VOLUME XXVI NUMBER 8

THE

JOURNAL OF GEOLOGY

NOVEMBER-DECEMBER 1918

SAMUEL WENDELL WILLISTON
1852–1918

Our distinguished senior colleague in vertebrate paleontology passed away August 30, 1918, honored and beloved by all who knew him. He seldom spoke of himself, still less of the long struggles which beset his career. Our admiration for his character and attainments is enhanced through the perusal of his personal recollections,[1] which reveal a lofty spirit and an unfaltering determination. In the opening pages of his reminiscences he writes:

> As the oldest living student of vertebrate fossils in America and one of the oldest in the world, friends have urged me to write some of my recollections. Not that I am so very old, but because there were so few vertebrate paleontologists in the days when I first became interested in the subject—only Leidy, Cope, Marsh, and a few other lesser lights in America. Nor were there more than a dozen others in all the world, of whom Sir Richard Owen was the chief, who had published much about extinct vertebrates. It has never seemed to me that there was much of interest that I could say about myself, nor very much about the pioneers in paleontology that I could tell. I begin to feel that there are not many more years of work before me, and to regret that I have not accomplished more. . . . . But the way has often been hard, and I am thankful to be spared so long and to have done what I have.

And again, in closing:

> My life, as I look back on it, has had many discouragements and many pleasures. I have made many mistakes, as I now can see, and I have not

[1] See *Recollections*, an unpublished autobiography, written May, 1916, copyrighted by Mrs. S. W. Williston.

accomplished what I might have done. If I may extenuate my views I will say that for a country boy, with but little help and wholly without influence, the road to success is very hard. . . . . Perhaps for me experience was the best teacher, and an easy path in youth might have caused failure. But it was hard, and I have more than once been discouraged. I have drifted along somehow, with one underlying ambition, to *learn*. My plans and ambitions may seem fickle, first as an engineer, next as a physician, as a chemist, entomologist, paleontologist. I have tried various things, when one of them steadily pursued would have been better. In reality there was only one ambition—*to do research work in science*. And I have realized that ambition in a measure. I have published about 300 books and papers totaling about 4,000 pages. But the chief satisfaction that I find now in looking back over my life is that I have been the means, to some extent at least, of assisting not a few young men to success in medicine and in science.

Like all men of science who have risen to distinction, Williston was self-made, the impulses all coming from within; yet he was instinctively alert to seize every chance to learn and to expand his horizon. We cannot imagine a life-story more helpful than his to the youth predisposed to science who has both to discover his own talent and to explore every avenue of opportunity which presents itself.

Williston was born in Roxbury, now a part of Boston, July 10, 1852. "The Williston family," he writes, "has been traced back to about 1650 in Massachusetts; they were about the usual run of common people, no one famous or even noted, whether for good or evil. . . . . Some of them served in the War of the Revolution, and many were fishermen." His father was born in Maine, and he remarks of this branch of the family that "they knew little of schools. My father, if he ever went to school, did not take kindly to study, for he never learned to read or write. . . . . It was a great pity, too, for my father was a man of far more than ordinary ability as a mechanic—he was noted always for his skill. . . . . Of all his children I resembled him the most, both physically and mentally." His mother was from England, having come with her parents to New Jersey about 1812. She had a fair common-school education, and the effects of her early English training and her accent remained through life.

In the small garden attached to the little frame house in Roxbury began Williston's first studies in natural history, at the age of four:

My father had a little garden. He was planting potatoes one day with my aid, when several toads were unearthed. I was very curious to know where they came from, and he told me that they grew in the ground. I puzzled my childish brain about them and determined to raise a crop of them myself, so the next day I sedulously collected all the small toads I could find, in my little apron, and proceeded to plant them as I had seen my father plant potatoes. My father observed me and asked what I was doing. I told him I was planting them to see them grow. It caused him so much amusement that I went away crying to tell my mother about it. For years, until I was so old that I resented it, my father always called me "Toad."

The double point of this batrachian incident lies in its indication of an experimental mind, and in the coincidence that forty-one years later Williston succeeded Cope as one of the leading world-students of the extinct batrachian group.

