
NATIONAL ACADEMY OF SCIENCES

BIOGRAPHICAL MEMOIRS

VOLUME XII—NINTH MEMOIR

BIOGRAPHICAL MEMOIR

OF

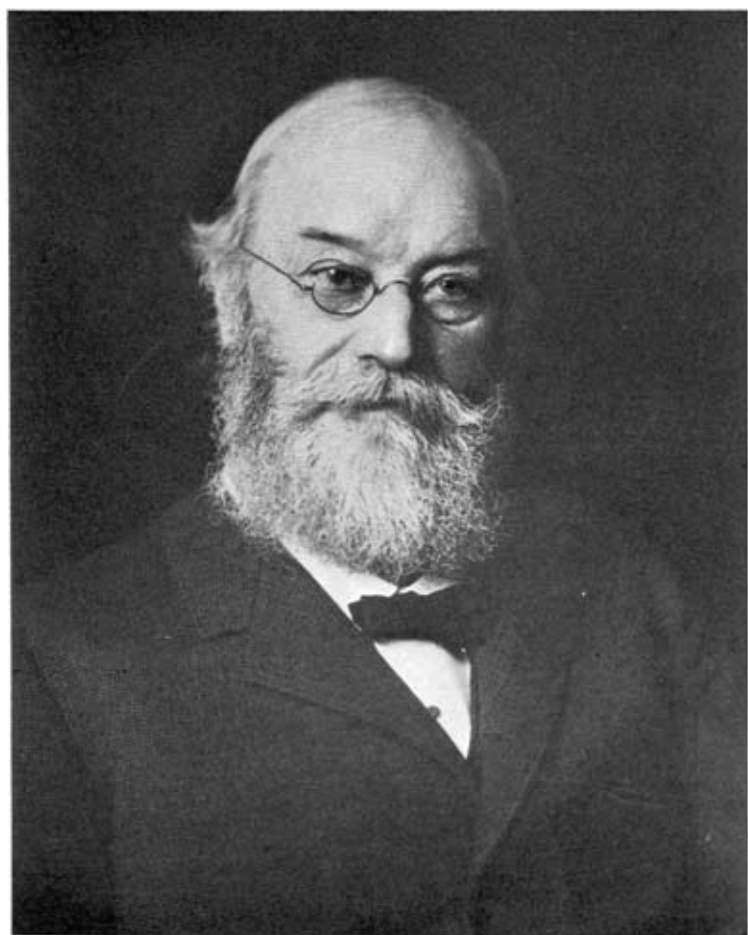
WILLIAM HENRY BREWER

1828-1910

BY

RUSSELL H. CHITTENDEN

PRESENTED TO THE ACADEMY AT THE ANNUAL MEETING, 1927



Amos Brewer

WILLIAM HENRY BREWER

BY RUSSELL H. CHITTENDEN

Professor William H. Brewer was a conspicuous figure in American science, a man of broad sympathies, wide interests, public-spirited to a high degree, and, above all, a scholar and a man of research. Living in a period when science was less specialized than at present, he was drawn into many fields of endeavor, on all of which he left the impress of his strong personality and his breadth of knowledge. Filled with a love and reverence for natural science in all its branches, he was not content to limit himself to any one special field of work, but passed from one to another with a freedom and purpose that bespoke profound knowledge and a deep-seated desire to bring to the aid of the public the benefits to be derived from the applications of science. He was a typical representative of the old school of American educators, a type we shall probably never see again. For thirty-nine years he held the chair of Agriculture in the Sheffield Scientific School at Yale, but that title by no means represents the scope of his activities; still agriculture and the sciences which contribute to its development constituted the nucleus around which his thoughts and endeavors revolved.

Brewer's ancestry was chiefly Dutch and French Huguenot, and in minor degrees Danish, French, and Scotch-Irish. His father was a descendant of Adam Brouwer Berkhoven, who emigrated from Cologne in 1642 and settled in New Amsterdam (New York). The name Berkhoven may have been his surname, but more probably indicated that he came from Bercham in North Brabant in the Netherlands, for he was of Dutch and not German origin. This name, however, persisted as late as 1700, after which the name Brouwer was used, soon changed however to Brower. The oldest tide mill on Long Island, at Gowannis Creek, in Brooklyn, owned by some member of the family, was long known as Brower's Mill.

Shortly after the close of the Revolution, there was much

patriotic changing of names and William Brewer's grandfather, Nazareth Brower, who lived near Poughkeepsie, changed his name to Brewer. Of the fifteen children of Nazareth only two, however, followed the example of their father and adopted the new name. Henry, William Brewer's father, born in 1804, took the new form, Brewer, and retained it throughout his life.

William Brewer's mother was Rebecca Du Bois, born in Poughkeepsie in 1800, and married to Henry Brewer in 1827. She was a descendant of Louis Du Bois, who was born in 1626 at Wicres, in La Bassée near Lille, in French Flanders, now the old province of Artois. He was a Huguenot and on account of religious persecution went to Mannheim, Germany, where he married in 1655 Catharine Blanchen, also a Huguenot refugee. With their two children they came to America in the summer of 1660, settling in the Huguenot colony in Ulster County, New York, first at what is now Kingston, moving in 1662 to New Village, or Hurley. The following year this village was destroyed by the Indians, and the wife of Louis and her three children were carried off and held captive for three months, when they were rescued by Dutch troops sent from New York. In 1666 Louis Du Bois with some other settlers purchased from the Indians land on the Wallkill River and established the town of New Paltz, where he died in 1695.

William Henry Brewer was born on September 14, 1828, at Poughkeepsie, New York. Shortly after, his father bought a farm at Enfield, six miles from the village of Ithaca and settled the family there in the spring of 1830. On this farm young Brewer spent his childhood, going to the district school in the earlier years and later to the nearby Ithaca Academy, which he attended for four consecutive winters until the spring of 1848. During the summer months he worked on the farm with his father, acquiring a live interest in all that pertained to agriculture. Evidently the father was a progressive man, keenly appreciative of the advantages to the farmer of a knowledge of the sciences relating to agriculture. Consequently he listened sympathetically to the expressed wish of William, now twenty years of age, that he be allowed to go to New Haven and enter

the "School of Applied Chemistry," under Professors John Pitkin Norton and Benjamin Silliman, Jr. Permission being granted, he started for New Haven in the fall of 1848, taking his first journey in a public conveyance.

The "School of Applied Chemistry" started at Yale in 1847, the beginning of the Sheffield Scientific School, was dominated largely by John Pitkin Norton, who from his training abroad had gained a wide knowledge of chemistry, especially in its applications to agriculture. Brewer had read accounts of some of Norton's researches, and it was this that had inspired the wish to study with the man who knew so much about scientific agriculture. Possessed of a high degree of intelligence and endowed with unbounded enthusiasm, Brewer entered on his work in the Analytical Laboratory with a determination to acquire all there was to know as speedily as possible. But after a short experience he began to realize there was much to learn; chemistry, mineralogy, geology, botany, German, French all aroused his interest, and we find from his diary that he soon understood he must take more time than the year originally planned. He records the great satisfaction his father's permission to spend two years in study in New Haven gave him. These years were full of profit, not only in the accumulation of a fund of useful knowledge and experience, but the country lad with limited vision who left the farm for the first time in 1848 was rapidly growing into a man of broad outlook, with a true appreciation of relative values, who realized that the natural sciences were destined in the near future to occupy a position of supreme importance in the development of practical agriculture and in the improvement of the industrial life of the country. Among his more intimate associates in the chemical laboratory were Samuel W. Johnson and George J. Brush, with whom he was destined later to coöperate for many years in the upbuilding of the Sheffield Scientific School.

When he returned home in the summer of 1850 Brewer was in some doubt as to his future. The promotion of agriculture through the sciences had been constantly in his mind and he had been studying with that object always before him, but the two years at Yale in close association with such men as Pro-

fessors Silliman, Senior and Junior, and John P. Norton, had given him new thoughts and aspirations. Life on the farm appeared less attractive, and it is clear from his diary that he was gradually turning towards teaching as a profession. He saw that the country had need of schools or colleges of agriculture and he thought possibly here might lie his opportunity. In the meantime he worked on the farm during the summer and fall of 1850, but in December of that year he entered the Ithaca Academy as a teacher of chemistry. There he had a small laboratory and much time was spent in arranging such illustrated lectures on chemistry as his limited apparatus would permit. He was far from satisfied with his surroundings, however, and longed for an opportunity to do something more directly connected with agriculture. He was thinking constantly of a school of agriculture, and he relates in his diary of that date a long conversation with a Swiss medical student regarding the agricultural schools of Switzerland, how they were conducted, the character of the curriculum, and the success of the students after completing their studies.

