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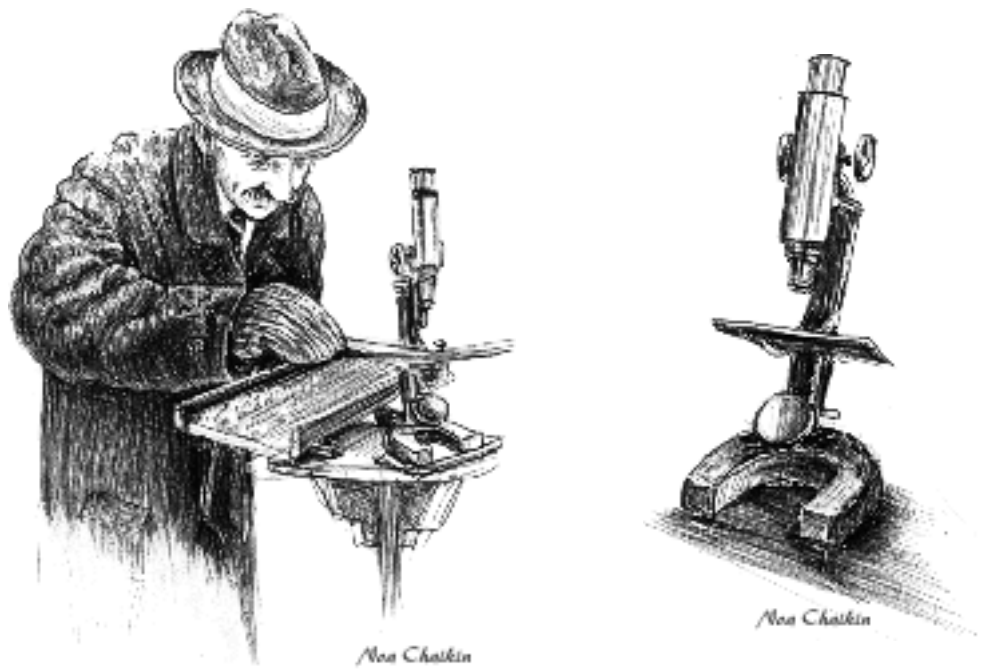

The Snowflake Man

DUNCAN C. BLANCHARD, (1970). Weatherwise, 23(6), 260-269.

ON the ninth day of February 1865, Lee's army was evacuating Richmond while Grant's army was moving southward to block the retreat. And on that same day, in the small village of Jericho in northern Vermont, Wilson Alwyn Bentley was born. By the time of his death, 66 years later, he was known to thousands around the world as the Snowflake Man. His researches into the mysteries of rain and snow were discussed in over 100 newspaper and

magazine articles, in 10 technical articles in the *Monthly Weather Review*, and in his book 'Snow Crystals." His painstaking work, carried out entirely by himself on his small Jericho farm, was so thorough and gave such new insights into the formation of precipitation that he deserves the title of America's First Cloud Physicist.

The Bentley homestead was in a valley on the east end of Jericho snuggled up at the base of Bolton Mountain. The country winters were long and hard, and in those days attendance at the one-room schoolhouse was very infrequent. Perhaps it was because of this that Bentley obtained his lifelong passion to study and understand water in all of its forms-dew, frost, clouds, rain, and especially snow in the form of ice crystals. At the age of 60 he recalled those early days:

I never went to school until I was fourteen years old. My mother taught me at home. She had been a school-teacher before she married my father, and she instilled in me her love of knowledge and of the finer things of life. She had books, including a set of encyclopedia. I read them all.

And it was my mother that made it possible for me, at fifteen, to begin the work to which I have devoted my life. She had a small microscope which she had used in her school teaching. When the other boys of my age were playing with popguns and sling-shots, I was absorbed in studying things under this microscope: drops of water, tiny fragments of stone, a feather dropped from a bird's wing, a delicately veined petal from some flower.

> But always, from the very beginning, it was snowflakes that fascinated me most. The farm folks, up in this north country, dread the winter; but I was supremely happy, from the day of the first snowfall-which usually came in November-until the last one, which sometimes came as late as May.

