ness that overwhelmed the Roman empire pervaded Britain, as well as every other portion of it, but the wickedness was essentially Roman; neither Engla, Sexna nor Celts, except with those limitations already pointed out, those who had made themselves parcel of the Roman government, had anything to do with it but to sweep it away from the face of the earth which it had polluted so long. Two of the kings are named as being of the Devonians and South Welsh, the others might belong to North Wales, Cumberland, and Strathclyde; but the people of the two last were of Teutonic blood. Whoever will read the 7th book of Salvianus of Marseilles, DE GUBERNATIONE DEI, will have no doubt that these cives Britones or Britanni, were the Roman provincials, the Romani of Salvianus.

We have seen in 369, that a Roman legion was sufficient, with the help of the Britanni, to put down the native party. At a later period, three ceols, which would hardly contain fifty men each, were enough to destroy utterly the Roman provincials. The Picti had already assumed their national appellations of English and Sexe, and the Britanni were soon lost in the primitive Cymry. The Roman empire was in a state of rapid and inevitable dissolution, and England had this advantage over the states of the continent, that her own children achieved her independence and nationality, and even then the foundations of her future greatness were laid.

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## ON THE SNOWS AND SNOW CRYSTALS OF THE WINTER 1854-55, AS OBSERVED AT WARRINGTON.

*By Thomas Glazebrook Rylands, Esq.*

(READ APRIL 26TH, 1855.)

My wish in preparing the following communication has been two-fold: to lay before you certain observations I have made during the past winter; and to attract more general attention hereafter to the richness and variety of what, with little license, may be called the "treasures of the snow."

I know no class of objects so easily accessible by every one, which at the same time offers equal attraction, and is capable of affording so large an amount of gratification to all classes of observers. At the hands of the British meteorologist, at least, this subject demands, as it deserves, a much more careful investigation than it has hitherto had. So few have been the snow observations made in this country, that it is impossible to say whether

the large variety of crystals seen during the past winter are of rare or of common occurrence. Thus much, however, we may affirm, that the Polar snows have, up to this time, produced no crystals more complex or beautiful than the snows of our own climate, the difference being simply, that they are occasionally larger than our own. Captain Scoresby gives one-third of an inch as the diameter of the largest he figured during his several voyages to Spitzbergen and Greenland, which is rather smaller than one now recorded; but Sir Edward Belcher, in a letter to Mr. Glaisher, states that many crystals with *radii* an inch and more in length were seen by him in the Arctic seas.*

Captain Scoresby's work has been carefully examined, with the view of making a comparison between his observations and my own. This attempt has resulted in the conviction, that to render such observations practically valuable, a more definite statement of the atmospheric condition at the time, than he has furnished, must be recorded. Without this, the forms themselves alone can be compared, all conclusions of higher value being difficult, if not impossible.

In selecting from the multitude of forms seen, those of which drawings have been made, my aim has been to preserve such as I considered the typical modifications of the snow from which they were obtained, and so many as seemed necessary to shew the variation to which some of these types are subject. With one or two exceptions, the crystals were collected on a slab of plate glass, and were sketched while in that position. To shew that the process of sketching is not necessarily a hasty one, I may mention that at temperatures but two or three degrees below the freezing point, crystals have remained unchanged for from twenty to thirty minutes while under observation.

The lens used throughout was one of Mr. Ross's Coddingtons, the magnifying power of which is about twenty linear at six inches; it defines clearly, lines which cannot be more than the four or five thousandth of an inch in breadth. I found no practical advantage in using higher powers, but regard the constant employment of the same power as more important.

My only regret in producing these drawings is that they convey so feeble an idea of the exquisite beauty, and perfection of detail, seen in the

* Captain Scoresby's observations were confined to the months of April, May, and June. The season and locality of Sir E. Belcher's are not stated.

originals: they have, however, been made with all the care I could command, and considering the difficulty of representing, by little more than diagrams, objects of so complex and delicate a character, are such, I believe, as may be relied on. None but perfect crystals were drawn; generally they were about the twentieth of an inch in diameter; when much larger or smaller the measurement of them is stated in the plates.