Greatly to his delight, in the spring of 1851 he was invited to take charge of the Oakwood Agricultural Institute at Lancaster, in Erie County, New York. This he accepted with alacrity, thinking that here he might be able to put in operation some of the plans he had outlined in his mind for a school of agriculture, but when he took up the work at Lancaster he found conditions so impossible, students so few in number, and equipment so poor and scanty, that no satisfactory progress could be hoped for. It was a grievous disappointment, but he remained there through the year in accordance with the agreement, doing the best he could under the adverse circumstances. As he wrote in his diary, however, there was no chance to do any satisfactory work, but perhaps it was good discipline for him. At the close of the school year, in April, he returned to Ithaca, doing a little teaching, but devoting most of his time to studying botany and French in preparation for the forthcoming examinations at New Haven, when he hoped to take the bachelor's degree. Yale had decided to grant the degree of Bachelor of Philosophy to students in the "School of Applied

Chemistry" who met the specified requirements, and on Commencement Day, 1852, six men received the degree, the first class to graduate from what is now the Sheffield Scientific School. Among these six were William P. Blake, George J. Brush, and William H. Brewer.

An interesting sidelight is thrown upon the character of the examinations in Brewer's diary of that date. The examinations, he wrote, "were much more rigorous than any of us had anticipated. In chemistry, each was taken in a different manner and no one as he had expected. The examinations in this science continued about an hour each, the questions by Benjamin Silliman, Jr., in the presence of Professor John Pitkin Norton and Dr. J. Lawrence Smith. In geology the questions were by Professor Silliman, Sr. When we understood that he was to examine us in that science there was rejoicing, as none of us supposed that he would be minute, but in this we were decidedly mistaken. He was by no means as inclined to let us go with mere general principles as we had anticipated, but was minute and exact on many points where we least expected it. The botany and mineralogy were by Professor James D. Dana and were as thorough as the rest. The French was by M. Legendre."

Having obtained his degree, thus completing satisfactorily the first chapter in his career, he was uncertain what step to take next. Hampered as he was by the need to secure sufficient money for his expenses, there were necessary limitations in his choice. Above all he wished to go abroad and study with some of the renowned European chemists, but that was at the time not possible. With his ardent love of the open air and all that pertained thereto, he had found great pleasure and satisfaction in exploring the region about New Haven and that section of New York State where he had lived. He had wandered far afield in the study of flora and minerals. The mountains and the valleys were for him an inspiration and a delight, and nothing gave him greater pleasure than to seek and study the plants and minerals in hidden and difficultly accessible places, whether on the mountain top or in the deep gorges. All through his life this love of untrammelled nature showed itself, and when

later on events so shaped themselves that he could travel far into the wild and even into the unknown, his cup of happiness was filled to overflowing. In the meantime he had to support himself, and he applied for the position of geologist and mineralogist on the Gunnison Expedition, an exploring expedition beyond the Rocky Mountains. Fortunately, on account of a delay of the mails, he lost the appointment and so by the merest chance was prevented from joining that party, all but four of whom were murdered by the Indians near Salt Lake.

Again he took up teaching in an academy, this time at Ovid, New York, where he gave the instruction in physiology, natural philosophy, and agricultural chemistry. This was a much more satisfactory position than he had had previously and for three years he remained there, until August, 1855, reasonably contented, but always looking forward to the time when he could go abroad and increase his knowledge of the world and of the sciences in which he was so deeply interested. His success at Ovid Academy was very marked and tended to strengthen his faith in his ability as a teacher. He also gave many courses of illustrated lectures in near-by towns on chemistry and natural philosophy, which helped to swell his income and thus brought nearer the time when his cherished hope could be realized. All his spare time, however, was spent in botanical work, collecting and studying the plants, and especially the mosses of that section of New York State. He also had some correspondence with Agassiz, and he undertook to collect for him the fishes of that region to aid Agassiz in his great work on the fishes of the United States. Finally, however, he found himself in a position to carry out his long delayed plan of going to Germany, and in September, 1855, he sailed for Hamburg, going by sailing vessel for economy's sake, saving thereby seventy or eighty dollars; a voyage of forty-one days.

For two years he was abroad, spending the first year at Heidelberg, mainly with Bunsen, while the larger portion of the second year he was at Munich working under the renowned Liebig. Chemistry naturally occupied the greater portion of his time, but geology, mineralogy, and especially botany were given some attention, particularly during the vacation periods when

he made many excursions throughout Germany and Switzerland collecting and studying botanical specimens and minerals. In some of these excursions he covered much territory. Thus, in the summer of 1856, he walked six hundred miles through Switzerland, botanizing in many localities and collecting a wealth of botanical material. Again, he took a month's walking trip, geologizing in the Tyrol Mountains. He visited the great Hohenheim Agricultural School, near Stuttgart, at that time perhaps the most noted school of its kind in the world, and made a careful study of the methods of instruction employed there. Later, while in France, he spent some time at the *École Imperiale d'Agriculture* at Grignon, the most complete agricultural school of that country, and while in England prior to sailing for home he visited many of the more noted English farms. His stay in France was short, but he found time to go with the Botanical Society of France on an excursion of about two weeks in southern France, where he saw much that was new to him. In Paris he was able to attend the lectures of the distinguished chemist Chevreul, during his two months' stay in that city.

Thus ended the two years of European study, but the mere recital of these facts gives only a faint suggestion of all that he absorbed during this eventful period. As one reads the many letters he wrote home during these two years, it is easy to perceive that Brewer quickly caught the spirit of the great masters with whom he was studying, and that they inspired in him an enthusiasm for better means and methods of instruction and research in the sciences to which he was devoted. Under Liebig, particularly, he gained broader views of the many ways in which chemistry could aid agriculture, both directly and indirectly. He evidently looked on Bunsen as the more profound and brilliant chemist, but Liebig gave him much to think about in matters pertaining to the life processes of animals and plants, the cultivation of the soil and the broader aspects of agriculture as a science and an art.

There is no evidence in Brewer's letters of that date that he contemplated taking up chemistry as a profession. Chemistry with him was a means to an end, that end being agricul-

ture, but he was so in love with the natural sciences that he worked at them all with almost equal zeal. Even in these earlier years he had an encyclopedic mind, and it simply was not in him to confine his intellectual activities to any one field of work. His temperament was such that he took a keen and vivid interest in everything about him, and he was rapidly accumulating a fund of information and original knowledge on many subjects, destined to be of great help to him in later life. His letters during this European experience were filled with observations of all kinds, not only on scientific matters but on social customs, habits of life of the people, political and economic problems, etc. Nothing was too insignificant to be noted and remarked upon, nothing escaped his eyes, and as a result, when Brewer returned to America, he came back equipped with an amount of special and general knowledge possessed by few men of his age.

After his return from abroad he accepted the professorship of natural sciences at Washington College, Pennsylvania, now Washington and Jefferson College, but in 1860 an opportunity presented itself which he was quick to seize. In that year the State Legislature of California authorized a geological survey of the State calling for, among other things, a full and scientific description of its botanical productions. Professor J. D. Whitney was the geologist in charge and he offered to Brewer the position of first assistant on this survey. Consequently, on October 22, 1860, Brewer sailed for California with all the baggage and instruments for the survey, by way of the Isthmus of Panama, reaching San Francisco November 15. He was astonished at the size and appearance of the city, then only about ten years old, not expecting to see such large streets and fine buildings as met his eye. On the first of December the party was at Los Angeles, then a city of about 3,500 inhabitants, and on the plain about twenty miles from the sea and fifteen miles from the mountains they made their first camp and started the work of the survey.

