abundantly shown by his famous *Notes on Virginia* and his numerous letters to men of science. It was something to defend America triumphantly from the charge

of the Abbé Raynal of the degeneracy of the man of Europe transplanted to America, and something more to confound the naturalist Buffon with his superior knowledge on a question of natural history and force the admission from the French philosopher that he should have consulted the Virginian before publishing his work, "so as to be sure of his facts." He invented a plow, a hemp brake, a pedometer, and a copying press.

The name James Madison was rendered doubly distinguished at this period in being the common possession of the illustrious "Father of the Constitution" and of his cousin once removed, the First Bishop of the Episcopal Church of Virginia and first President of the College of William and Mary after the American Revolution. The latter held the chair of natural philosophy in William and Mary College and was a worthy successor of Dr. William Small. He was an ardent friend of the American Revolution, and so strong a champion of free principles that it is said of him that in his sermons he would never speak of "the kingdom of Heaven," but of "that great Republic where there was no distinction of rank and where all men were free and equal." Doubtless his introduction in co-operation with Mr. Jefferson of the elective system of study at William and Mary, in 1779, was an expression of this feeling. He had the use of extensive apparatus selected by Dr. Small in London, perhaps the best in the United States at the time, and excelled in physics and astronomy. In a paper to the American Philosophical Society in 1779, he submitted an interesting disquisition on the Aurora Borealis, and in 1789 communicated his observation on a lunar eclipse and the transit of Mercury across the sun's disk. In the lecture room he was indefatigable, and spent four to six hours a day. He introduced what was the first systematic course of lectures on political economy in any American College, and his enthusiasm threw a peculiar charm over his lectures on natural philosophy.

A contemporary of Dr. Madison was James Greenway, of Dinwiddie County, an ardent botanist. He wrote a number of interesting letters for the Philadelphia Society, in which he dwelt upon the fertilizing value of the pea, the nature of a certain poisonous plant found in Virginia, and an extinct volcano in North Carolina.

The current of the 19th century now sets in strongly and the limits of my paper confine me to a very brief mention of names.

Ephraim McDowell, born in 1771, in Rockbridge County, a graduate of medicine in the University of Edinburgh, who practiced his profession at Danville, Virginia, was the first to operate for ovarian tumor, and became famous as the father of ovariotomy.

Benjamin Winslow Dudley, of Spotsylvania County, born in 1783, a graduate of the University of Pennsylvania and student afterwards at London under Cooper and Abernathy. He performed the first operation for stone in the bladder and was spoken of as the greatest lithotomist. It has been said that Benjamin Dudley's career presents the longest list of successful operations of any surgeon of modern times.

William B. Rogers, a link between Massachusetts and Virginia, studied from 1819 to 1825 at William and Mary College, where his father, Patrick Kerr Rogers, was Professor of chemistry and natural philosophy and subsequently held his father's chair, and six years later a similar one at the University of Virginia. As State officer he made the first report on the geology of Virginia—a work which has no superior, and is full of original suggestions. After thirty-five years' service in Virginia he moved to Massachusetts, where in 1860 he founded in Boston the famous Institute of Technology and died in that city in 1882, having seen his pet project crowned with success. But Rogers never forgot the claims of Virginia, and shortly before his death, in a published

letter to John W. Draper, referred with enthusiasm to the freedom of its great University and "the large relative space," which it had always given to "physical and mathematical science,"—"an example," he said, "only slowly adopted by the older Universities," by which I suppose he meant Harvard and Yale, though he had too much politeness to mention them by name.

Edmund Ruffin was born in Prince Edward County, Virginia January 5, 1794, and educated at William and Mary College. He was an immense reader of books and by his works on scientific farming produced an entire revolution in agriculture in Tidewater, Virginia. His system embraced the use of marl and leguminous crops as fertilizers of poor soil, drainage, blind ditching, and the five field rotation of crops. Probably there was nothing positively new in this, but his books and writings as Editor of the *Farmers' Register* had a personal force about them that compelled results. Those results, as told by the census of the United States were that, whereas lands in Eastern Virginia had steadily declined in value, since the Revolution, leading to large emigrations southward, from 1835 to 1860 they steadily increased by the millions of dollars, and Virginia was never so prosperous as when the Civil War came on.