During the next two years young Bentley spent many a winter's day in a cold room at the rear of the farmhouse, peering through the microscope at ice crystals collected from the passing storms. He was fascinated by the beauty and intricacy of the crystals, and attempted to capture this by making drawings of them. He made hundreds of sketches but was painfully aware that what he drew was a poor substitute for what he saw. One day he chanced to read, probably in his mother's encyclopedia, about cameras that could take photographs through a microscope. Bentley and his mother somehow persuaded his father that they must buy a bellows camera and a microscope objective. His father, however, to the end of his days thought the whole thing a lot of nonsense, and that the proper thing for a farmer to do was farming.

For over a year Bentley experimented with the microscope, the camera, and the dry plates of that day that were used to record the photographic image. He knew nothing about photography and failure followed upon failure. But through persistence and learning by trial and error he slowly approached his goal. He learned how to work rapidly before the ice

crystal changed shape, how to use transmitted light by pointing the camera to the sky, and how to get sharpness of detail on the crystal by using a large f-stop. And then, during a snowstorm on 15 January 1885, he obtained the first photomicrographs ever taken of an ice crystal:

> The day that I developed the first negative made by this method, and found it good, I felt almost like falling on my knees beside that apparatus and worshipping it! It was the greatest moment of my life.

(A snowflake is usually composed of many ice crystals that collide and stick together as they fall. But almost always individual ice crystals can he found in any snowfall. Sometimes, when it is snowing lightly, the air contains a multitude of twinkling ice crystals which drift slowly earthward to produce a blanket of snow.)

For 13 years Bentley worked quietly and obtained over 400 photomicrographs of ice crystals. He kept detailed meteorological records, and pondered over the meaning of the shapes and sizes of the crystals and why they often varied from one storm to the next. The outside world had yet to hear from him. He was shy and soft-spoken, and felt that his meager education prevented him from discovering anything which had not been found by research workers in the universities. Interestingly enough it was a university professor, George Perkins of the University of Vermont, who heard of Bentley's work and convinced him that he did indeed have something worthwhile to tell the outside world. His first article was published in 1898 in Appleton's *Popular Scientific Monthly*. In that article we see the style that was to characterize all of his writing; Bentley observed nature with both the eye of the poet and the eye of the scientist. Listen to what he has to say concerning the structure of an ice crystal:

> A careful study of this internal structure not only reveals new and far greater elegance of form than the simple outlines exhibit, but by means of these wonderfully delicate and exquisite figures much may be learned of the history of each crystal, and the changes through which it has passed in its journey through cloudland. Was ever life history written in more dainty hieroglyphics!

This publication opened the floodgates of Bentley's creativity and over the next ten years he observed, photographed, and experimented with ice crystals, raindrops, and dew. He wrote many popular and technical articles, most of them on his studies of ice crystals. His main ideas were set forth in detail in a number of scientific papers in the *Monthly Weather Review*. A 1902 paper, one of the most extraordinary and detailed of his writings, exploded with ideas and hypotheses. The previous winter had been a frenzy of activity for Bentley and he obtained over 200 photomicrographs! His analysis of his data convinced him, among other things, that different segments of a storm (east, north, etc.) produced their own predominant type of ice crystal, that the form of the crystal (stellar, hexagonal plates, etc.) was a function of the air temperature, that the circulation within the storm could be deduced from the crystal structure, and that the change in form often noted in a single crystal reflected the changes in the temperature of the air through which the crystal fell on its journey to the ground. In this latter suggestion, which Bentley discussed in detail, he was years ahead of the

meteorological thinking of his time. Thirty years were to pass before Nakaya in Japan was to consider it again.

During the summer months Bentley's curiosity was directed to the problem of the origin of rain. In his day hundreds of routine measurements were being made across the country of the amount of rain that fell per day or per Weak, but no one thought to ask the important question concerning the sizes of the raindrops. No one, that is, except Wilson Bentley. He reasoned, quite correctly, that if you wish to find out how rain is formed there was no better place to start than by measuring the sizes of the raindrops. In the year 1898 he began his studies on rain, for he had "the desire to add, if possible, a little to our knowledge regarding rainfall phenomena. . . ." And add he did. For seven years, from 1898 through 1904, he made 344 measurements of the sizes of raindrops from seventy different storms. In 1904 he published, again in the *Monthly Weather Review*, an incredible paper which on the basis of ingenuity and number of new ideas is perhaps unmatched in the world's scientific writings on raindrops and raindrop phenomena.