For four years Brewer had charge of the field parties during the summer, spending the winters in San Francisco working up his notes. This survey under Whitney was thorough and

comprehensive. They climbed and named many of the higher mountains, mapped the country and reported on the geology, botany, mines, etc., of the State. While Brewer had general oversight of all the field work his special duty was the study of the flora of the State. The botanical collections were made entirely under his direction and mostly by him. The total number of species collected was about two thousand, and when it is remembered that these plants were growing spontaneously over an area of about 160,000 square miles, it is clear that Brewer must have become thoroughly acquainted with the geography of the State of California. In his Journal, under date of December 19, 1862, he wrote, "The field work for the year has closed. I have been adding up my perigrinations in this State since I arrived twenty-five months ago, and the following are the figures: mule-back, 3,981 miles; on foot, 2,067 miles; public conveyance, 3,216 miles; a total of 9,264 miles. This has been over an area 625 miles long in extreme length, and has been nearly all in the coast ranges. Probably no man living has so extensive a knowledge of the coast ranges of this State from personal observation as I have, but I have seen very little of the grand features of the Sierras." He had, however, two years more of exploring in California before his work there was finished.

These four years in the wilds of California were glorious years for Brewer. Here he had opportunity to utilize all his accumulated knowledge of geology, botany, geography, etc. Things new and unusual were all about him, exciting his curiosity and his admiration; peculiar geological formations, mineral deposits, new and rare plants, lofty mountains, beautiful valleys, wonderful forests, all combined to keep his enthusiasm for the work in hand at a high level. His Journal teems with vivid descriptions of the wonderful scenery of that new country, but his enthusiasm reaches the highest point when he is able to record the finding of some rare plant, such as the *Darlingtonia*, "the wonder and admiration of botanists," which he discovered near the Castle Mountains, some twenty-five miles from Mt. Shasta.

Equally enthusiastic was he over Mt. Shasta, about which

little was known. Even the height of the mountain had not been definitely determined. Brewer, with Professor Whitney and two others, made the ascent in September, 1862, one of the first parties to reach the top, the highest point of land in California. In his Journal of that date is the following record: "Williamson and Fremont guessed that it (Mt. Shasta) was 17,000 feet high, and so it went into maps at that height. Last year a Mr. Moses measured it with a barometer, which was not graduated low enough, and gave it as a little less than 14,000 feet. So much was known of its height, but of its geology I am not aware that anything was known. We have not found a particle of light in any written authority. No wonder then that we had for long months looked forward to this trip, that we gazed on the mysterious peak with longing eyes from afar off, and that the excitement increased inversely as the square of the distance diminished. We were now camped at its base." He continues, "the first four miles were up a rather gentle slope, through a forest whose beauty cannot be appreciated from any description, mostly of cone-bearing trees, all of species peculiar to the Pacific slope; cedars 20 feet in circumference, spruce as large in girth and taller, sugar pines 4 to 8 feet in diameter and 200 to 250 feet in height, pitch pines nearly as large. I measured one sugar pine that lay beside the trail; it was 7 feet in diameter, the top had been consumed by fire all above where it was 8 inches in diameter, but 225 feet remained—it must have been at least 250 or 275 feet high—and I doubt not that some of the trees of this region are over 300 feet high."

That day they ascended slowly, making various observations on the way and camped for the night at an elevation of 4,100 feet, with the lofty peak of the mountain towering above them. The next morning, many hours before sunrise, they started for the top. Brewer's Journal record reads as follows: "For half a mile or more our way lies over loose blocks of lava, or dry ashy soil, then we strike a strip of snow, up which we follow. But what a path and what a grade. Hour after hour we toil on it, sometimes in the snow, sometimes on a strip of loose rock beside it. The snow is melted into rough waves, often

several feet deep, by the summer's sun, but is now frozen crisp. The bright moonlight gives way to gray dawn, and this to twilight, then the sun comes up and gilds the summit ahead of us, and casts dark shadows far into the valleys beneath.

"We are following up a sort of wide ravine in which the snow lies; on either side are sharp ridges, the naked lava standing out. It appears to have been wreathed in curious forms as it flowed there, and then in later times had weathered into fantastic shapes. Walls, battlements, pinnacles, shooting up hundreds of feet. The ascent grows steeper and steeper as we ascend toward the "Red Bluffs," a sharp ridge at the altitude of almost 13,000 feet. . . . The next thousand feet is less steep but scarcely less difficult, a part of the way over hard lava, or a conglomerate made of pieces of lava cemented with a red volcanic ash, sometimes on snow which was much more difficult. It had melted, forming a surface entirely unlike anything I have ever seen in Switzerland or Tyrol."

The height of Mt. Shasta, as they determined it, was 14,400 feet, "the highest land yet measured in the United States." In his Journal, Brewer wrote, "I feel proud that I took the first accurate barometrical observations to measure the highest point over which the stars and stripes hold jurisdiction." Mt. Shasta was plainly an extinct volcano. As Brewer wrote in his Journal, "geologically, it is nearly as barren as it is botanically. A great cone of lava, little else, not—like *Ætna*—made up of an almost infinite number of small lava streams, but it seems to have been formed in a comparatively short period by a few gigantic eruptions. It appears to belong to a series or chain of volcanoes that probably had their greatest activity during the Tertiary period, but extended down to comparatively modern times."

Brewer naturally expected to find on the upper slopes of Shasta alpine plants, grasses, mosses, etc., but instead he found utter barrenness. To quote from his Journal, "a few shrubs and sub-alpine plants flourish just above the timber for a few hundred feet, but all above 10,000 feet is a scene of unmixed desolation, not relieved by any plant, nor did we see insect or bird above this height. This barren scene succeeds almost im-

mediately the disappearance of the upper zone of timber, and above 10,000 feet I sought in vain either herb or shrub in the soil, or even a moss or lichen in the rocks. Yet, strange enough, we found the famous 'red snow' in quantities (probably the *Protococcus nivalis*.)"

The difference between Mt. Shasta and the lofty mountains of Switzerland, for example, Brewer thought was due to the porous character of the lava composing Shasta. As he wrote in his Journal, "In Switzerland even the few hours of sun on some days, warm into life plants wherever they can obtain soil, up to highest points of naked rock. Springs gush from many points and innumerable rills course over the higher slopes. Not so here at Shasta. The water from the melting snow is immediately absorbed by the porous lava. The soil, a mixture of volcanic ashes and comminuted lava, would undoubtedly possess great fertility with water, but as it is, is dry and dusty. From the summit to the base I saw but one spring, the waters of that sank in a few rods, and one small rill ran from the snows of a ravine, and that, too, sank in less than half a mile from the snow."

With all his work and tiresome travel, Brewer found time to write innumerable letters home, and a perusal of these shows perhaps more clearly than anything else his great enthusiasm for and his deep interest in the natural beauties of California. As geologist and botanist he had enthusiasm and interest in all that the State had to offer to the scientific explorer, but beyond this was a love and admiration of the wonderful scenery all about him; the light and shade on lofty mountains, the brilliant coloring of the flowers in green valleys, the songs of the birds, the magnificent trees in the forests, and the tumbling waters of the mountain streams all called forth a feeling of wonder and admiration akin to reverence, to which he was constantly giving expression.

Brewer was greatly interested in the country along the edge of the San Joaquin and Sacramento valleys, especially the tableland to the north, with its hills of lava and mountain chains. In his diary he writes, "Lassens Peak, and in fact that whole part of the chain, like Mt. Shasta, is a gigantic extinct volcano,

perhaps about 12,000 feet high, a volcano not only much higher but vastly greater in every respect of magnitude and effects, than *Ætna*, but it is flanked by a considerable number of smaller cones, old volcanoes, from 1,000 feet high, up to that of the main peak itself, many of these cones being much higher and greater than *Mt. Vesuvius*.

"Here, in a former age of the world, was a scene of volcanic activity vastly surpassing anything existing now on the earth. The materials from these activities not only formed the mountains themselves, and covered the foothills, but also came down on the plain for more than 100 miles. Sometimes volcanic ashes covered the whole region many feet thick, then sheets of molten lava would flow over it, hardening into the hardest rock, then ashes and lava again. These formed beds of enormous thickness, regularly stratified, descending with a gentle slope toward the Sacramento River, and even crossing it in one place near Red Bluffs. But all volcanic action ceased ages ago, and the snows and rains falling on the high lands about Lassens Peak form streams which radiate over it, and they have worn deep canyons, channels in this lava often a thousand feet deep, but generally less. Between these are table-lands, sometimes strewn with loose boulders of lava, othertimes with a surface of nearly naked lava, with only enough soil to support here and there a few straggling shrubs and herbs during the wet parts of the year."