John Peter Mettauer, of Prince Edward County, Bachelor of Arts of Hampden Sidney College, Virginia, and M. D. of the University of Pennsylvania, in 1809. He was the first on this continent to operate for cleft palate, the first to employ iodine in the treatment of scrofula, and was one of the first to conceive the idea of curing vesico-vaginal fistula, and among the first in such major operations as amputation of the shoulder, ligation of the carotid, and resection of the superior maxilla.

Cyrus Hall McCormick, son of Robert McCormick, born February 15, 1809, in Rockbridge County, where on his father's farm for six years he experi-

mented and perfected the reaper which revolutionized agriculture throughout the world. Not only did it vastly increase the area of grain cultivation, but it was the stimulus of the phenomenal development of every manner of farm implement. It had a profound influence upon the fate of the Union; for William H. Seward attributed to it and not to the armies of the North the subjugation of the South. "The reaper is to the North what slavery is to the South," he said. "By taking the place of regiments of young men in the Western harvest fields, it releases them to do battle for the Union at the front, and at the same time keeps up the supply of bread for the nation's armies. Thus without McCormick's reaper, I fear the North could not win, and the Union would be dissolved."

Matthew Fontaine Maury, born in Spotsylvania County, Virginia, January 14, 1806, son of Richard Maury and Diana Minor, his wife. He was educated at private schools and entered the navy. He suggested a system of reforms in the navy department, which adopted in 1842 introduced order where chaotic conditions formerly prevailed. As head of the National Observatory in Washington, he made a profound study of the varying depths, and the winds and currents of the sea, and by his work "Sailing Directions," and his "Physical Geography of the Sea and Its Meteorology," which last work is said to have passed through more editions than any modern book of its kind, won for him the name of "Pathfinder of the Seas." He suggested all the principles of the modern weather bureau operations, instituted a system of deep-sea soundings, and showed that the bottom of the sea between Newfoundland and Ireland was a plateau admirably adapted for a telegraphic cable. He suggested to Cyrus W. Field, the character of the cable to be employed and how it should be laid. In generous recognition of this fact, Mr. Field said, "I am a man of few words: Maury furnished the brains;

England gave the money; and I did the work." As chief of the water defences of the South under the Confederacy, he was the father of the torpedo and mining system now employed so generally in the European War. He was covered with honors and medals by all the European governments, was urged by the French government to take charge of their great Observatory at Paris, and invited to Russia by a personal letter from the grand Admiral Constantine. Instead of accepting, he preferred to live a plain Virginia citizen, having charge at his death, February 1, 1873, of the chair of meteorology at the Virginia Military Institute at Lexington, Virginia. By many he was regarded as the greatest of all American scientists.

John L. Porter,[1] of Norfolk County, was born September 19, 1813, son of Joseph Porter, the proprietor of a ship building establishment at Portsmouth, Virginia, the largest south of the Potomac River. In 1846 he was appointed acting naval constructor in the United States navy and superintended the construction of many ships. When Virginia seceded, he held a similar position under the Confederate Government, and later was promoted chief constructor. In 1846 when engaged in work for the United States government at Pittsburgh, Pennsylvania, he conceived the design of an iron vessel capable of going to sea, which would, nevertheless, be shot-proof. His plans and designs were submitted to the Navy Department and were not approved. This was ten years before England and France began thinking on the subject of ironclads, and so far as Mr. Porter was concerned was the result of his own ideas without assistance from anyone. In 1861 the possibility of the value of iron clads in war was generally discussed, and Mr. Porter recurred to his scheme. He submitted the plans of 1846 slightly