What did Bentley discover about rain? What didn't he! He found that the largest raindrops are about one-quarter of an inch in diameter (about 6 mm). He suggested that in some cases the size was determined by the size of snowflakes high within the cloud-the flakes had melted before they got to the ground. Bentley went on to tell how he had found different sizes of raindrops in different types of storms. He believed that there was a connection betWean lightning and raindrop size. And from an examination of his hundreds of raindrop samples he deduced that rain could have its origin either from melting snow or from a process that involved no ice or snow at all. But sometimes, he concluded, the sizes of the raindrops indicate that both processes may have operated at the same time. We know today that most of what Bentley suggested is indeed true, although some of his ideas are still being debated. Most astonishing of all is that he recognized a dual origin of rain, an idea that has been firmly established only in the past 20 or 30 years.

Are you curious about how Bentley measured the sizes of raindrops? The first measurements ever made of drop size were done in England only three years before Bentley began his work. Did Bentley know about it? Apparently not, for he never mentioned it nor did he copy the technique of measuring the size of the splash when raindrops hit a piece of slate or dyed paper. He developed an ingenious method of measuring raindrop size that utilized materials found in his own farmhouse. He took some flour from the kitchen, sifted it into a pan until he had a layer about an inch deep. He exposed the pan of flour to the falling rain for several seconds. Each raindrop soaked up some flour and formed a tiny dough pellet. When the pellets were dry he measured them and so found the size of the original raindrop. By dropping drops of known size from the end of broom splints into the flour he found that the diameter of the dough pellet was about equal to that of the drop. This simple yet effective technique is still being used today.

These years of excitement and discovery occurred shortly after Bentley's father had died. He had the problem of taking care of his mother, who by this time was an invalid, and of running the farm. He shared the operation of the farm with his brother who, with his wife and eight children, lived in one half of the old farmhouse. The farm did well and they built it up from a ten to a twenty-cow dairy farm. And Bentley

did his share of the work. Though small in size, probably not more than 120 pounds in weight and little over 5 feet in height, he was agile, muscular, and extremely well coordinated. He could dig a row of potatoes and pitch hay as fast as any other farmer in the valley. Although introverted and sensitive, his sense of humor and gentle nature made him liked by all. Nevertheless, many of the people in the village, like his father and brother, thought him just a bit odd and he was the butt of many a village joke.

One long time Jericho resident told this writer that one night he went to a kitchen tunk (square dance) at a local farmhouse. Bentley was there, too. Shortly before the dance was over a number of the boys sneaked outside to where Bentley's horse and buggy were waiting, and reversed the large rear wheels with the smaller front wheels. Then they hid and waited to see Bentley's reaction when he came out. But there was no reaction! "He went home like that and drove the buggy several days before he noticed it. I don't know what you'd call that." One might call it absentmindedness or one just might call it an example of Willie Bentley's puckish humor. Maybe he knew that the wheels had been reversed from the start and simply decided to play along with the game.

Bentley never married though it appears he came close to it once or twice. After the death of his mother he lived alone in his side of the house. His bachelor's quarters were a sort of organized confusion. A kitchen stove, a huge wood box, a couple tables, a piano covered with piles of sheet music, movie magazines, books, manuscripts, odds and ends of experiments, photographic equipment, correspondence, and photographs of ice crystals all blurred together in one large room. But somehow, by methods known only to him, Bentley was able to find things when he wanted them.

He was polite and never aggressive in his speech, but his excitement showed when he began talking about nature. He had delicate, rounded facial features and was described as being handsome in his youth. A well-groomed shock of dark hair receded with the years until at age 60 his hairline ran vertically over his head from ear to ear. As if to counteract this, he grew a large, bushy mustache. He had no real use for clothes, and his only dress-up suit served his purposes for many a year. It was shiny and green with age, and desperately in need of pressing. In the winter he kept warm in a large, dark overcoat and a soft felt hat that was clamped tightly to his head with a long scarf that came down over his ears and was tied beneath his chin.

He had musical talents and had been taught to play the piano, probably by his mother. He also could play the clarinet, cornet, and violin. But the piano was his favorite. He would entertain himself and the neighborhood children by playing and singing the popular songs of the day. With his clarinet he played in a small brass band that he had organized. And with his violin and his humor he entertained the villagers by imitating birdcalls, frogs, barnyard animals, and certain people in the village!