The big trees of California naturally interested him and he measured and recorded the circumference and height of many of the larger specimens, especially those in the celebrated Calaveras Grove. At a height of three feet from the ground, the "Pride of the Forest" had a circumference of 60 feet; "Pioneers' Cabin," 74 feet, "Mother and Son," 82 feet. He recounts how Professor Whitney counted the annual rings of one tree having a diameter of 24 feet inside the bark, cut six feet from the ground, and found its age to be 1,255 years. Many of these trees were 300 feet high, some reaching even 400 feet. Of course, this is an old story now and the "Big Trees" are known to everyone, but in 1863 it was quite different, and Brewer's interest and enthusiasm were fired by these won-

derful specimens of tree growth. All through his life forestry had a great attraction for him, and there is no doubt that these big trees of California, the various groves of which he visited in due time, had a distinct influence in molding his opinions regarding forest conservation and forest management, both of which he advocated strongly later on in life.

During these years of exploration, the party was skimming the cream from the geology and geography of California, passing from one section of the State to another, climbing mountains, mapping valleys, measuring waterfalls, collecting plants and minerals. The labor was hard, but they were keyed up to a joyous endeavor that overcame all obstacles, and to Brewer, especially, no labor was too great when it brought to light some new feature in the geology of the region, some new plant, or a new mineral, or even a new experience in the picturesque or romantic. In the fall of 1863 Clarence King, who had just graduated from the Sheffield Scientific School, joined Brewer and went with him on many of the excursions made the latter part of that year. On one occasion, the last of September, Brewer and King made the ascent of Lassens Peak, about 11,000 feet in height, the description of which Brewer wrote in his Journal, "has the merit of rigid truthfulness in every particular."

"We were up at half past one, had an early breakfast by the light of the bright moon, and at 2:45 we were on our way. First, up a canyon for a thousand feet, then among rocks and over snow, crisp in the cold air, glittering in the bright moonlight. At 4, we are on the last slope, a steep ridge, now on loose boulders and sliding gravel, now on firmer footing. We avoid the snow slopes; they are too steep to climb without cutting our way by steps. We are on the south side of the peak, and the vast region in the southeast lies dim in the soft light of the moon, valleys asleep in beds of vapors, mountains dark and shadowy. At 4:30 appears the first faint line of red in the east, which gradually widens and becomes a lurid arch as we toil up the last steep slope.

"We reach the first summit and the northern scene comes into view. The snows of Mt. Shasta are still indistinct in the

dusky dawn. We cross a snow field, climb up boulders and are soon on the highest pinnacles of rock. It is still, cold and intensely clear. The arch of dawn rises and spreads along the distant eastern horizon. Its rosy light gilds the cone of red cinders across the crater from where we are, Mt. Shasta comes out clear and well defined. The gray twilight bathing the dark mountains below grows warmer and lighter. The moon and stars fade, the shadowy mountains rapidly assume distinct shapes, and day comes on apace.

“As we gaze in rapture the sun comes on the scene, and as it rises, its disc flattened by the atmospheric refraction, it gilds the peaks one after another, and at this moment the field of view is wider than at any time later in the day. The Marysville Buttes rise from the vapory plain, islands in a distant ocean of smoke, while far beyond appear the dim outlines of Mt. Diablo and Mt. Hamilton, the latter 240 miles distant. North of the Bay of San Francisco, the coast ranges are clear and distinct, from Napa north to the Salmon Mountains, near the Klamath River. Mt. Helena, Mt. Johns, Yollobolly, and all the other prominent peaks are in distinct view, but rising high above all is the conical shadow of the peak we are on, projected in the air, a distinct form of cobalt blue on a ground of lighter haze—a gigantic spectral mountain, projected so high in the air that it seems far higher than the original mountain itself—but as the sun rises, it sinks into the valley, and like a ghost it fades away at the sight of the sun.

“The snow on the Salmon Mountains glitters in the morning sun, a hundred miles distant, but the great feature is the sublime form of Mt. Shasta towering above the neighboring mountains, truly a monarch of the hills. In the east, valley and mountain chain alternate until all beyond becomes indistinct in the blue distance. The peaks about Pyramid Lake are plainly seen, while Honey Lake glistens in the morning sun, seemingly quite near. A few miles to the north are four volcanic cones, the highest above 9,000 feet entirely destitute of all vegetation, scorched and broken. The lava tables beneath are covered with dark pine forests, here and there furrowed into deep canyons, or rising into mountains with pretty valleys

hidden between. Several lower peaks about us are spotted with fields of snow, still clean and white, sometimes of rose color with the red microscopic plant, as in the Arctic regions. Here and there from the dark forest of pines that forms the carpet of the hills curls the smoke from some hunters' camp or Indians' fire."

These quotations show more clearly than any words of the writer could how strongly Brewer was impressed by the matchless scenery of the country which he was exploring. They also serve to show the artistic nature of the man, for like a true artist he was seemingly compelled by the very beauty of the surroundings to make a word picture in order to preserve the impression made upon his mind. When we recall the extent of his journeying through California, it is easy to understand that he must have had many occasions for expressing his enthusiastic admiration. In his field work during the year 1863 he traveled 4,243 miles, with a total for the three years of 13,507 miles, of which 6,560 miles were on horseback or mule, and 2,772 miles on foot. Truly he knew California as few other men did.

Not far from Esmeralda the party found traces of enormous glaciers there in earlier times, said to be the first found on the Pacific slope. On the lofty mountains of this region, at an altitude of about 10,000 feet, the alpine plants were especially conspicuous and Brewer reports in his Journal the collection of over one hundred species of mountain plants during his exploration of these mountains. Equally noticeable was the prevalence of *Pinus contorta*, a scrubby pine, at 8,000 to 9,000 feet, this being practically the only tree at a height of 9,700 feet. At higher levels, up to 11,000 feet or more, a low shrub, *Pinus flexilis*, was conspicuous. One of these lofty mountains was named Mt. Dana in honor of Professor James D. Dana, while another mountain, over 13,000 feet high, which Brewer did not succeed in climbing, being stopped 125 feet from the top by the glassy surface of the almost vertical rock, was named Mt. Tyndall, in honor of Professor John Tyndall, the eminent English physicist and mountain climber.

During the winter months in San Francisco, Brewer found time to participate in some of the scientific activities of this city.

He became a member of the California Academy of Sciences and for a time was its recording secretary; he lectured occasionally, taking such topics as the mountain scenery of California, and in many other ways became more or less identified with the life of the place. In 1863 he was elected Professor of Natural Science in the College of California, now the University of California, which position he accepted subject to his duties in connection with the Survey. This position, however, he did not hold long, for in the summer of 1864 he resigned to accept the Chair of Agriculture in the Sheffield Scientific School at Yale. His field work on the Survey ceased in December, 1864, after four years of fruitful endeavor and adventurous life. His experiences during this period undoubtedly had a strong influence on his later career, especially on his instruction in physical geography and in forestry, while his love for California and interest in its development lasted throughout his life. In his bibliography will be found the titles of many papers dealing with observations made during his California experiences, testifying to his continued thought of the phenomena observed there.

Before entering on his duties at New Haven, it was necessary for Brewer to complete his obligations to the Survey. The large botanical collection had to be carefully studied and the plants classified and arranged; new species described and the results put in proper shape for publication. To do all this satisfactorily, proper equipment and expert advice were needed, and these he found in the Herbarium of Harvard University where he worked from December, 1864, until April, 1865, aided by the advice of Professor Asa Gray, who described many of the new species found. Thus was prepared for the press the "Flora of California," or a systematic description of the plants growing in that State, mainly collected by Brewer, including about 2,000 species. The material thus elaborated was finally published in 1876, making a large part of Volume 1 of the Geological Survey of California, under the title "Polypetalæ," by W. H. Brewer and Sereno Watson, the latter having added somewhat to the original collections made by Brewer.

Brewer's knowledge of the western country was further

broadened by a camping trip through the Rocky Mountains in the summer of 1869, with Professor J. D. Whitney and a group of four Harvard students in geology and mining, among whom was William M. Davis. In this exploring trip of three months, Brewer saw much of the geography and geology of the Rocky Mountains, also adding to his botanical collections.

