

in three layers, the first being 1 foot, the second 1 ft. to 1 ft. 6 in., and the third 1 ft. 6 in. to 2 ft. from the bottom of the silo. By doubling the figures of the bottom layer analysis, adding these to the second and third layer analysis, and dividing by 4, we obtain a fair representation of the average composition of the silage taken throughout the silo, for by so doing we obtain the average of the analyses of each 6-inch layer of silage. The results of the analyses are as follows, calculated on the dry matter. The moisture was practically the same, being 70.48 per cent. in the grass and 72.97 in the silage.

*Composition of Grass and Silage (dried at 100° C.).*

	Grass.	Ensilage.
Fat (ether extract).....	2.80	5.38
Soluble albuminous compounds..	3.06	5.98
Insoluble albuminous compounds..	6.94	3.77
Mucilage, sugar, and extractives, etc. ....	11.65	4.98
Digestible fiber.....	36.24	33.37
Indigestible woody fiber.....	32.33	31.79
	93.02	85.27
Soluble mineral matters.....	5.24	12.62
Insoluble mineral matters.....	1.74	2.11
	100.00	100.00

The striking difference in the mineral matter of the grass and silage I will merely draw attention to; it is not due to the salt added to the silage. I may say, however, that other analysts and I myself have found similar striking differences. For instance, Prof. Kinch\* found in grass 8.50 per cent. mineral matter, in silage 10.10 per cent., which, as he points out, is equivalent to a "loss of about 18 per cent. of combustible constituents"—a loss which we have no proof of having taken place. In Mr. Smetham's sample the loss would have to be 50 per cent., which did not occur, and in fact is not possible. What is the explanation?

I am, however, considering now the organic constituents. Calculating the percentages of these in the grass and silage, we obtain the following figures:

*Percentage Composition of Organic Compounds.*

	Grass.	Ensilage.
Fat (ether extract).....	3.01	6.31
Soluble albuminous compounds..	3.29	7.01
Insoluble ".....	7.46	4.42
Mucilage, sugar, and extractives	12.52	5.84
Digestible fiber.....	38.96	39.14
Indigestible woody fiber.....	34.76	37.28
	100.00	100.00

The difference in the total nitrogen in the grass and silage is equal to 0.68 per cent. of albuminoids. Practically it is a matter of impossibility that the nitrogen could have increased in the silo, and it will be a very safe premise upon which to base any further calculations that the total amount of nitrogen in the silage was identical with that in the grass. There may have been a loss, but that is not yet proved. Arguing then upon the first hypothesis, it is evident that 100 parts of the organic matters of silage represent more than 100 parts of the organic matter of grass, and by the equation we obtain 10.75 : 11.43 :: 100 : 106 approximately. If now we calculate the composition of 106 parts organic matter of grass, it will represent exactly the organic matter which has gone to form 100 parts of that present in silage.

The following table gives these results, and also the loss or gain in the various constituents arising from the conversion into silage:

*Organic Matter.*

	In 106 pts. Grass.	In 100 pts. Silage.	Loss or Gain.
Fat (ether extract).....	3.19	6.31	+3.12
Soluble albuminous compounds	3.49	7.01	+3.52
Insoluble ".....	7.91	4.42	-3.49
Mucilage.....	13.27	5.84	-7.43
Digestible fiber.....	41.30	39.14	-2.16
Indigestible woody fiber.....	36.84	37.28	+0.44
	106.00	100.00	

These calculations show, provided my reasoning be correct, that the chief changes which take place are in the albuminous compounds, which has already been pointed out by Professors Voelcker, Kinch, and others; and in the starch, gum, mucilage, sugar, and those numerous bodies termed extractives, which was to be expected. But they show most conclusively that the "decrease in the amount of indigestible fiber and increase in digestible" so much spoken of is, so far as our present very imperfect methods of analyzing these compounds permit us to judge, a myth; and I have not yet found any sufficient evidence to support this statement. A loss, then, of 6 parts of organic matter out of every 106 parts put into the silo has in this instance taken place, due chiefly to the decomposition of starch, sugar, and mucilage, etc. And as the grass contained 70 parts of water when put into the silo, the total loss would only be 1.7 per cent. of the total weight. This theoretical deduction was found by practical experience correct, for Mr. Smith, agent to Lord Egerton, upon whose estate this silage was made, in his report to Mr. Jenkins says the "actual weight out of the silo corresponds exactly with the weight we put into the same."