Willie Bentley seldom complained about anything, and he seldom got angry. He loved people, and he loved the world of nature, that grand, mysterious world that produced the ice crystals, the rain, the fog, and the dew. He had a very special view of this world and was often saddened because he could not communicate what he saw to others. In

this was both the triumph and the tragedy of the life of Wilson Bentley. At this point in his life, about 1910, he was 45 years old, and though he would live another 21 years the majority of his creative contributions had been made. Although they would be little recognized during his lifetime, they were permanently recorded in the pages of the *Monthly Weather Review*. They could not be erased or lost. That was his triumph.

His tragedy was the wall of silence that greeted his work during these years. When asked toward the end of his life what his neighbors thought of him, Bentley replied,

> Oh, I guess they've always believed I was crazy, or a fool, or both. Years ago, I thought they might feel different if they understood what I was doing. I thought they might be *glad* to understand. So I announced that I would give a talk in the village and show lantern slides of my pictures. They are beautiful, you know, marvelously beautiful on the screen. But when the night came for my lecture just **six** people were there to hear me. It was free, mind you! And it was a fine, pleasant evening, too. But they weren't interested.

Could we really expect them to be interested? How many people, even today when science is a prime mover in our society, are really interested in science? Very few. They may respect it but do not understand it, and thus have little interest in it. In 1910 the villagers of Jericho did not understand what Bentley was doing, and quite naturally they showed little interest in his work. They were practical Vermont farmers who understood that they had to plant so many acres of corn or potatoes, and that a herd of cows had to be milked twice a day. They well understood this and thus they were interested in it. They found it difficult to understand why one of their kind would waste his time looking at snow, raindrops, or dew. This would never bring in more money or make the crops grow faster. The price that Bentley had to pay in loneliness is the price that all must pay whose inner vision allows them to see what others can never see.

We can understand the reaction of Bentley's friends and neighbors to his work, but it is not so easy to understand the reaction of the world of science. This was silence, utter and complete. During the ten years that Bentley's creative efforts were at their maximum not one article by others about his work appeared in the *Monthly Weather Review*. None of the many brilliant ideas suggested by Bentley in his articles was ever followed up by other meteorologists. His work wasn't even mentioned! Even criticism of his efforts would have been better than no comment at all. One can only conjecture as to the reasons for this silence from the world of meteorology. Was it because of an intellectual arrogance that blinded the PhD's of the world of science from realizing that a "simple farmer" could also discover the truths of nature? Or was it because Bentley revealed his emotions in his writings, a heresy in the objective world of science writing. No doubt both contain an element of truth, but probably the main reason was that Bentley and his ideas were far ahead of his time. No scientists in America in the first 10 years of this century understood anything about the sizes of raindrops, or how ice crystals formed in storms, or whether lightning had anything to do with it. Bentley travelled alone into a new research frontier.

Although Bentley's inner drive to know and understand was exceedingly strong, and he was capable of spending many long and lonely years in this pursuit, he needed someone in the world of science with whom he could share the excitement of crossing the frontiers of knowledge. The creative person cannot work forever in a vacuum; he must communicate and interact with his peers. Bentley did not have this interaction, and this may have been the reason why he did little creative work after about 1910.

But he never stopped thinking. He was just as excited as ever about the world around him. But he began to write more and more for the general public. The poet and the artist in Bentley took over. He had to tell of the beauty and the elegance he saw in the world of the ice crystals, the frost and the dew. He wrote many articles for such magazines as *Country Life*, *National Geographic*, *Popular Mechanics*, and *The New York Times Magazine*. He began to lecture more and more, not only to local groups in surrounding communities but to scientific organizations like the Buffalo Museum of Science and the Franklin Institute in Philadelphia. He prepared boxes of lantern slides of dew, frost, ice crystals, and clouds. He sold these at little or no profit to himself, and in the 1920's dozens of colleges and universities in America had the Bentley slides to show to students in the sciences. No doubt these slides still exist, buried in the back of instrument rooms beneath years of accumulated dust.

By 1920 Bentley was known to thousands, not by name but as the Snowflake Man. The best of his photomicrographs were in demand by jewelers, engravers, and by the textile industry. He kept busy supplying the outside world with his latest pictures while continuing his work in his own world, the world of his farm and the surrounding valley. His mind was always active and his interests seemed to know no bounds. He studied the aurora and kept detailed records of its appearance in the northern sky. He made weather observations three times a day, recording the type and amount of low, middle, and high clouds, temperature, and precipitation. He was an amateur geologist, and roamed the countryside collecting rock specimens for his collection. He wanted others to see the beauty of nature and contributed to the Fresh Air Fund to help bring city children to the countryside. His admiration for the delicate beauty of the ice crystal extended itself to the delicate beauty of girls faces, especially their smiles. He made a catalog of smiles such as he made a catalog of ice crystals. He often would question a strange girl on the street who was smiling in a certain way. "I found many possessing charming smiles. When complimented and questioned if they knew why they smiled prettily, the lucky possessors answer was invariably 'no.' " One wonders what unspoken questions the girls had after such encounters!