In the spring of 1865 Brewer took up his work as Norton Professor of Agriculture in the Sheffield Scientific School, and for a period of thirty-eight years, until his retirement from active service in 1903, his life was devoted primarily to the interests of this vigorous department of Yale University. The chair he occupied was established as a result of the Scientific School becoming the recipient of the Land Grant Fund of Connecticut, designed by Congress (1862) to promote instruction in agriculture and the mechanic arts. In conjunction with Professors S. W. Johnson, A. E. Verrill, and Daniel C. Eaton, he organized a well-defined course in agriculture which for many years was under the special jurisdiction of Brewer and Johnson, the latter holding the Chair of Agricultural Chemistry. In the history of agriculture in Connecticut the names of Brewer and Johnson are inseparably connected. They worked together for a common good, though by methods radically different, for they were men of totally different types.

As has been well said, Brewer "was a professor of agriculture not only in the Sheffield School but throughout the State," and he labored incessantly for the advancement of agriculture in Connecticut by every means at his command. His wide knowledge and broad experience accumulated through the previous years rendered him peculiarly fitted to bring aid to the farmer. For with all his academic training he retained some of the atmosphere of the soil. He had been brought up on the farm; as a young man he had tilled the soil and gathered the crops. He knew the mind of the practical farmer and he could talk to him in ways that could be understood, and above all he carried with him an air of authority that impressed his hearers and gained their confidence. The farmers of the State soon realized that he was their friend, and that he was actuated solely by a desire to aid them, consequently he was able to

accomplish much for the betterment of agriculture in Connecticut.

His influence, however, extended far beyond the confines of the State. Commencing with the first annual report of the Connecticut Board of Agriculture in 1867, his addresses to the farmers and his many papers on matters relating to agriculture were conspicuous features of the reports during a period of thirty years, adding much of value and thereby helping the circulation of the reports outside the State. The range of his contributions was large, embracing topics quite divergent, but all relating to matters in which the farmer had a live interest, such as the origin and constitution of soils; causes which affect the vitality of seeds; woods and woodlands; practical suggestions on tree-planting in sanitary effects; pollution of streams; the water supply and drainage of farm, house, and farm buildings in their sanitary relations; the educational influence of the farm; the carrying of farm products; the farm in its relation to public health; the English race horse, a lesson in the history of the art of breeding, etc.

While his colleague, Professor S. W. Johnson, was the prime mover for the creation of an agricultural experiment station in Connecticut, the first one to be established in the United States, Brewer was active in support of the movement and was a member of the Board of Control for a period of thirty-three years, serving as a member of the Executive Committee, and its secretary and treasurer from the date of its organization in 1877. Here he rendered valuable service through his knowledge, common sense, and honesty of purpose. These attributes, soon recognized at home and abroad, led to repeated calls for his services on many matters connected directly or indirectly with agriculture. Thus, as special agent on the Tenth Census, he prepared a voluminous report on the cereal production of the United States, in which he studied especially the distribution of production in accordance with geographical, physical, and climatic features; the physical and chemical character of the different cereals; the relation of cereal production to livestock growing, etc. In the Sheffield Chemical Laboratory, under his direction, a large amount of work was done bearing

on the chemical composition of the different grains and their products. He also prepared as a part of this report a brief history of American agriculture. Likewise a report on pasture and forage plants.

When in 1882 the Commissioner of Internal Revenue turned to the National Academy of Sciences for an investigation of the various products formed from starch, notably glucose, a committee of five members of the Academy was appointed to consider this question, Brewer being one of the committee. The report, which was exhaustive and based on a large amount of original work, showed conclusively that the manufacture of sugar from starch is valuable and commercially important: that the glucose is of exceptional purity and in no way inferior to cane sugar in healthfulness. Again, the National Academy was called upon by the Commissioner of Agriculture for an investigation of the sorghum sugar industry, and of the committee of four to study this question Brewer was one.

Brewer was greatly interested in the problems of animal breeding and for many years he gave a course of lectures to his students on the "Laws of Heredity and Principles of Breeding," the syllabus of these lectures having a wide circulation. The evolution of breeds of domestic animals, as illustrated in swine, was a favorite topic and was the subject of many lectures to farmers and State Boards of Agriculture. His study of the development of the American trotting horse, however, was his most important contribution to this general subject. Recognizing that the breeding registers and turf records constitute a great collection of valuable data bearing on the evolution of speed in the horse, he proceeded to arrange and study this voluminous material with a view to determining what the ultimate speed limit of the trotting horse must be. As is well recognized, the origin of most breeds is shrouded in more or less obscurity; it is uncertain how far the special traits are the result of conscious or unconscious selection, what part training, nutrition, and physical environment play in the development of the special qualities. In the case of the trotting horse, Brewer pointed out, "the formation of this new breed is so recent, the development of a special quality has been so marked,

there is such an abundant literature pertaining to its history . . . that we have the data for a reasonably accurate determination of the influences at work which led to this new breed being made, the materials of which it is made, and the rate of progress of the special evolution."

The timing of horses on the race track, as far back as 1806, led to the accumulation of data bearing on the speed of trotters, and about 1818, through judicious breeding and careful training, horses were produced capable of trotting a mile in 3 minutes. By 1830 the speed had been increased to a mile in 2:32 minutes, while by 1881 it had reached a mile in 2:10 $\frac{1}{4}$ minutes. Brewer carefully tabulated all the available data, thereby gaining information regarding the rate of increase in speed, etc. Thus, in 1843, there was only one horse having a record of 2:30, while in 1882, 1,684 horses had a record of 2:30 or better. In 1871 there was only one horse with a record of 2:17, but in 1882 there were 18 horses having a record of 2:17 or better. Brewer obviously could not determine how far this fast gait acquired by the well-bred and trained trotter is due to inherited habit, inherited training or to adventitious variation and selection, but he got together a mass of material from which it was possible to plot curves showing how fast horses will ultimately trot and when this maximum will be reached.

In 1873, when the writer first knew Brewer, he was intensely interested in the controversies going on, especially between Bastian and Tyndall, regarding spontaneous generation. Tyndall's work on the dust of the air and the probable relation of the latter to putrefaction, infection, etc., he had followed closely and he quickly realized the full significance of these and kindred observations in their bearing on infectious diseases. He made many observations himself on micro-organisms and taught a small class of students, working under his direction on microscopic technology, the bearings of the newer knowledge on sanitation, water supply, sewage disposal, etc. It was this knowledge, and his faith in the practical value of the results gradually accumulating, that caused him to take an active part in the organization of a State Board of Health for Connecticut, and a local Board of Health for New Haven. This was a form

of public service for which he was peculiarly fitted and he entered into it with all the ardor of a crusader. Opposition of all sorts had to be met and overcome, the people had to be educated, made to see that so-called obnoxious rules and regulations were for their own good. Brewer and his associates had a difficult situation to deal with, but with a combination of wisdom and good sense he guided the growth of these two boards until public health work in Connecticut came to be recognized on all sides as a safeguard to the community. He served as president of the City Board from 1876 to 1889, and as president of the State Board of Health for sixteen years, but he was on the latter board for thirty-one years, i. e., from its organization in 1877 until his retirement on account of failing health. Many-sided knowledge, combined with his pleasing personality, and especially the power to use the spoken word convincingly, yet prudently, enabled him to carry through successfully many plans for the betterment of public health. He was likewise active in the American Public Health Association.

From his earliest years Brewer had manifested great interest in forestry, an interest that had grown steadily with his increasing appreciation of the importance of the forests to the national welfare. His observations abroad, combined with his California experiences, had given him a wealth of knowledge which he was using frequently in support of proper methods of maintenance and increase of the forests of the country. In 1874 he prepared a map, based on the results of the Census of 1870, for Walker's Statistical Atlas, showing the distribution of woodland and forest systems in the United States. The following year he wrote a report which gave an analysis of the forest resources of the country. Later, when public attention was being directed to the declining condition of the forests, he became an ardent advocate for a thorough investigation of the matter, and in 1896, when at the request of the Government the subject was taken up by the National Academy of Sciences, he was one of the Commission appointed to investigate and formulate proper methods for the preservation of the forest resources of the country. As a member of this United States Forestry Commission, Brewer traveled widely over the country to the west-

ern coast and took an active part in the survey which the Commission made. Eventually, as a result of the recommendations submitted to the Government, the National Department of Forestry was established, with Mr. Gifford Pinchot as Chief Forester. When in 1900 the Yale Forest School was established, Brewer took an active part in its organization, serving as a member of its governing board and giving for several years a course of lectures on forest physiography and meteorology. He was likewise active in the organization of an undergraduate course in "Studies preparatory to the study of forestry," in the Sheffield Scientific School.