On taking a general view of the figures, it will be seen that the forms which enter into their composition are, the granular, acicular, and tabular; and that the last may be again divided into the circular, stellate, prismatic, and hexagonal. Further, it will be observed that the acicular forms in particular are sometimes *winged* or *foliated*, exhibiting leaf-like expansions, with toothed or irregular edges: and lastly, that in some the *rays* or primary branches spring from a central *nucleus*, while in others the centre is simple. Now by the use of these terms, together with about the same number, borrowed from botanical phraseology, I have found little difficulty in describing, in a few words, even complex crystals, so as to reproduce, in my own mind at least, an accurate idea of their peculiarities. My rule has been to separate the description of the nucleus from that of the ray, and to write the several forms as they occurred in succession from the centre of the former to the extremity of the latter. By this means a record has been secured of several specimens, under circumstances in which it was inconvenient or unnecessary to make drawings.

I am not aware that observations were omitted on any day when snow fell. Perfect crystals were seen on thirteen days, and it is somewhat curious that on every occasion except two, the best crystals fell at or about nine o'clock in the morning.

In the annexed table I have collected such meteorological results as seemed most important, and, added to this table, the abstract which follows of the notes made in my journal, conveys all the information within the limits of my means.*

* The Warrington register unfortunately includes only the readings of the barometer, hygrometer, self-registering thermometers, and rain-gauges, together with the usual wind, cloud, and weather observations. But we are informed by Mr. Glaisher that "Doctor Smallwood, of Isle Jesus, Canada East, has traced an apparent connexion between the form of the compound varieties of snow crystals and the electrical condition of the atmosphere, whether negative or positive," and that he is engaged upon further experiments. Such a connexion is far from improbable; and it is to be hoped that ere long this important class of observations will be more generally made in England. At present they are almost wholly confined to the Royal Observatory.

## METEOROLOGICAL RESULTS FROM OBSERVATIONS MADE AT THE TIMES CRYSTALS WERE OBSERVED.

| Date and Time of Observations. | Barometer corrected & reduced to sea level. | Thermometer in shade. | Dew point below air temp. | Grs. of vap. in a cubic foot of air. | Humidity. (saturation = 1·0.) | Minimum on grass. | Terrestrial radiation. | Direction and Force of the wind. | Reference to the figures of the crystals observed. |
|---|---|---|---|---|---|---|---|---|---|
| 1855. | In. | ° | ° | Grs. | | ° | ° | | |
| Jan. 30. 9 A. M. | 29·864 s. | 28·8 | 8·0 | 1·59 | ·74 | 7·2 | 9·0 | E. Light air. | Figs. 1, 2, 3. |
| Feb. 6. Noon. | „ r. | 39·0 | „ | „ | „ | 33·1 | 1·0 | N.E. „ | „ 4. |
| „ 8. 9 A. M. | 30·064 r. | 27·2 | 9·2 | 1·15 | ·57 | 22·2 | 4·2 | N.E. Light breeze. | „ 5, 6, 7, 8, 9. |
| „ 11. 9 „ | 29·733 f. | 23·4 | 4·2 | 1·21 | ·68 | 9·3 | 6·0 | N.E. Calm. | „ 10, 11, 12. |
| „ 13. 9 „ | 29·588 f. | 20·8 | ·0 | 1·62 | 1·00 | 11·4 | 8·1 | N.E. „ | „ 13 to 19. |
| „ 14. 9 „ | 29·488 f. | 23·8 | 14·2 | 1·06 | ·59 | 11·0 | 8·9 | N. „ | Simple hexag'l prisms |
| „ 18. 9 „ | 30·100 s. | 18·0 | ·0 | 1·47 | 1·00 | 1·6 | 9·3 | E. Light air. | Figs. 20, 21. |
| „ 21. 9 „ | 29·936 s. | 22·8 | 1·7 | 1·63 | ·94 | 5·7 | 8·9 | Calm. | „ 24. |
| „ 22. 5 P. M. | „ s. | „ | „ | „ | „ | „ | „ | S.E. In gusts. | „ 22, 23. |
| Mar. 10. 9 A. M. | 29·896 f. | 28·8 | ·0 | 2·13 | 1·00 | 27·7 | 0·3 | S.E. Light. | „ 25 to 34. |
| „ 11. 9 „ | „ f. | „ | „ | „ | „ | „ | „ | S.E. „ | „ 35, 36, 37. |
| „ 12. 9 „ | 28·899 f. | 35·6 | 1·0 | 2·67 | ·97 | 30·7 | 0·2 | S.W. Fresh breeze. | „ 38, 39. |
| „ 23. 3 P. M. | 29·276 r. | 35·5 | 4·5 | 2·27 | ·85 | 31·5 | 0·8 | N.E. Mod. breeze. | „ 40. |
| „ 28. 8.30 A.M | 30·148 r. | 35·3 | 3·0 | 2·39 | ·90 | 21·2 | 7·2 | N. Light air. | „ 41. |
| Apr. 3. 9 A. M. | 29·800 f. | 34·8 | 2·9 | 2·35 | ·90 | 32·1 | 1·5 | E. „ | „ 42, 43. |

*The letters attached to the readings of the Barometer* indicate whether the mercury was rising, steady, or falling at the time.