The intellectual and social environment of Roxbury probably never would have produced a geologist or a paleontologist, and while the next step in Williston's life was hard, yet it was propitious, as the events proved:

In the spring of 1857 my parents decided to emigrate to Kansas. A colony had left the year before for Manhattan, and the letters that came back had infected many with the desire to go West. . . . . The abolitionists were urging eastern people to colonize the territory in order to help John Brown preserve it to the "Free States." . . . . The trip was long and tedious, by rail to St. Louis, then a small place, and thence by steamboat up the Missouri River to Leavenworth. There was no Kansas City then. We reached Leavenworth about the twentieth of May. Here we remained a few days in a very small hotel, while my father bought a yoke of oxen and a wagon and such provisions and household things as were indispensable, and we started on the slow and tedious drive of 115 miles to Manhattan through a country but very sparsely settled. For the most part we children rode in the covered wagon, while my father and cousin walked and drove the oxen. My mother was very homesick on the way. I can remember how long and bitterly she cried. One could not blame her; she now realized for the first time in this wilderness what she was leaving behind, perhaps forever. Nor did she see the East again for nearly thirty years, and my father never. We reached Manhattan June 7. The Emigrant Aid Society, under whose auspices this long journey was undertaken, provided a small log cabin, about 15 feet square inside, two and a half miles east of Manhattan, for our temporary use until a house could be built in the town itself. My memory of events is now becoming clearer. The house of our temporary occupation had but a single room with a loft reached by a ladder. There were two beds in the room below, screened off by cloth curtains that my mother soon found for them, and we

four boys slept in the loft. A big fireplace in one end, used for cooking, and a rough table and a few chairs comprised the furniture. I do not wonder that my mother was despondent, for there were no neighbors within two miles, and she needed courage, for the Potawatomie Indians had a village in the immediate vicinity, and the word Indian in the East was a synonym of savage. . . . . Like most Indians, they were thieves and unreliable, but I do not suppose we were in much danger for our lives. . . .

With these New England instincts, almost the first building erected in the village was a stone schoolhouse in the western part of town. It was of two stories, the first of which was never completed and served as a fine playhouse for the younger children. The second floor, in a single room twenty by thirty in size, was where my early education was obtained as far as algebra and McGuffey's fifth reader. My mother took the *Boston Free Flag*, a semi-literary paper, and there were a few books in the town the first winter I spent in it. Among other gifts of the Emigrant Aid Society to this colony was a small library of a few hundred volumes of more standard books, but I did not find a great deal in it to interest me. They were too mature for my childish comprehension. One only I recall, Stevens' *Antiquities of Central America*. I read it when I was about seven years old, and although I have not seen the work for many years I can still vividly visualize its many pictures of Aztec ruins in Yucatan. It directed my interest to Tschudi's *Peru* and Prescott's *Conquest of Mexico*, which a few years later made a deep impression on me and gave me that fondness for history which formed a large part of my reading for the next ten years. The Sunday-school libraries were soon exhausted, as I would take home every Sunday all that the teachers would permit. One only I can recall, Adoniram Judson's *History of His Missionary Experiences in Tahiti*.

Another incident of my seventh year stands out vividly in my recollections. Just north of Manhattan is Blue Mont, a steep and high bluff, the termination of a range of hills ending abruptly in the Blue River. In the sand bars of the river we boys often gathered clams, and I was surprised to find on the summit of Blue Mont shells which looked much like clamshells. I asked my father how they had got to the top of the bluff on the rocks, for all the clams I had seen lived in the water and could not crawl on land. He told me they had been left there by the great deluge which once covered all the earth. I took some of the shells to my Sunday-school teacher and she told me the same, and so Genesis acquired a new interest for me, and most of the verses I was required to memorize each week from the Bible were chosen from the Old Testament. My mother had prohibited us boys from going to Blue Mont and the river, for like most mothers she was afraid of the water, and not until I had surreptitiously learned to swim did she consent to let me go in swimming. Our favorite swimming-hole was among large stones filled with fossil shells of lower Permian age, and they were my first studies in paleontology. The old cottonwood house was too cold and inhospitable for our large family, and in 1859

my father built a better house about a quarter of a mile away. It was two full stories in height, and twenty by thirty, a large house then for the village. It was built chiefly of black walnut lumber, sawed by the little "Emigrant Aid" sawmill, and was long known as the "Black Walnut House." Its shingles and floors were of pine, brought up the Kaw River on a steamboat, one of the three that ever went so far up the river. I remember especially the boat, because its name in large letters spelled to me "Col-o-nel Something," and it worried me not a little that everyone persisted in calling it "Kernal." The pronunciation of the English language was a very mysterious and incomprehensible thing to me in those days.