Following the request of President Roosevelt, the National Academy of Sciences appointed a committee to consider and report upon the desirability of instituting scientific explorations of the Philippine Islands and on the scope proper to such an undertaking. Of this committee Professor Brewer was appointed chairman. As a result of the study made by this committee a comprehensive report was submitted in 1903 recommending that the Government undertake the following scientific explorations: coast and geodetic work and marine hydrography; land topography, including surveys and classification of the public land; geology and mineral resources; botany; problems of forestry; zoology; anthropology. To this study Professor Brewer devoted much thought and effort, and he often expressed the wish that he might go to the islands and view with his own eyes the resources that existed there.

For many years Brewer gave to the students in the Sheffield Scientific School a course of lectures on physical geography. He naturally took great interest in this subject, his broad experience as a geographer in the survey of California, his travels elsewhere, his geographical studies in general, all combined to render him peculiarly fitted for work in this field. With his customary enthusiasm, he brought together much new and original material, built up a large collection of maps, books, and photographs, revised Warren's Physical Geography, making of it, with the new material added, one of the most authoritative textbooks on this subject, and thus created a department of study at Yale that won general recognition. As chairman of the

commission appointed to organize a topographical survey of Connecticut in 1889, he gave during a period of six years freely of his time and knowledge to insure the survey being made with proper accuracy and with due regard to economy. As a result, largely of his efforts, excellent and useful maps of the State were produced. Among the many subjects in geography that especially interested him was the subject of river deposits in their bearing on delta formation. For many years he carried on experiments upon the mechanical suspension of clays in river waters and the conditions under which their sedimentation takes place, studying particularly the effect of small admixtures of mineral salts upon the rate of precipitation.

His interest in geography and geographical research often led him far afield. Twice he went on exploring voyages to the far north; once into the Greenland seas on the steamship *Miranda*, which unfortunately was wrecked near the Arctic Circle, exposing the people on board to grave dangers, from which they were rescued only after a long period of serious discomfort. The second voyage was into Behring Sea in 1899 with the Harriman Alaska Expedition, where he saw much to interest him. In the second volume of the scientific reports of this expedition is a paper by Brewer on "The Alaska Atmosphere." When the Arctic Club was founded, Brewer served for many years as its president.

To give an adequate presentation of all that Professor Brewer did for the Sheffield Scientific School at Yale during his long period of active service—from 1865 to 1903—would be a difficult matter. In the early years, when the very life of the institution was uncertain, Brewer, like his associates Brush, Gilman, Johnson and a few others, gave all his strength and energy to place the school on a firm foundation. Through his broad training he was especially qualified to fill many gaps, and this he did with unflinching generosity and with complete disregard of self-interest. Later, when he was able to limit his activities to those subjects in which he was especially interested, he became through his knowledge, enthusiasm, and patience one of the most beloved instructors in the Scientific School, looked on by his large classes of students with admiration and respect.

In the words of one of his admirers, "he was one of the most striking personalities connected with the Scientific School and with Yale University." As a member of the Governing Board of the School he helped shape its policies for that time and for the future, and as a member of the Board of Sheffield Trustees, he shared with others many of the financial and other responsibilities that pertain to such a board. His conscientious performance of all duties that devolved upon him, his excellent judgment and wise counsels made him invaluable, while his unflinching courtesy, kindness of heart, and sweetness of disposition rendered him an associate with whom it was a pleasure to work.

His services to science and to the public were widely recognized. Washington and Jefferson College, in 1880, conferred on him the degree of doctor of philosophy. This same year he was elected a member of the National Academy of Sciences. In 1903, at the time of his retirement from active service in the university, Yale gave him the degree of doctor of laws, and the same year Wesleyan University conferred on him a similar degree. In 1909, at the time of the celebration of its fiftieth anniversary, the University of California gave him the degree of doctor of laws.

On August 14, 1858, he married Angelina Jameson, of Ovid, New York. She died in June, 1859, and ten years later, on September 1, 1868, he married Georgiana Robinson, of Exeter, New Hampshire. Of this marriage there were four children, viz., three sons and one daughter.

During the last two years of his life, failing health curtailed his activities and imposed restrictions more or less irksome, but these Brewer accepted with characteristic calmness and philosophy. On November 2, 1910, he passed quietly away, eighty-two years of age.

Brewer's traits and achievements were in a measure the result of what he had derived from John P. Norton, Bunsen, and Liebig. From them he acquired a stimulating eagerness for research which led him in many directions, into many fields. He was essentially an explorer, carefully recording his observations on every sort of scientific subject. There were no limita-

tions in his search for truth, for with his observing temperament he could not be content in any narrow field of research, no matter how much of interest it might have for him. He was led in many directions not through lack of thoroughness, but partly because the many services demanded of him he regarded as duties, and partly because of his broad interests and his love of scientific adventure. One is reminded of the words of Sterne: "What a large volume of adventures may be grasped within this little span of life by him who interests his heart in everything and who, having eyes to see what time and chance are perpetually holding out to him as he journeyeth on his way, misses nothing he can *fairly* lay his hands on." Brewer never wittingly missed an opportunity to see and record; his powers of acquisition were exceedingly great, but he lacked the disposition, or rather the opportunity, to digest all that he had absorbed.

Again, he was so deeply possessed by a sense of personal obligation to the community that he often sacrificed himself and his time for the benefit of others in a way that few men are willing to do. As one of his colleagues wrote: "His knowledge, suggestiveness, and original ideas were at the service, and freely given, alike to his friends and to the stranger who sought him, and innumerable must be those who profited by them. How far what has been accomplished for general advancement, at many times, in many places, and by many people through his help and influence cannot be measured, but the sum total would be astonishing if we could but know it." Public service was the keynote of his life; a life of unselfish effort, in which his knowledge and experience were freely given.

Apart from his professional work and scientific achievements there is another side to Brewer's character that calls for comment, if there is to be a judgment of the whole man. His social qualities were of a rare order. He was endowed with conversational gifts of an unusual quality, and as he was possessed of a memory retentive to a remarkable degree, with a broad experience of life under many conditions, he was a delightful companion, having a fund of stories, anecdotes and merry jests that enlivened any group of which he happened to be a mem-

WILLIAM HENRY BREWER—CHITTENDEN

ber. He radiated good nature, enjoyed wholesome fun, and was quick with an apt quotation or witty rejoinder when in congenial company. To those who knew him intimately his genial fellowship and friendly, generous nature constitute an abiding memory.

BIBLIOGRAPHY

- 1851 Determination of Nitrogen in two Varieties of Indian Corn.
Proc. Amer. Assoc. Adv. Sci., for 1850, pp. 386-387.
Analysis of the Inorganic Constituents of a Variety of Indian Corn.
Proc. Amer. Assoc. Adv. Sci., for 1850, pp. 387-389.
- 1858 Agriculture and Agricultural Schools in Europe.
Trans. N. Y. State Agric. Soc., for 1857, vol. 17, pp. 163-218.
- 1859 The New York State Agricultural College Farm. Its Characteristics as indicated by its Botany.
Trans. N. Y. State Agric. Soc., for 1857, vol. 18, pp. 398-406.
Some observations on the Motions of Certain Winding Plants.
Amer. Jour. Sci. (2), vol. 27, pp. 202-205.
- 1860 The Frost of June, 1859.
Agric. Rep't U. S. Pat. Off. for 1859, pp. 555-558.
Tobacco and its Culture.
In: Outlines of Yale Agricultural Lectures, pp. 97-99.
Hops and their Culture.
In: Outlines of Yale Agricultural Lectures, pp. 104-105.
- 1866 Contributions to: Whitney's Geology of California.
Whitney's Geology of California. (Review.)
Amer. Jour. Sci. (2), vol. 41, pp. 231-246, and pp. 351-368.
Observations on the presence of Living Species in Hot and Saline Waters in California.
Amer. Jour. Sci. (2), vol. 42, pp. 391-393, and vol. 42, p. 429.
Tenacity of Life in the Seeds and Spores of Plants.
Amer. Jour. Sci. (2), vol. 42, pp. 393-394.
On the Age of the Gold-Bearing Rocks of the Pacific Coast.
Amer. Jour. Sci. (2), vol. 42, pp. 14-18.
Mt. Hood.
Amer. Jour. Sci. (2), vol. 42, pp. 422-424.
Alleged Discovery of an Ancient Human Skull in California.
Amer. Jour. Sci. (2), vol. 42, pp. 424-425.
- 1867 Irrigation in California.
1st Annual Rep't Conn. Board Agric., pp. 13-24.
Diseases of Plants caused by Fungi.
1st Annual Rep't Conn. Board Agric., pp. 63-74, and pp. 90-103.