[1] For a sketch of John L. Porter, see a History of Norfolk Co., Va., by John W. H. Porter.

modified to the Confederate government, accompanied with a model, and his ideas were applied to the *Merrimac,* a Federal warship, which had been burnt to the water's edge when the Gosport Navy Yard at Portsmouth was abandoned, in 1861, to the Confederates. The subsequent career of this vessel thus cased in armor is known to history. In a battle with the Federal wooden battleships at Newport News on March 8, 1862, the *Merrimac,* or *Virginia* as she was now named, demonstrated in the most convincing manner the superiority of iron ships over wooden ones, no matter how gallantly manned and bravely fought. The battle was an epoch-making one, and revolutionized naval warfare throughout the world. It is a curious fact that in the use of the torpedo, mining and the sub-marine as instruments of war, in the development of trench warfare, in the employment of iron ships in battle, in the invention of the machine gun (by Gatling, a North Carolinian), and the choice of a uniform best adapted to service in the field, bluish gray, (generally adopted in the great European war) the old agricultural South led the nations of the world.

John Mercer Brooke, son of General George Mercer Brooke, a distinguished officer of the old United States army, a member of an old Virginia family, was born December 18, 1826. He was associated with Maury at the Naval Observatory and aided him in his deep-sea sounding, and devised the deep-sea sounding apparatus, which was so useful when the submarine telegraph cable came to be laid. And in recognition of his service to science, he received from King William I. of Prussia, the gold science medal of the Academy of Berlin. In 1863 Captain Brooke was made chief of ordnance and hydrography under the Confederacy, and among the innovations introduced by him was the "air space" in artillery, which was soon generally accepted as one of the most important improvements in ordnance.

Dr. Walter C. Reed, born in Gloucester County, in 1846, and educated at the University of Virginia, from which he graduated as Doctor of Medicine in 1868. As assistant surgeon in the United States army he studied the cause of yellow fever. In February, 1901, he read before the Pan-American Medical Congress at Havana a paper in which he gave a modest and scientific history of the results achieved by himself and his colleagues, which established one of the most remarkable discoveries of modern sciences—that yellow fever is conveyed by the bite of a mosquito of a certain species. On his return to the United States he was received with enthusiasm by the Johns Hopkins Medical Association and other medical bodies, who realized the soundness of his conclusions and the importance of his discovery. Dr. Reed stood pre-eminent both as a man of science and a disinterested lover of humanity. Since the cause was made known, rendering prevention possible, the dread scourge of yellow fever has practically ceased.

Probably I ought not to pass by Henry Draper, son of the eminent scientist Dr. John W. Draper, who was professor at Hampden Sidney College for three years. Of him it may be said that England gave parentage, Virginia birth, and New York training and the field of action. He was the first to obtain a photograph of the fixed lines in the spectra of the stars, and the first to prove in this way the existence of oxygen in the sun—pronounced at the time the most brilliant discovery ever made by an American.

With Draper, I finish this paper, though other names of closer identity with the State might be added, and I do not go into the field of the present day. Doubtless the *résumé* shows that there has been no lack of individual talent for science in Virginia, and that nowhere has science excited more interest, but it is clear that there has been little community support in its favor. Men born in Virginia

have generally had to go elsewhere for preferment. The Philosophical Society established, in 1773, died with the Revolution and probably would have died shortly anyway. None succeeded it—at least none to count. The only societies that had a continuous existence were the political and agricultural societies. Country people cannot get together conveniently, and when they do it must be for merry making, for politics, or for private and public business.

As a child, I saw the plantation life before the war, and was brought up with others who saw it more fully, and there was never anything equal to it for joy and happiness. The poorest white man had perfect independence, and even the slaves had a kind of independence which had to be coaxed to labor. But we missed in Virginia what we still miss, in spite of all changes that have ensued, that which we see here to-day in this Society—the touch of mind with mind, the mingling of soul with soul, leading to great community results. If in Massachusetts personal independence has been less, community strength has been conspicuous from a very early period.