We had been in this home but a very short time, not long enough to get settled, when there came up one evening one of those "cyclones" for which Kansas was long notorious. It threatened to blow down the house, and did destroy the house from which we had just moved, distributing some of its lumber quite into our back yard. . . . .

In 1860 my father bought the "Emigrant Aid Saw and Grist Mill." . . . . This was the year of the great drought, when practically no rain fell for fifteen months, and the crops were almost a total failure. Our subsistence for many months was almost exclusively corn meal and sorghum. There was no coffee except barley coffee, no tea, and no sugar. I have never been fond of corn bread since that time. When after more than a year my father obtained a sack of flour, the biscuits that my mother baked linger in my mind as the greatest delicacy and luxury of my life. . . . .

It was during this time that I got my second lesson in natural history. My father was very fond of fishing and hunting and went fishing every Sunday in the Blue River. Among the fishes that he brought home, chiefly catfish, shad, and buffalo, were river sturgeons. I usually helped him clean and prepare them for cooking. I observed that the sturgeons had no backbone like the other fishes, but instead, a long fibrous rod, the notochord. I puzzled greatly over it, but no one could give me any enlightenment. It was one of the things that later directed my interest to natural history.

Blue Mont College, founded by the Methodists in 1859, became merged into the State Agricultural College in 1864, and I was a very happy boy when in 1866 I was permitted to enter it.

Williston was now fourteen years of age, but it was not until a year later that he came under the influence of real scholarship and of a truly great work of science:

It was about this time, when I was fifteen years old, that Professor Mudge loaned me Lyell's *Antiquity of Man*. I remember the night I brought it home there was a dance at our house, in which I was not included, but it gave me the opportunity in an upstairs room to read the book until the guests departed in early daylight hours. I was thoroughly convinced, when conviction meant

antagonism to the church's teachings. Professor Mudge lectured about this time on evolution, to which he remained opposed until his death. It was my first introduction to the doctrine to which I soon after became a devoted disciple. . . . .

I was very fortunate in the character of my teachers, especially the teacher of science, Professor Mudge. I have published a brief sketch of his life and need not say more about him here. I doubt not that my life has been devoted to natural science chiefly because of his influence. I studied every study that he taught and they were many: natural philosophy, chemistry, botany, geology, zoölogy, veterinary science, mineralogy, surveying, spherical geometry, conic sections, calculus, etc. Mudge had a considerable collection of fossils and minerals that filled a long case. To me it was a wonderful museum. There were no laboratories of any kind, no microscopes, and but few instruments. The college catalogue of about that time, in enumerating its equipment, gravely mentions an electric machine, three Leyden jars, and six test tubes. The electric machine was a never-ending source of delight. The Professor occasionally got it out and charged the Leyden jars, and then, with hands joined in a circle, gave us a shock. He prophesied that some day electric light would take the place of other illuminations. My ambition was to make a machine myself, and I nearly succeeded, but I found no way of boring a hole through the glass plate for the shaft. The oxyhydrogen light was another great wonder. My greatest interest was given to physics, or natural philosophy as it was then called. I read every book on the subject that I could get in the library. Chemistry had second place, while biology interested me but little.

Williston left home at the age of seventeen, adventuring life first as a day laborer and then as a railroad engineer's assistant. He returned, however, to the Kansas Agricultural College and took the degree of B.S. in March, 1872. Once again he took up civil engineering, which he followed for a year. It was this profession that prepared him for his field work and for his subsequent observations in geology. It was in the spring of 1873 that he undertook the study of medicine in the office of his old family physician. Here he had free access to the doctor's library, and he at once turned to his initial studies in anatomy and physiology, which laid the foundation of his anatomical training and ultimately qualified him for a professorship in the medical school of Yale University.

In the meantime he had become an enthusiastic follower of the Darwinian doctrine, which was not at that time accepted as a demonstrated fact, and in February, 1874, he delivered in the local

Congregational church what he believed to have been the first public lecture in favor of evolution given west of the Mississippi River.