WILLIAM HENRY BREWER—CHITTENDEN

- 1868 Cattle Breeding in its Relations to Dairy Farming.
3rd Ann. Rep't Amer. Dairy Assoc., pp. 17-35, Utica.
Parasitic Diseases that injure the Flesh of Animals for Food.
2nd Annual Rep't Conn. Board Agric., pp. 33-49.
On the Age of the Gold-Bearing Rocks of California.
Amer. Jour. Sci. (2), vol. 45, pp. 397-399.
The Variation of Animals and Plants Under Domestication.
(Review.)
Amer. Jour. Sci. (2), vol. 46, pp. 140-143.
- 1869 On the Constitution of Old Pastures and Meadows.
3rd Annual Rep't Conn. Board Agric., pp. 72-90.
Carl Friedrich von Martius. (Obituary Notice.)
Amer. Jour. Sci. (2), vol. 47, pp. 288-291.
- 1873 Lecture on Weeds.
6th Annual Rep't Conn. Board Agric., pp. 107-116.
Discovery of Mt. Tyndall.
Pop. Sci. Mo., vol. 2, pp. 739-741.
Exploration in the Rocky Mountains and the High Peaks of
Colorado.
Jour. Amer. Geogr. Soc., vol. 3, pp. 193-215.
- 1874 Contributions, chiefly relating to the *Sequoia gigantea*, to the
Yosemite Guide Book.
San Francisco and Boston.
The Woodlands and Forests of the United States.
Walker's Statistical Atlas (based on the results of the
census of 1870), 5 pp., folio.
Map Showing in Five Degrees of Density the Distribution of
Woodland Within the Territory of the United States.
Walker's Statistical Atlas, pl. 4.
- 1875 The First Century of the Republic's Agricultural Progress.
Harper's New Mag., May, pp. 880-889. Reprint. In:
First Century of the Republic. New York, 1876.
An Inquiry Respecting the Revision of Thoroughbred Do-
mestic Animals.
Proc. Amer. Assoc. Adv. Sci., vol. 23, pp. B 82-86. Re-
print: Amer. Jour. Sci. (3), vol. 10, pp. 67-68.
On the Formation of Hail in the Spray of the Yosemite
Falls.
Amer. Jour. Sci. (3), vol. 10, pp. 161-164.
Walker's Statistical Atlas of the United States. (Review.)
Amer. Jour. Sci. (3), vol. 10, pp. 83-88, and pp. 164-168.
- 1876 The Water Supply and Drainage of Farm, House and Farm-
Buildings in their Sanitary Relations.
7th Annual Rep't Conn. State Board Agric., pp. 135-139.

NATIONAL ACADEMY BIOGRAPHICAL MEMOIRS—VOL. XII

- Botany of California.
Vol. 1. (With Sereno Watson and Asa Gray.) Cambridge, Mass. Roy. 8, 628 pp.
- 1877 Woods and Woodlands.
Annual Rep't Conn. Board Agric., pp. 180-199.
The Experiment Station and its Work.
Annual Rep't Conn. Board Agric., pp. 101-105 and pp. 108-243.
General Report of the Judges of Group VI.
International Exhibition of 1876, Reports and Awards, Group VI, pp. 1-22, and also 135 of the "Reports on Awards."
The Principles of Breeding.
Rep't N. H. State Board Agric., 20 pp.
The Gases of Decay and the Harm They Cause in Dwellings and Popular Places.
Papers and Rept's Amer. Pub. Health Assoc., vol. 8, pp. 199-204.
Report of the President of the Board.
4th Annual Rep't Board of Health New Haven, pp. 3-5; also, Year Book City of New Haven for 1876, pp. 179-181.
- 1878 The Origin and Constitution of Soils.
11th Annual Rep't Conn. Board Agric., pp. 67-83.
Syllabus of Lectures on the Laws of Heredity and Principles of Breeding. New Haven, 8, 8 pp.
Letter of the President of the Board.
5th Annual Rep't Board of Health New Haven, pp. 3-4; also, Year Book City of New Haven for 1877, pp. 159-160.
The Principles of Breeding.
Annual Rep't Vt. State Board of Agric., pp. 17.
What Shall We Do With Our Tramps?
New Englander, July, pp. 521-532.
- 1879 Varieties of Cultivated Plants, What They Are, How They Are Multiplied and Improved.
12th Annual Rep't Conn. State Board of Agric., pp. 14-34.
The Causes Which Affect the Vitality of Seeds.
12th Annual Rep't Conn. State Board Agric., pp. 203-217.
Pollution of Streams.
1st Annual Rep't Conn. State Board of Health for 1878, pp. 61-62.
Pollution of Streams.
1st Annual Rep't Conn. State Board of Health for 1878, pp. 71-78.

WILLIAM HENRY BREWER—CHITTENDEN

- Letter of the President of the Board.
6th Annual Rep't Board of Health New Haven; also,
Year Book City of New Haven for 1878, pp. 181-187.
- Work Which a National Agricultural Association May Do.
Lecture delivered at Organization of the American Agri-
cultural Association, December, 1879.
- Sheffield and North Sheffield Hall.
In: Kingsley's Yale College, a Sketch of its History,
vol. 11, pp. 116-117.
- John Pitkin Norton, Biographical Sketch of
In: Kingsley's Yale College, a Sketch of its History,
vol. 11, pp. 118-121.
- Practical Suggestions on Tree-Planting in Sanitary Effects.
Papers and Rep'ts Amer. Pub. Health Assoc., vol. 4, pp.
42-43.
- 1880 Contributions to: Botany of California, by Sereno Watson.
Cambridge, 1880, Roy. 8, vol. 2.
- List of Persons Who Have Made Botanical Collections in
California.
Sereno Watson's Botany of California, vol. 2, pp. 553-559.
- Public Health is Public Wealth.
3d Annual Rep't Conn. State Board of Health, pp. 25-30.
- On Rotting Wood.
Papers and Rep'ts Amer. Pub. Health Assoc., vol. 5, pp.
66-68.
- Letter of the President of the Board.
7th Annual Rep't Board of Health New Haven; also,
Year Book City of New Haven for 1879, pp. 217-224.
- Fermentation in Its Household Relations.
13th Annual Rep't State Board Agric., pp. 224-248.
- 1881 Letters of the President of the Board.
Rep't Board of Health New Haven, for 1880, 80 pp.
- Agricultural Societies: What They Are and What They
have done.
14th Annual Rep't Conn. State Board Agric.
- On the Action of Muddy Water on Sewage.
Papers and Rep'ts, Amer. Pub. Health Assoc., vol. 6,
pp. 334-335.
- The Laws of Breeding.
Bull. Nat. Wool Manfg. Assoc., vol. 11, p. 261.
- Letter of the President of the Board.
8th Annual Rep't Board of Health New Haven, pp. 3-12;
also, Year Book City of New Haven for 1880, pp.
193-203.