*The thermometers in the shade* are placed four feet above the ground.

*The hygrometrical deductions* are obtained from Mr. Glaisher's tables.

*The force of the wind* is expressed in the terms of the scale given p. 43 of the Royal Society's Report on Physics, including Meteorology; April, 1840.

*The minimum on the grass* is that which occurred during the preceding night, and the *terrestrial radiation* is the difference between these readings and those of a similar thermometer in the shade.

From the first to the fifteenth of January the sky was generally covered with cloud; the mean temperature was 42·2°. No snow had been recorded up to this time. During the night of the sixteenth a change took place; and the mean reading of the thermometer from that day to the end of the month was 30·4°.

Pulverulent hail was recorded on the 17th and 22nd. Imperfectly crystallized snow, with sleet, on the 21st and 26th, at temperatures varying little from the freezing point; on the last named occasion snow fell during the night to the depth of nearly two inches, the density of which was about one-tenth that of water. The first perfect crystals, respecting which I have the following note, were seen as follows :—

January 30th, 9 a.m. "Sky obscured by dense and rather low cumulo-stratus cloud; hoarfrost on the grass; light snow falling, chiefly composed of fig. 1. Figs. 2, 3, and others of the same forms, variously combined, not uncommon. The snow was not sufficient to cover the ground."

The mean temperature of the month of February, at Warrington, was 28·8°; at Greenwich it was 29·3°, which is the lowest yet recorded there for this month, in a register extending back to the year 1814.

The frost which commenced on the 16th of January continued until the 3rd of February, and the weather was then broken for two or three days.

February 6th, 9 a.m. "The ground white with frozen rain, which on examination is found to consist of transparent spherules of ice, resembling minute hailstones. This whiteness is confined to those situations where the raindrops have been dispersed on falling, as on the grass, and under the branches of certain trees: the hard walks and flags are covered with sheets of ice.

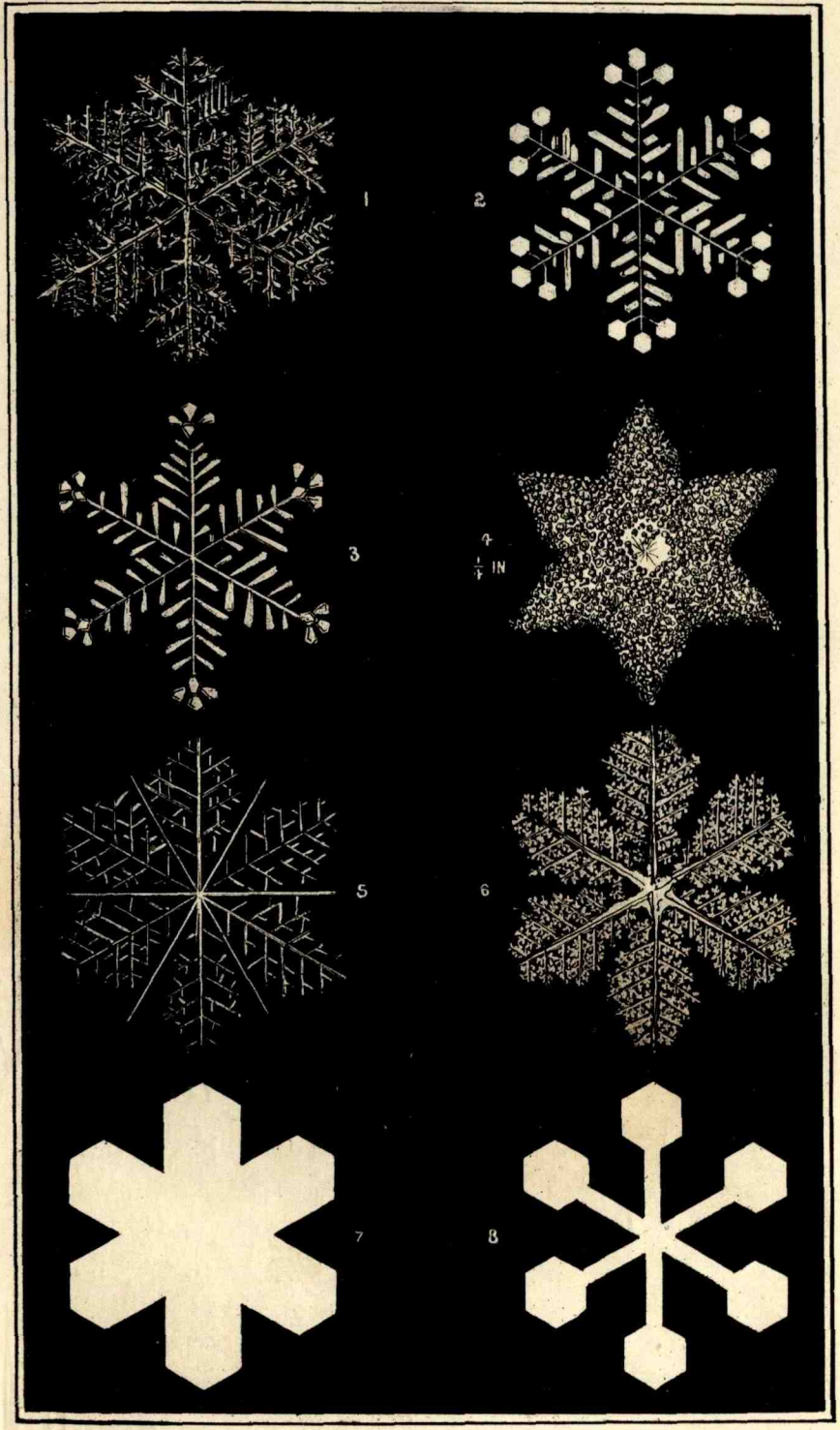
At noon the sky became gradually obscured by dense cloud, from which fell first powdery hail, and then the stars fig. 4, many of them perfect, and quarter of an inch across. Under the lens there were found to be snow crystals covered with the same peculiar spherules of granular hail, which I saw this morning. The amount of covering varied considerably; some of the stars being rendered almost spherical, while many shewed sufficient evidence of the crystal within. The snow fell thickly, but only for a minute or two.