Quite by accident Williston accepted an invitation from a fellow-student to accompany him to northwestern Kansas (Smoky Hill Valley), where Professor Mudge, already famous through his discovery in 1872 of the specimen of *Ichthyornis*, was collecting. He writes:

> We left on the fifth [July, 1874]. *It was this accidental and thoughtless decision that led to my life's devotion to paleontology.* Had I not gone with him, in all probability I would today have been a practitioner of medicine somewhere in Kansas. We joined Mudge about the fourteenth and started almost immediately south. In a few days I found a good specimen of pterodactyl and became an enthusiastic lover of the sport of collecting fossils—for sport it seemed to me. I had planned that autumn to go East, if I could borrow a couple of hundred dollars, to attend a medical college. And so I returned to Manhattan by rail in September but did not succeed in getting the necessary funds. Mudge thereupon asked me to return, which I did about the first of October, and remained until we returned in November. . . . . For my season's work Mudge paid me $25, which bought me a suit of clothes and other things badly needed. My total cash income this year was not more than $50. It was the hardest year of my life. My board I worked for in part, in part I had it paid for by my parents, but I did not have a second whole shirt, and when I gave my address I had to borrow clothes to wear, for my clothes were ragged and patched.
>
> Times now began to improve. Professor Marsh and Professor Cope, as is well known, were rivals and very jealous of each other. They had been quarreling with each other for two or three years, with mutual criminations and recriminations. Because of the discoveries Marsh was making in the Cretaceous of Kansas, Cope grew eager to participate in them but could find no one to undertake these collections, for Marsh was afraid to have too many learn about the region for fear that Cope would seduce some of the assistants by the offer of higher pay. He therefore instructed Mudge to retain his assistants of the previous summer. Brous and I were engaged for the following season at $35 a month and our expenses. We accepted the offer gladly and started for the field overland in early March, meeting Mudge at Ellis on the railroad. We stipulated that I should quit in September to allow medical lectures. . . . .
>
> We collected chiefly along the Smoky Hill Valley that season, as far west as Fort Wallace, and got many valuable specimens. . . . . By Marsh's directions each had signed his name to the specimens he had collected. Perhaps that was the reason he invited me in February to come to New Haven. I

promptly accepted his invitation and sold my watch and borrowed enough to take me there in March. . . . . It was thus with feelings almost of awe that I met Professor Marsh for the first time at New Haven, Connecticut, on March 19 or 20, 1876. My heart was in my mouth when I knocked at the basement door of the old Treasury Building and heard the not very pleasant invitation to "come in." There was a frown on Marsh's face, accentuated by his nearsightedness, as he waited for me to state my business. No doubt he thought me a wild and woolly westerner in my military cloak, slouch hat, and cowboy boots, as I stammered my name. But he quickly made me feel more at ease. He found me quarters in a little building in the rear of Peabody Museum then approaching completion. The next day he set me at work studying bird skeletons with Owen's *Comparative Anatomy* as a guide. He was then deeply interested in his Odontornithes, and wanted newer specimens, especially of the smaller forms, which were very difficult to find in the Kansas chalk. For recreation I helped a few hours every day to carry trays of fossils to the museum.

Williston was now twenty-four years of age Vertebrate paleontology had become his first love, but he had leanings toward human anatomy and medicine and entomology, first as an avocation and then as a vocation. He was afforded no independent opportunities for paleontological research and publication by Professor Marsh. In the summer seasons of 1876 and 1877 he collected with Professor Mudge in the Cretaceous chalk of Kansas. In 1877 he was sent by Professor Marsh to the Morrison, Canyon City, and Como quarries to co-operate with Professors Lakes and Mudge and Mr. Reed in taking out the types of *Atlantosaurus*, *Diplodocus*, and other sauropods. In Professor Marsh's laboratory Williston worked on the dinosaurs. In the field in 1878 he helped to collect the "Jurassic Mammals" and some of the smaller dinosaurs. For nine years (1876–85) he worked in Professor Marsh's laboratory, where he became closely associated with Marsh's other assistants, especially Harger and Baur, who influenced him greatly and for whom he had great admiration. He wrote a biographic note on Harger in 1887, which gives some interesting side lights on the relations of Professor Marsh to his assistants. In 1878 he published a brief communication on American Jurassic dinosaurs in the *Transactions* of the Kansas Academy of Sciences; but he had very little opportunity for further publication in vertebrate paleon-

tology as long as he was in New Haven. This led to the renewal of his medical studies.

