

Chemistry, Physics, Technology, etc.

BIELA'S COMET AND THE METEORS OF NOVEMBER 27TH.

BY PROFESSOR DANIEL KIRKWOOD.

The fact that comets on their approach to the sun have at times undergone the process of dissolution is abundantly sustained by recorded observations. The latest and most remarkable instance of such disintegration is that of Biela's comet. This body completes its revolution about the sun in a little more than six years and eight months. Shortly before its perihelion passage in January, 1846, it was seen to separate into two distinct fragments. Astronomers, anxious to see whether the parts had remained separate during an entire revolution, awaited the return in 1852 with more than ordinary interest. The *two comets* appeared at the predicted time; their distance from each other having increased to more than five times that of the moon from the earth.

At the next return, in May, 1859, both comets escaped detection. This was attributed solely to the fact that the relative positions of the comets, the earth, and the sun, were unfavorable for observation.

It will be noticed that three periods of the comet are very nearly equal to twenty years. Hence the perihelion passage of January, 1866, like that of 1846, was in circumstances favorable to telescopic scrutiny. A diligent watch was maintained during several weeks for the expected wanderers: the search, however, was without success. It was accordingly inferred that the same cause which had produced the bi-partition in 1845 had occasioned a still further separation, so that the dissevered fragments had become invisible. The comets were again due in September, 1872, but escaped, as before, the most powerful telescopes.

The orbit of the original comet intersected that of the earth at the point passed by the latter about the 29th of November. A collision of the two bodies was therefore inevitable in case they should both reach this point of intersection at the same time. To quiet the apprehension of such a catastrophe, M. Arago showed that a collision could not reasonably be expected for thousands or even millions of years to come. It is evident, however, that the probability of impact must be vastly increased by the disintegration of the comet and the diffusion of its fragments around a considerable arc of the orbit. Now, as it is well known that the comets connected with the meteoric streams of August 10th and November 14th have been for many cen-

turies in the process of dissolution, it is altogether probable that the breaking up of Biela's comet did not commence with the *visible* separation in 1845. Analogy therefore led astronomers to expect the appearance of meteors—the products of disintegration—about the last of November. The fact was noticed several years since that a considerable number of meteoric stones had fallen at this epoch. It is also known that a shower of falling stars was observed in France on the 29th of November, 1850.

Now as the greater part of the matter which constituted the comet of Biela must have passed the earth's orbit (in 1872) but a few weeks previous to the earth's arrival at the point of intersection, it seemed not improbable that parts of the cluster might still be passing during the last days of November. Professor Newton, of Yale College, actually detected these straggling fragments on the evening of November 24th, 1872. During five hours he counted 250 meteors, over three-fourths of which radiated from Gamma Andromedæ. A more remarkable shower, however, was observed in Indiana on the evening of November 27th. Professor Joseph Tingley, of Greencastle, counted 110 in forty minutes. This would give 165 per hour for one observer. But according to Professor Newton, the whole number visible at any station, when the sky is entirely clear, is five times the number seen by a single observer. The enumeration by Professor Tingley accordingly indicates an actual fall of 825 per hour. At Princeton, Indiana, Professor D. Eckley Hunter, with assistants, counted 70 meteors in thirty minutes; the position of the observers being such that more than one-half of the sky could not be seen. Again on the evening of December 3d, at about 10½ o'clock, an extraordinary meteor was seen at Bloomington, Indiana. Its apparent magnitude was estimated at one third that of the full moon. Its light, which was of a bluish tinge, illuminated, like a flash of lightning, all objects on which it fell. It appeared a little North of East, at an altitude of about 35°, and the direction of its motion was nearly conformable to the radiant observed by Professor Newton on the 24th of November. It seems therefore not improbable that it may have been a straggling member of the same group.

As the meteors of this cluster are doubtless the *debris* of Biela's comet, if we find the epoch at which the original body would have crossed the earth's orbit *near* the 29th of November, we may regard the collision of our planet with some of the large fragments—and hence a grand meteoric display—as highly probable at the same period. An easy calculation, which need not here be repeated, gives

the last of November, 1892, as such an epoch. The phenomena will doubtless be looked for with a very lively interest.

Bloomington, Ind., Dec. 5th, 1872.

BITUMINOUS COAL ; ITS ORIGIN, VARIETIES AND A FEW OF ITS SPECIAL USES.

The substance of a paper presented at the Dubuque Meeting of the American Association for the Advancement of Science.

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(Continued from page 69.)

In the ooze the *Stigmaria* almost reveled, penetrating it in every direction, and these curious vegetable forms with their spreading rootlets are bound in the greatest abundance in cannel coals, all flattened but in exquisite preservation. The existence of so many *Stigmaria* in the cannel coals, the beds of which extend often for many miles, almost necessitates the conclusion that they grew *in situ*. If the *Stigmaria* is always a true root of *Sigillaria*, or other tree, as held by Dawson and others, we must conclude that trees, having their roots attached, grew in the wettest parts of the marsh, which were, therefore, not open lagoons as some have supposed. But Dawson asserts that "*Sigillaria* grew on the same soils which supported Conifers, *Lepidodendra*, *Cordaites* and ferns, plants which could not have grown in water." He also claims that most of the underclays which, so far as I know, universally contain rootlets of *Stigmaria* "are, in short, loamy or clay soils, and must have been sufficiently above water to admit of drainage."

These views require us to believe that the *Stigmaria* could not have grown where they are found in cannel coal, but were floated to their present places as detached fragments.

If thus floated we should expect that they would show sometimes local accumulation on drifted heaps. So far as my observations go, they are very evenly distributed over the whole cannel coal area. Moreover, if detached and floated bodies and afterwards buried in the accumulating mud, we should naturally expect them also to go to decay and form vegetable muck similar to the surrounding mass. On the other hand, Lesquereux, Goldenberg and others hold that the true *Stigmaria* was an aquatic plant. Lesquereux thus writes: "It is my belief that the genus *Stigmaria* does not represent tree roots, but floating stems, of which species of the genus *Sigillaria* constitute the flowers or fruit-bearing stems." It was, if I understand his views, only under favorable circumstances that these stems preceded the