February 8th, 9 a.m. Snow during the night to the depth of quarter of an inch, and still falling lightly. The sky is about half covered with clouds of variable character. Crystals numerous and beautiful, chiefly acicular and hexagonal. Figs. 5, 6, 7, 8, 9, were sketched between nine and eleven o'clock, together with other allied forms, which have been previously observed and published by Dr. Nettis and Captain Scoresby; and several, which since have been recorded under this date, by Mr. Glaisher of the Royal Observatory.*

* The crystals figured by Dr. Nettis, (observed at Middleburg during the severe winter of 1740,) are published in the Philosophical Transactions for 1775; those by

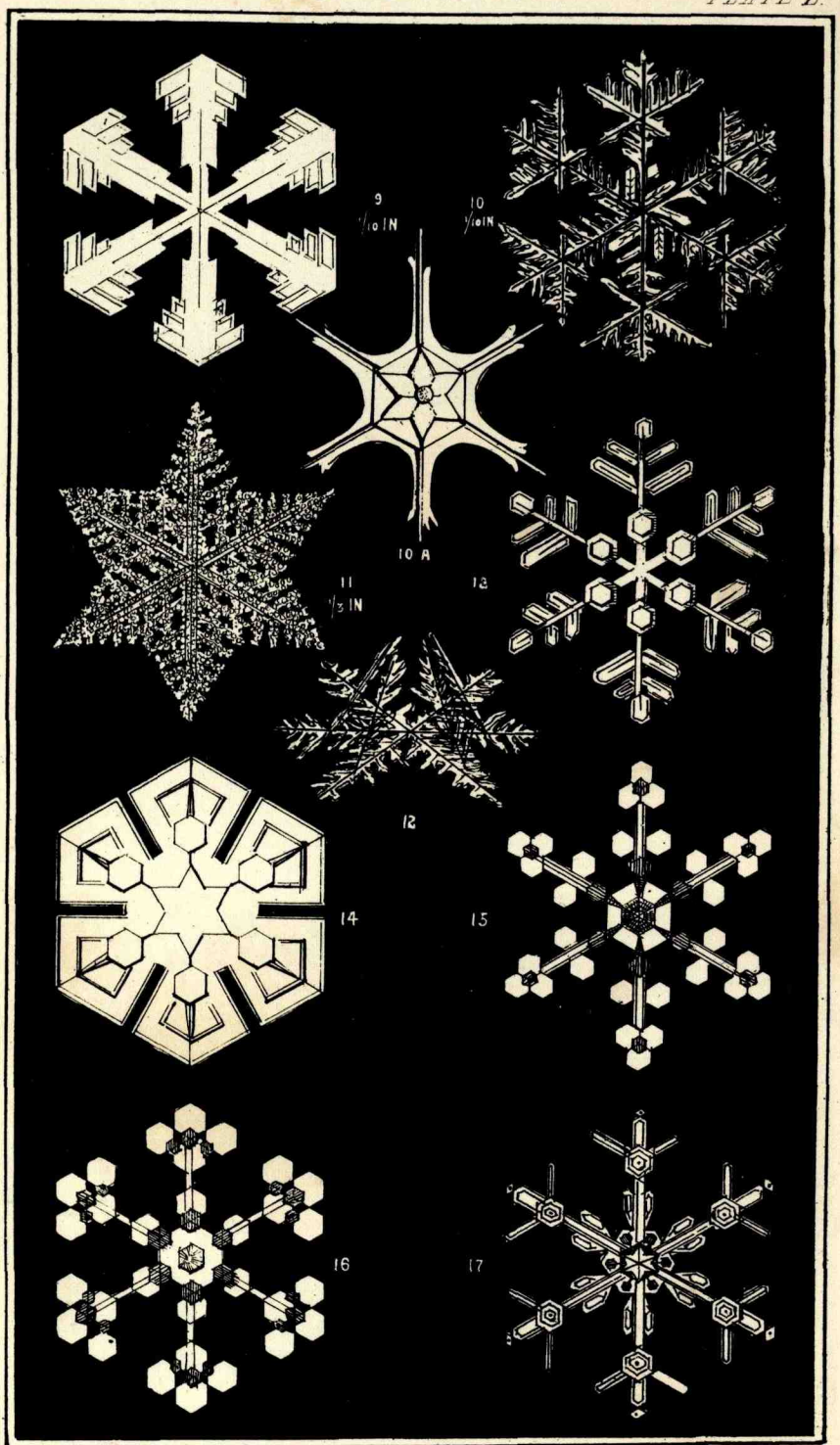
# SNOW CRYSTALS.

PLATE A.




F. G. Rylands, Del.

W. J. Hammond, Lith.




T. C. Eyland's, Del. W. J. Hammond, Lith.

Fig. 5 was the only crystal seen which had twelve rays.

It was on the 9th of February that the most severe frost of the late rigorous winter set in; and from that day until the 24th, when the thaw commenced, the thermometer in the shade was rarely more than two, and but once four degrees above the freezing point. The wind varied from north to east, but was nearly calm throughout. There was not altogether, until the 22nd, snow sufficient to be registered by the gauge. The meteorological observations give the following results for these fifteen days:

| | |
|---|---|
| Mean temperature . . . . . | 24·6°. |
| Mean dryness . . . . . | 4·4°. |
| Mean minimum on grass . . . . | 9·4°. |
| Mean terrestrial radiation . . . . | 8·5°. |

There was a copious hoarfrost on the ground every morning until the 23rd.

Such a condition of the atmosphere as this, might well be expected to produce snow crystals exhibiting high forms of crystalline development. It will be seen that during this period the most perfect crystals have occured.