While acting as assistant in paleontology he studied medicine at Yale, received the degree of M.D. in 1880, continued his post-graduate studies, and received the degree of Ph.D. at Yale in 1885. He then became demonstrator of anatomy (1885–86) and professor of anatomy (1886–90) at Yale and practiced medicine in New Haven, where he was health officer in 1888–90.

In 1886 he published some criticisms of Koken's work on *Ornithocheirus hilsensis* which give us some hint of his abiding interest in Kansas fossil reptiles, an interest which was soon to bring great results.

The turning-point in his scientific career, from anatomy and medicine to paleontology, came at the age of thirty-eight, when he returned to the University of Kansas as professor of geology. Kansas was the scene of his first inspiration in paleontology, and here his fossil studies and vigorous health marked the happiest period of his life. He taught both vertebrate and invertebrate paleontology, anatomy, and medicine, and several of his students have achieved distinction in these fields.[1] With respect to the breadth of his studies and of his influence at this time, his life was comparable only to that of Joseph Leidy, who, it will be recalled, was at once an anatomist, a physician, a paleontologist, and a microscopist of distinction. He soon began to publish studies on the Cretaceous reptiles of Kansas. Henceforth Kansas plesiosaurs and turtles, mosasaurs and pterodactyls, were the subjects of a long list of papers, mostly in the *Kansas University Quarterly*, from 1890 to 1899, with occasional articles on Kansas fossil mammals (*Platygonus*, *Aceratherium*, *Teleoceras fossiger*). Meanwhile he made many explorations of the Cretaceous of Kansas for fossil reptiles. At Kansas University Williston also kept up his two avocations of anatomy and dipterology; he served as professor of anatomy and dean of the medical school. He also continued to publish many papers on recent Diptera.

[1] Among these paleontologic students, who have since become known for their researches, were: E. C. Case, C. E. McClung, Roy L. Moodie, Herman Douthitt, Alban Stewart, Elmer S. Riggs, Barnum Brown, M. G. Mehl, and E. H. Sellards.

WORK ON THE DIPTERA

We may for a moment divert our attention to Williston's great work on the Diptera. At the Pittsburgh meeting of the Entomological Society of America in 1917 he gave many interesting reminiscences of his early work; he showed that he turned to the Diptera when he despaired of securing original material in vertebrate paleontology. It is seldom that science has seen talent so evenly divided between subjects so remote as dinosaurs and flies.

J. M. Aldrich, in his *Catalogue of North American Diptera* (Smithsonian Miscellaneous Collections, 1905), cites sixty-seven titles by Williston, covering the period from 1879 tg 1899, and adds this note:

> An admirable feature of Williston's work, which does not show fairly in the above list, is the attention he has given to identifying and redescribing the species of other writers. In all his longer papers this is a prominent part, frequently occupying as much space as the new descriptions, and requiring more time than they in preparation.

This feature of Williston's work was, in fact, the result of his ever-active desire to be helpful—the same desire which prompted him to prepare his *Manual of North American Diptera*, a book which is indispensable to a beginner in dipterology and a very great convenience to advanced workers. It was this kindly, sympathetic spirit too which endeared him to his students and fellow-entomologists, while his accurate observations and keen judgment commanded respect everywhere.

Williston practically ceased active work on flies twenty years before his death, although his interest in them continued, as was shown by occasional papers, especially from 1906 to 1908 and again in the later years of his life. He jokingly said in conversation that he did not dare to think of flies lest he be tempted to take too much time from fossils. His collection of Diptera from the United States and Canada is now in the University of Kansas; the remainder of his collection, including much of the valuable material which he had collected while writing the volumes on Diptera in the *Biologia Centrali-Americana*, is in the American Museum of Natural History.