In 1924 the first research grant ever awarded by the American Meteorological Society was given to Bentley for ". . .40 years of extremely patient work." The grant was no doubt small but it was the recognition by the scientific community that meant most to Bentley. He had never been overly concerned with money, and certainly made no attempt to make his studies into a profit-making venture. It is likely that he could have, had he wanted to. In the balance sheet of life he gave the acquisition of money a very low priority. In 1926 he made this clear when he said, "From a practical standpoint I suppose I would be considered a failure. It has cost me $15,000 in time and materials to do

the work and I have received less than $4,000 from it."

A few years later Dr. William J. Humphreys, chief physicist for the United States Weather Bureau, responding to requests from all over the country to preserve in one collection the best of the Bentley photomicrographs, organized a drive to obtain the necessary financial support. He was successful, and Bentley turned to the enormous task of sorting through some 4,500 photomicro graphs. For one reason or another the work went slowly but, finally, in the summer of 1931 the material was handed in to the publisher. In November the book, "Snow Crystals," was published. It had a short introduction by Humphreys, but by far the major part of the book was a magnificent collection of nearly 2,500 photomicrographs. Most of the pictures were of various forms of the ice crystal; about 100 were of frost and dew. In Jericho Bentley received a copy of the book but, unfortunately, we have no record of how he felt when he held in his hands the work of a lifetime, a work now preserved for all the world to see.

But winter was fast approaching and he had little time to admire the book. He was 66 years old, and though in good health did not get around or do things quite as rapidly as he had before. The camera had to be ready for the first snow. This was the same camera with which he had taken his first photomicrograph 46 years before. It was old, it was battered, but it still worked. With it he had taken his 5,381st photomicrograph on the first of March of the preceding spring. He looked forward to the winter ahead with as much zest as he had approached that first winter with the camera.

He made routine entries in his log book of weather conditions, entries that marched over the pages and through the years to give a unique record of weather in that part of Vermont. On Monday, the 7th of December, 1931, he finished his entry, "Cold north wind afternoon. Snow Flying." That was the last entry Wilson Bentley was ever to make.

The following week both his nephew and wife knew that something was wrong. Bentley stayed in bed for several days, but he refused any help. Nothing was wrong, he said, he had taken care of himself for over 40 years and he didn't need any help now. But by the end of the next week it was clear that something was very much wrong. A doctor was called but it was too late. Wilson Bentley died of pneumonia on the afternoon of the 23rd of December, 1931.

The following day the obituary columns of many a newspaper across the country reported his death. But perhaps the most poignant and understanding comments came from his own hometown paper.

> Longfellow said that genius is infinite painstaking. John Ruskin declared that genius is only a superior power of seeing. Wilson Bentley was a living example of this type of genius. He saw something in the snowflakes which other men failed to see, not because they could not see, but because they had not the patience and the understanding to look.
>
> Truly, greatness blooms in quiet corners and flourishes under strange circumstances. For Wilson Bentley was a greater man than many a millionaire who lives in luxury of which the 'Snowflake Man' never dreamed.

His friends and neighbors had understood him after all.

Postscript

In writing this brief account of the life of Wilson Bentley I have not been completely objective. I didn't intend to be; in fact, I couldn't be. Any biographical account must be partly subjective, for all the facts that detail a person's life are never known, even by the person himself. In Bentley's case the facts are few and far between. I have talked to many people about Bentley and written to many more. I believe I know most of the published material by and about Bentley, but still the gaps exist. I need help in filling these gaps, for I would like to attempt the much more detailed biography that Bentley deserves. I would appreciate it if you would share with me any information you may have on Bentley. If you knew him, if you heard him lecture, if you have any pictures of him or any of his letters I would be most happy to hear from you. His letters especially would be very welcome. The voluminous correspondence that was in the farmhouse at the time of his death appears to have been lost. But much must still exist; the few letters that have been sent to me have been very informative.