- 1882 The Adaptation of Agriculture to the Improvements in Implements, Machinery and Transportation.
 15th Annual Rep't Conn. State Board of Agric., pp. 313-321.
 On the Disposition of the Color Markings of Domestic Animals.
 Trans. Amer. Assoc. Adv. Sci., vol. 30, pp. 246-251.
- 1883 The American Trotting Horse; Why He Is, and What He Is.
 16th Annual Rep't Conn. State Board of Agric., pp. 215-242.
 The Evolution of the American Trotting-Horse.
 Amer. Jour. Sci. (3), vol. 25, pp. 299-304.
 Reprint: Nature, vol. 27, pp. 609-611.
 Lectures on the Principles of Breeding.
 Rep't Minn. State Board of Agric.
 On the Apparent Size of Magnified Objects.
 Proc. Amer. Assoc. Adv. Sci., vol. 31, pp. 139-145.
 Contributions to the Report to the National Academy of Sciences.
 Nov., 1882, entitled: Investigation of the Scientific and Economic Relations of the Sorghum Sugar Industry.
 Washington, 152 pp.
 Report on the Cereal Production of the United States.
 Rep't 10th Census, vol. 3, pp. 371-553; also published separately, 172 pp.
 Pastures and Forage Plants. Report on Cattle, Sheep and Swine.
 Rep't 10th Census, vol. 3, pp. 959-964.
 Syllabus of a Course of Lectures on Sanitary Science.
 5th Annual Rep't Conn. State Board of Health, pp. 85-91.
 Competition in Farm Products.
 An address delivered before the 42d Annual Fair of the Housatonic Agric. Soc. Trans. Housatonic Agric. Soc. for 1882, pp. 3-13.
- 1884 The Educational Influence of the Farm.
 17th Annual Rep't Conn. Board of Agric., pp. 180-202.
 Heredity and the Principles of Stock Breeding.
 Syllabus of Lectures, 8 pp.
 The Evolution of Breeds of Domestic Animals as Illustrated in Swine.
 Proc. Soc. Arts (of the Mass. Inst. Technology) for 1883-84, pp. 8-12.

WILLIAM HENRY BREWER—CHITTENDEN

- Letter of the President of the Board.
11th Annual Rep't Board of Health New Haven, pp.
5-11; also Year Book City of New Haven for 1883,
pp. 213-19.
- Report on Glucose prepared by the National Academy of Sci-
ences in response to a request made by the Commissioner
of Internal Revenue.
(Contributions to) Washington, 108 pp.
- The Subsidence of Particles in Liquids.
Mem. Nat. Acad. Sci., vol. 2, pp. 163-175.
- Sanitation on the Farm.
18th Annual Rep't Conn. Board Agric., pp. 168-182.
- 1885 Letter of the President of the Board.
12th Annual Rep't Board of Health, New Haven, pp.
3-6; also Year Book City of New Haven for 1884,
pp. 209-212.
- Glucose.
7th Annual Rep't Conn. State Board of Health, pp. 143-
154.
- The Asiatic Cholera from a Layman's Point of View.
Proc. Soc. Arts (of Mass. Inst. Technology) for 1884-85,
pp. 94-102.
- On the Suspension and Sedimentation of Clays.
Amer. Jour. Sci. (3), vol. 29, pp. 1-5.
- Glucose in Its Sanitary Aspects.
Papers and Rep'ts Amer. Pub. Health Assoc., vol. 10,
pp. 100-105.
- 1886 Milk for Cities
19th Annual Rep't Conn. Board Agric., pp. 209-224.
- Report on the Tariff Classification of Wool.
(Contributions to) Rep't Nat. Acad. Sci. for 1885, pp.
81-89.
- The Right and Expediency of Public Vaccination.
8th Annual Rep't Conn. State Board of Health, pp. 233-
247.
- 1887 Health History of New Haven.
In: History of New Haven, Edited by Edward C. At-
water. New York, Roy. 8, pp. 416-422.
- Report on the Value of Public Sanitation as Exemplified in
the Experience of Memphis.
American Public Health Association at Memphis, Nov.
8-11, 1887. Rep't State Board of Health, pp. 156-160.
- 1888 The Carrying of Farm Products.
21st Annual Rep't Conn. State Board Agric., pp. 233-250.
- Letter of the President of the Board.

- 15th Annual Rep't Board of Health New Haven; also
Year Book City of New Haven for 1887, pp. 215-218.
- Letter on the Evolution of Breeds.
In: A. Graham Bell, Facts and Opinions Relating to the
Deaf. London, 1888, 12, pp. 92-96.
- 1889 The Farm in its Relation to the Public Health.
22nd Annual Rep't Conn. State Board Agric., pp. 186-
197.
- Letter of the President of the Board.
16th Annual Rep't Board of Health New Haven, pp. 3-6;
also, Year Book City of New Haven for 1888, pp.
189-192.
- The Great Basin.
Bull. Amer. Geogr. Soc., vol. 21, pp. 197-227.
- The Cow Pea, its Origin and Botanical Characters.
Rep't Storrs Agric. Exper. Sta. for 1888, pp. 99-101.
- The Farm and Farmer the Basis of National Strength.
Mass. State Board of Agriculture at Fitchburg, Dec. 4,
1889.
- 1890 The English Race-Horse; A Lesson in the History and the Art of
Breeding.
23d Annual Rep't Conn. Board Agric., pp. 199-234.
- Is It True that Farming is Declining in New England?
New Englander, Apr., pp. 228-342; reprint: 19th An-
nual Rep't N. H. State Board Agric., pp. 303-316.
- How It Has Come About that the American Farmers and
Especially Those of New England are Treated With
Disrespect by the Writers in Our Newspapers.
New Englander, May, pp. 410-427.
- The Brighter Side of New England Agriculture.
19th Annual Rep't N. H. State Board Agric., pp. 642-661.
Revised: Warren's New Physical Geography.
Philadelphia, 4.
- 1891 The Past and Future of Connecticut Agriculture.
24th Annual Rep't Conn. Board Agric., pp. 153-157.
- The American Trotting-Horse.
Rep't N. H. State Board Agric. Concord, 30 pp.
- 1892 Horse Breeding for Connecticut.
25th Annual Rep't Conn. Board Agric., pp. 175-187.
- Sereno Watson.
(Obituary Notice.) Amer. Jour. Sci. (3), vol. 43, pp.
441-444.
- On the Hereditary Transmission of Acquired Characters.
I. Agric. Sci., vol. 6, pp. 105-107; II. Ditto. Characters
due to Nutrition, Agric. Sci., vol. 6, pp. 153-156; III.

WILLIAM HENRY BREWER—CHITTENDEN

- Ditto. Characters due to the Exercise of Function,
Agric. Sci., vol. 6, pp. 249-254; IV. Ditto. Charac-
ters due to Disease, Agric. Sci., vol. 6, pp. 345-348.
- 1893 Report of the Commissioners of the State Topographical Survey.
Contributions to. New Haven, 8 pp.
The Mutual Relations of Science and Stock Breeding.
Address before Amer. Assoc. Adv. Sci. 1893. Vol. XLII.
- 1894 A Century of Connecticut Agriculture.
From Rep't Sec'y Conn. State Board of Agric., 1894.
- 1895 Isolation Hospitals a Means of Public Protection.
Rep't Conn. State Board of Health, 1895, pp. 268-273.
The Effect of Well-Kept Grass-Land, long established, in
Giving Stability to Business.
Rep't Conn. Board of Agric., Dec. 17, 1895, pp. 35-47.
The Relation of Universities to Charity and to Reformatory
Work.
Rep't Conference of Charities and Correction, 1895.
Atmospheric Dust in the Arctic Regions.
The Last Cruise of the *Miranda*, pp. 148-161.
- 1896 Earth Tremors at Niagara Falls.
Yale Scientific Monthly, 1896.
- 1901 The Alaska Atmosphere—Alaska—Harriman.
Alaska Expedition with Cooperation of Washington
Academy of Science, pp. 279-289, 1901.
- 1902 John Wesley Powell.
Amer. Journal of Science, 1902. Vol. XIV.
- 1903 Biographical Memoir of Sereno Watson.
Nat. Acad. Sci., Nov., 1903, pp. 267-290.
The Debt of This Country to Learned Societies.
Address at the Centennial Anniversary of the Connecticut
Academy of Arts and Sciences, 1903, Centennial Vol-
ume of the Transactions. Reprint at New Haven.
Scientific Survey of the Philippine Islands.
Report of Committee, Nat. Acad. Sci.
- 1904 Opening Address at 2d Annual Sanitary Conference of the Health
Officials of Connecticut.
Dec. 14, 1904.