PALEONTOLOGIC WORK IN KANSAS[1]

Williston's paleontologic contributions on the Cretaceous fauna of Kansas began in 1879 with a short paper entitled "Are Birds Derived from Dinosaurs," and included fifty-three communications, chiefly to the Kansas Academy of Science, the *Kansas University Quarterly*, and the University Geological Survey of Kansas; also three volumes on the *Cretaceous Fishes* in co-operation with Alban Stewart; and *Paleontology* (*Upper Cretaceous*), Part I, Volume IV of the University Geological Survey, which was chiefly prepared by Williston with the assistance of his students Adams, Case, and McClung, and is a thorough review of the geology and marine fauna of the Cretaceous seas, containing the first clear distinctions and restorations of the great Kansas mosasaurs, *Clidastes*, *Platecarpus*, and *Tylosaurus*. This work became the standard for all subsequent researches of Osborn, Wieland, and others on the Cretaceous fauna. It contains some admirable restorations of mosasaurs and other fossils which may be compared with those of Dollo from the Maestrichtian of Belgium. The second part, Volume VI of the University Geological Survey, covering the Carboniferous and Cretaceous, published in 1900, included the Cretaceous fishes alluded to above, and the Carboniferous invertebrates by Joshua W. Beede.

In 1897 Williston published his first paper on Paleozoic tetrapods, a brief description of "A New Labyrinthodont from the Kansas Carboniferous"; his second was on the "Coraco-Scapula of Eryops Cope" in 1899; but nearly a decade elapsed before the Paleozoic reptiles and amphibians became his chief subject. From 1897 to 1902 he was engaged chiefly upon his series of papers on fossil vertebrates of Kansas for the University Geological Survey of Kansas.

Williston concluded his studies of the Cretaceous fauna during the early years of his professorship in Chicago, beginning in 1902. Thus his work on the Kansas Cretaceous fauna, following the very disjointed contributions of Leidy, Marsh, and Cope based on

[1] These notes on Williston's work on fossil reptiles and amphibians have been prepared in collaboration with Professor W. K. Gregory, of the American Museum of Natural History.

inferior material, marks the turning-point in this field to the new order of description and generalization based upon complete material, including even the skin impressions of several great mosasaurs. In his observations on the mosasaurs, plesiosaurs, pterodactyls and marine turtles, and the birds with teeth, Odontornithes, he placed the osteology of these several animals on a much more secure basis, adding a number of new generic types, such as a short-necked plesiosaur, *Dolichorhynchops osborni*.

His interpretation of function and habit is shown in his restorations of all these types, and his first observations on the feeding habits of the plesiosaurs and his more mature views on several of these animals were published during his sojourn in the University of Chicago, namely, "Relationships and Habits of the Mosasaurs," *Journal of Geology*, 1904; "North American Plesiosaurs," 1903, 1906, 1907. His first contribution to the phylogeny and classification of the Reptilia as a whole appeared in 1905 and was followed by his important discussion of this subject entitled "The Phylogeny and Classification of Reptiles," *Journal of Geology*, August, 1917. In this article, which expresses his mature opinions, he departed from his previous conservative attitude toward classification and proposed to add two subclasses of reptiles, the Anapsida and Parapsida, to the subclasses previously proposed by Osborn, namely the Synapsida and the Diapsida, making a fourfold grand division of the Reptilia. Doubtless it was Williston's intention to fortify this system of classification in his forthcoming general work on the Reptilia.

WORK ON PRIMITIVE AMPHIBIANS AND REPTILES[1]

In 1902, at the age of fifty, Williston was called to the University of Chicago as head of the new department of vertebrate paleontology, a chair which he occupied with great distinction and with continued influence for the remaining sixteen years of his life. He now began to concentrate his attention more exclusively on vertebrate paleontology. During the first six years he continued his studies and publications on the Cretaceous reptiles; then he began to turn toward the study of far more difficult and obscure problems, namely the relatively primitive amphibians and reptilian life of the

[1] See footnote, p. 683.

Permian, where in several groups he marked the beginnings of the higher forms which he had previously studied, as well as the adaptive radiation of the lower forms to a great variety of habits and habitats.

Professor E. C. Case, now of the University of Michigan, who was one of Williston's students at the University of Kansas, had co-operated with the late Professor Georg Baur at the University of Chicago in the study of *Dimetrodon* and other Permian reptiles and had collected for that University a number of important types of pelycosaurs and cotylosaurs. After Baur's untimely death Case continued to collect and study the Permian reptiles and amphibians of Texas and other states, finally issuing his well-known Carnegie Institution monographic revisions of the Pelycosauria and Cotylosauria, in which he revised and extended Cope's work on these animals and figured the types and other important specimens in the American Museum of Natural History, in the University of Chicago, and elsewhere. Thus Cope, Baur, Case, and Broili had opened and partly explored an important field of work which Williston had long desired to enter.