I cannot list here all those with whom I have corresponded or talked with. But there are three I must mention. Mrs. Harold Hunt of Jericho, the former Amy Bentley who as a child lived in the other side of the Bentley farmhouse, has been very helpful with her childhood memories of Wilson Bentley. Miss Blair Williams of the University of Vermont is to be complimented for her efforts to tell what she knows of the Bentley story not only to me, but through television to the citizens of Vermont. And to Miss Ruth Nash of Pollack Pines, California, and her indomitable spirit, my thanks for her lively and detailed accounts of Jericho and Wilson Bentley of some 70 years ago.

The Major Scientific Publications of Wilson A. Bentley

1. Bentley, W. A., and G. H. Perkins. A study of snow crystals. *Appleton's Pop. Sci. Mon.* 53-1 (May 1898), 75-82.

   A description of snowflake photography is given. Three pages of plates are shown.

2. Bentley, W. A. Twenty years' study of snow crystals. *Mon. Wea. Rev.* 29-5 (May 1901), 212-14.

   This is his first paper in the *Monthly Weather Review*.

3. Bentley, W. A. Studies among the snow crystals during the winter of 1901-2, with additional data collected during previous winters. *Mon. Wea. Rev.* 30-13 (Annual 1902), 607-16.

   Here he attempts to classify the crystals as a function of temperature and to deduce from the crystal form the temperature and wind profile within the cloud. This was the major contribution in this paper. In this he was far ahead of his time. The paper is accompanied by 264 photomicrographs.

4. Bentley, W. A. Studies of raindrops and raindrop phenomena. *Mon. Wea. Rev.* 32-10 (Oct. 1904), 450-56.

This is the first study of raindrops in the United States and one of the best ever carried out. He sampled from 70 storms and made deductions concerning the segment of the Storm that gave drops of certain sizes. He commented on a relation betWean lightning and drop size and discussed the evaporation of drops. His greatest insight was the recognition of the dual origin of rain. It can evolve from snow or via coalescence. Here again Bentley was many years ahead of his time. All the raindrop samples were obtained with his flour method.

5. Bentley, W. A. Snow rollers. *Mon. Wea. Rev.* 34-7 (July 1906), 325-26.
6. Bentley, W. A. Studies of frost and ice crystals. *Mon. Wea. Rev.* 35-8-12 (Aug.- Dec. 1907), 348-52, 397403, 43944, 512-16, 584-85.

   This is a long and detailed account which includes 279 photomicrographa of frost and hail. He discusses at length the origin of frost crystals and their classification. He also discusses the formation of hail.

7. Bentley, W. A. Photomicrographa of snow crystals, and methods of reproduction. *Mon. Wea. Rev.* 46-S (Aug.1918), 359-60.
8. Bentley, W. A. The magic beauty of snow and dew. *Nat. Geog. Meg.* 43-1 (Jan. 1923), 103-112.

   The short text is accompanied by over 100 photomicrographa of ice crystals, frost patterns, and dew. He says the beauty of snow was known long ago for in the book of Job is "Hast thou entered into the treasures of the Snow?"

9. Bentley, W. A. Forty years' study of snow crystals. *Mon. Wea. Rev.* 52-11 (Nov. 1924), 530-32.

   Bentley's collection now numbers 4,200 photomicrographa. In this article he discusses, among other things, bubbles in ice crystals and the supercooling of cloud drops to around 0 degrees F.

10. Bentley, W. A. Some recent treasures of the snow. *Mon. Wea. Rev.* 55-8 (Aug. 1927), 358-59.

    He now has over 4,700 photomicrographs. He talks of past years and tells of his work with Professor Barnes at McGill University. He mentions an increased interest the world over in snow crystals. His text alternates from scientific talk to exclamations of beauty. He ends with "Perhaps it is not too much to say that the results of his studies form one of the 'little romances of science.'"

11. Bentley, W. A. Conical snow. *Mon. Wea. Rev.* 59-10 (Oct.1931), 388.

    This is a short paper of only two paragraphs. The same paper, with an added first sentence, was in *Science*, 75-1945 (8 Apr. 1932). 383.

12. Bentley, W. A., and W. J. Humphreys. *Snow Crystals*. New York, McGraw-Hill Book Co., 1931. 227 pp.

An unabridged and unaltered replication of the work was published by Dover Publications in 1962. It is a paperback and well worth the $3. The book contains only about 10 pages of text, but about 200 pages of photomicrographs. Nearly 2,500 photomicrographs are shown, most of snow crystals but some of dew, frost, and hail.

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