In my judgment these figures are of interest to the agricultural chemist for many reasons. First, they will clear the ground for future workers and eliminate from their researches what would have greatly complicated them—changes in the cellulose bodies.

Secondly, they are of interest because our present methods of distinguishing between and estimating digestible and indigestible fiber is most rough, and probably inaccurate, and may not in the least represent the power of an animal—say a cow—to digest these various substances; and most of us know that when a new method of analysis becomes a necessity, a new method is generally discovered. Lastly, they are of interest to the agriculturist, for they point out, I believe for the first time, the exact amount of loss which grass—or at least one sample—has undergone in conversion into silage, and also that much of the nitrogenous matter is changed, and so far as we know at present, lost its nutritive value. This, however, is only comparing silage with grass. What is wanted is to compare silage with hay—both made out of the same grass. Then, and then only, will it be possible to sum up the relative advantages or disadvantages of the two methods of preserving grass as food for cattle.—*Chem. News.*

\* *Journ. Chem. Society*, March, 1884, p. 124.

THE ILLUMINATING POWER OF ETHYLENE.

DR. PERCY FRANKLAND has obtained results which may be thus briefly summarized: (1.) That pure ethylene, when burnt at the rate of 5 cubic feet per hour from a Referee's Argand burner, emits a light of 68.5 standard candles. (2.) That the illuminating power of equal volumes of mixtures of ethylene with either hydrogen carbonic oxide or marsh-gas is less than that of pure ethylene. (3.) That when the proportion of ethylene in such mixtures is above 63 per cent. the illuminating power of the mixture is but slightly affected by the nature of the diluent. When, on the other hand, the proportion of ethylene in such mixtures is low, the illuminating power of the mixture is considerably the highest when marsh-gas is the diluent, and the lowest when the ethylene is mixed with carbonic oxide. (4.) That if 5 cubic feet of ethylene be uniformly consumed irrespectively of the composition of the mixture, the calculated illuminating power is in every case equal to or actually greater than that of pure ethylene until a certain degree of dilution is attained. This intrinsic luminosity of ethylene remains almost constant when the latter is diluted with carbonic oxide, until the ethylene forms only 40 per cent. of the mixture, after which it rapidly diminishes to zero, when the ethylene forms only 20 per cent. of the mixture. When the ethylene is diluted with hydrogen, its intrinsic luminosity rises to 81 candles when the ethylene constitutes 30 per cent. of the mixture, after which it rapidly falls to zero when the ethylene amounts to only 10 per cent. In the case of mixtures of ethylene and marsh-gas, the intrinsic luminosity of the former is augmented with increasing rapidly as the proportion of marsh gas rises, the intrinsic luminosity of ethylene, in a mixture containing 10 per cent. of the latter, being between 170 and 180 candles.

DIFFRACTION PHENOMENA DURING TOTAL SOLAR ECLIPSES.\*

By G. D. HISCOX.

THE reality of the sun's corona having been cast in doubt by a leading observer of the last total eclipse, who, from the erratic display observed in the spectroscopic, has declared it a subjective phenomenon of diffraction, has led me to an examination and inquiry as to the bearing of an obscurely considered and heretofore only casually observed phenomenon seen to take place during total solar eclipses. This phenomenon, it seems to me, ought to account for, and will possibly satisfy, the spectroscopic conditions observed just before, during, and after totality; which has probably led to the epithet used by some leading observers—"the flicker corona." The peculiar phenomenon observed in the spectroscopic, the flickering bands or lines of the solar spectrum flashing upon and across the coronal spectrum, has caused no little speculation among observers.