Accordingly in 1907 and 1908 Williston began to publish on this subject which occupied most of the closing decade of his life and constituted perhaps his greatest contribution to science. It is pleasant to record that Williston and Case at all times fully and cordially co-operated with each other in the study of Permian reptiles and amphibians. In 1908 he published an important but brief paper on the Cotylosauria, containing a description of the skeleton of *Labidosaurus incisivus*. In the same year Mr. Paul C. Miller, of the American Museum of Natural History, a collector and preparator of high rank, became Professor Williston's assistant at Chicago, and under his direction began a long series of explorations in the Texas Permian which have yielded results of the greatest importance to vertebrate morphology and paleontology. During the next decade these expeditions brought back to the University a great number of specimens, some of which will become more and more famous as their great importance is gradually realized. More or less complete skeletons were discovered, extricated with great skill, and admirably described in a long series of publications.

Among the more important of the new or little-known skeletons were the following, which, to students of the early evolution of the skeleton of vertebrates, will ever stand as important types:

Pariotichus laticeps, Williston
Trematops milleri, Williston
Aræoscelis gracilis, Williston
Seymouria baylorensis, Broili
Casea broilii, Williston
Mycterosaurus longiceps, Williston
Trimerorhachis insignis, Cope
Varanosaurus brevirostris, Williston
Ophiacodon mirus, Marsh

These were only the more conspicuous of the many priceless specimens which Williston and Miller have brought to light, and which the former has described and figured with the most painstaking care and accuracy. This material also enabled Williston to give definite and in many cases final figures of the sutural limits of the elements of the skull in most of these genera. Many investigators had attempted to do this from less extensive and complete material, but their results were often uncertain in detail and subject to important changes and corrections.

In 1911 he published from the University of Chicago Press his volume, *American Permian Vertebrates*, which comprises a series of monographic studies on some of the genera already noted. This work contains many new and original plates. Careful and extensive definitions are given of the orders Temnospondyla, Cotylosauria, Theromorpha, and of the included families and genera. In the same year, by invitation of Professor Schuchert, Williston examined and described the important collection of Permian reptiles which Mr. Baldwin had collected for Professor Marsh between 1877 and 1880, but which had never been thoroughly studied. Among other important results of this research was the erection of a new family of Cotylosaurs, the Limnoscelidæ, to include the skeleton of *Limnoscelis paludis* Williston. In 1912 he published, in collaboration with Professor Case, a paper on the "Permo-Carboniferous of Northern New Mexico," in the *Journal of Geology;* he also published a general review of primitive reptiles in the *Journal of Morphology*. In 1913 appeared a memoir in collaboration with Case and Mehl

on *Permo-Carboniferous Vertebrates from New Mexico*. The same year saw the publication of his important papers on the primitive structure of the mandible in amphibians and reptiles and on the skulls of *Arœoscelis* and *Casea*. The close resemblance of *Arœoscelis* to the Squamata especially in the temporal region was noted.

Early in 1914 came the publication on *Broiliellus*, one of Cope's "batrachian armadillos," and the fuller description of the osteology of *Arœoscelis*, with a discussion of the relationships of *Arœoscelis*, the Protorosauria, and the Squamata. He then referred *Arœoscelis* to the Protorosauria and placed this order next to the Squamata. In the same year he published a series of life-restorations of some American Permo-Carboniferous reptiles and amphibians.

His principal publication in 1914 was the book on *Water Reptiles of the Past and Present*, in which his life-work on these animals was admirably combined with the results obtained by other workers. Williston had shown a bent for the harmonious study of form and function, of structure and habit, of environment and adaptation, which he applied with skill and originality to the interpretation of the highly diversified forms of aquatic life. He followed Eberhard Fraas, of Stuttgart, in making a special study of aquatic adaptations in the vertebrates; consequently his book on the water reptiles constitutes one of the most important contributions which we have upon this subject.