The diffraction or interference bands projected by the passage of a strong beam of light by a solid body, as discovered long since by Grimaldi, and investigated later by Newton, Fresnel, and Fraunhofer, are explained and illustrated in our text books; but the grand display of this phenomenon in a total solar eclipse, where the sun is the source of light and the moon the intercepting body, has as yet received but little attention from observers, and is not mentioned to my knowledge in our text books.

In the instructions issued from the United States Naval Observatory and the Signal Office at Washington for the observation of the eclipse of July 29, 1878, attention was casually directed to this phenomenon, and a few of the observers at Pike's Peak, Central City, Denver, and other places have given lucid and interesting descriptions of the flight of the diffraction bands as seen coursing over the face of the earth at the speed of the moon's shadow, at the apparent enormous velocity of thirty-three miles per minute, or fifty times the speed of a fast railway train.

From a known optical illusion derived from interference or fits of perception, as illustrated in quick moving shadows, this great speed was not realized to the eye, as the observed motion of these shadows was apparently far less rapid than their reality.

The ultra or diffraction bands outside of the shadow were distinctly seen and described by Mr. J. E. Keeler at Central City, both before and after totality. He estimates the shadow bands at 8 inches wide and 4 feet apart.

Professor E. S. Holden, also at Central City, estimated the dark bands as about 3 feet apart, and variable.

From estimates which he obtained from other observers of his party, the distances between the bands varied from 6 to 1½ feet, but so quickly did they pass that they baffled all attempts to count even the number that passed in one second.

He observed the time of continuance of their passage from west to east as forty-eight seconds, which indicates a width of 33 miles of diffraction bands stretching outward from the edge of the shadow to the number of many thousands.

Mr. G. W. Hill, at Denver, a little to the north of the central track of the shadow, observed the infra or bands within the shadow, alluding to the fact that they must be moving at the same rate as the shadow, although their apparent motion was much slower, or like the shadows of flying clouds. He attributes the discrepancy to optical illusion.

At Virginia City the colors of the ultra bands were observed, and estimated at five seconds' duration from the edge of the shadow, which is equal to about 4 miles in width. These are known to be the strongest color bands in the diffraction spectrum, which accounts for their being generally observed.

Mr. W. H. Bush, observing at Central City, in a communication to Prof. Holden alludes to the brilliancy of the colors of these bands as seen through small clouds floating near the sun's place during totality, and of the rapid change of their rainbow colors as observed dashing across the clouds with the rapidity of thought.

All of these bands, both ultra and infra, as seen in optical experiments, are colored in reverse order, being from violet to red for each band outward and inward from the edge of the shadow.

It is very probable that the velocity of the passage of all the bands during a total eclipse very much modifies the distinctness of the colors or possibly obliterates them by optically blending so as to produce the dull white and black bands which occupied so large a portion of this grand panorama.

The phenomenon of these faint colored bands, with the observed light and dark shadows, may be attributed to one or all of the following causes:

1. A change in the direction of a small portion of the sun's light passing by the solid body of the moon, it being deflected outward by repulsion or reflection from its surface, and

\* A paper read before the American Astronomical Society, May 5, 1884.

other portions being deflected inward after passing the body by mutual repulsion of its own elements toward a *light vacuum* or space devoid of the element of vibration.

2. The colored spectral bands being the direct result of the property of interference, or the want of correspondence of the wave lengths due to divergence; the same phenomenon being also observed in convergent light. This is practically illustrated in the hazy definition of the reduced aperture of telescopes, and its peculiarities shown in the spectral rings within and beyond the focus.

3. Chromatic dispersion by our atmosphere, together with selective absorption, also by our atmosphere and its vapors, have been suggested as causes in this curious and complicated phenomena.

In none of the reports descriptive of the phenomena of polarization of the corona is there the slightest allusion to the influence that the diffraction bands may possibly have in modifying or producing the various conditions of polarization observed; although these observations have been made and commented upon during the past twenty-five years.

Investigations now in progress of the modifying relation of the phenomenon of diffraction in its effect upon not only the physical aspect of the corona, but also in some strange spectroscopic anomalies that have been observed near the sun at other times than during a total solar eclipse, will, it is hoped, result in a fuller interpretation of the physical nature of one of the grandest elements of creation—*light*; let there be more of it.

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