The year 1915 produced his papers on *Mycterosaurus*, a very interesting reptile, that threw light on the origin of the diapsid types, namely of reptiles with *two* arches at the side of the temporal region of the skull. Also on *Trimerorhachis*, perhaps the most archaic of the American Temnospondyls, or amphibia with the vertebrae composed of several pieces. In 1916 he published the careful description of the skull and skeleton of *Pantylus* and of *Theropleura*, together with the important discussion of the origin of the mammalian and reptilian types of sternum. This paper was followed by the admirable *Synopsis of the American Permo-Carboniferous Tetrapoda*, in which the principal types were illustrated, and careful definitions of the various groups were given. In 1917 he began a general work on the *Reptiles of the World, Recent and Fossil*, upon which he was actively engaged up to his

last illness; also the publication of his papers on *Edaphosaurus*, on the atlas-axis complex of reptiles, and, equally important, his brief paper on the "Phylogeny and Classification of Reptiles," previously mentioned. During the last two years of his life he was also preparing a paper on new Permian reptiles.

In summing up his life-work, "I like," says Doctor Gregory[1], "to emphasize the general features in which Williston was really preeminent, namely: (1) discovery of new material, Cretaceous Reptilia, Permian Tetrapoda, and Diptera; (2) conscientious and precise description of these; (3) eminently conservative synthesis of facts so as to work out a great and enduring record of Cretaceous and Permian reptiles; (4) intensive and successful specialization in several distinct lines of research and teaching.

It is a matter of the deepest regret to all of Williston's colleagues in paleontology that he did not live to complete his great comparative work on the Reptilia, which would have summed up all his researches and observations and the facts stored in his mind which have never found their way into print. As an investigator he combined in an exceptional degree anatomic accuracy in detail with breadth of vision and power of analysis. His associates in the special field of Permian research considered his opinion as a homologist weighty. A committee was formed, chiefly composed of Americans, of which Williston was senior, to endeavor to establish the difficult and intricate questions of homology and to base upon this an enduring terminology to replace the confusing whirlpool of names for certain skull bones which have accumulated since the time of Cuvier.

A few of the more general features of Williston's life-work and character are as follows: He strove arduously through forty years of investigation to discover new material in the field and to widen our basis of facts in several distinct lines of investigation; he preferred to discover new facts rather than to reinterpret older ones or to adjust the interrelations of facts; in general, his material was notably of his own finding. Nevertheless, especially in his late years, he labored very successfully to classify and synthetize his material, and with it that which had been treated by other workers.

[1] See footnote, p. 683.

Here his genial personal character and admirable relations with his colleagues shone forth; he was singularly appreciative of the work of other men and ready to adopt whatever he believed to be solid and enduring in previous attempts at classification. Thus Williston's work stands in contrast with that of Cope and Marsh, whose personal differences of opinion led to the setting up of two entirely distinct systems of classification as well as of nomenclature, irrespective both of priority and of merit.

Williston's keen, broad knowledge of human anatomy, of the muscles as well as of the bones, doubtless aided his penetrating insight into the habits of the extinct animals, and while generally conservative and cautious his phylogenetic studies and suggestions were of high value. His views on taxonomic standards[1] and upon college and high-school education[2] were, like his views upon paleontologic problems, characteristically sober, moderate, and well considered, lighted up in their expression with his genial, half-humorous manner. He was ready to confess and appraise defects or faults on his own side, but quick to resent exaggerated accusations and criticisms from the other side.

The closing years of Doctor Williston's life were clouded by illness and the sorrow of losing a much-beloved daughter. He was a devoted husband and father. His friends and colleagues met him last at the Pittsburgh meeting of the Paleontological Society of America, December 30, 1917, and enjoyed a few of his short and characteristically enthusiastic communications and discussions. With Doctor Holland, myself, and many other warm friends he stayed the Old Year out and saw the New Year in at the Society smoker. He returned home quite suddenly, and this was the last occasion on which we enjoyed his genial presence, his humorous narratives, and his inspiring influence in paleontology.

HENRY FAIRFIELD OSBORN

AMERICAN MUSEUM OF NATURAL HISTORY
NEW YORK CITY
December 28, 1918

[1] "What Is a Species," *Amer. Nat.*, XLII, 184–94.

[2] "Has the American College Failed to Fulfil Its Function?" *Proc. Nat. Educ. Assn.* (1909), p. 526.