February 11th, 9 to 10 a.m. The slight snow which has just fallen from a passing cumulo-stratus, consists altogether of separate crystals not combined into flakes, of which fig. 11 is by far the most common. These stars, often measuring more than the third of an inch in diameter, were formed wholly of gradually diminishing hexagonal prisms, with beaded angles. They were more or less deeply indented, but many of them, like the figure, such as would result from the intersection of two perfectly equilateral triangles.

The eleventh of February, it will be remembered, was a Sunday, and these large and beautiful stars, falling about the time of church going, were seen by many persons over a considerable district—near Liverpool as elsewhere. They were, perhaps, the first snow crystals generally noticed in England for many years.

While sketching fig. 11, I first observed the fact that crystals, when slightly thawed, were not always melted into shapeless masses, but assumed new and definite forms; thus the prisms composing fig. 11 took the shape of the rays beyond the hexagons in fig. 13. Impressed with the idea that

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Captain Scoresby in his "Account of the Arctic Regions," Edinburgh, 2 vols. 8vo., 1820. A large proportion of both series will be found in the Encyclopœdia Metropolitana; article Meteorology. Mr. Glaisher's figures have hitherto appeared only in the Illustrated London News for February 17th and 24th of the present year.

a similar procedure with other specimens might throw some light on the formation and markings of snow crystals generally, I attempted to produce changes in many after I had observed them. The results were often instructive; but the effect produced upon fig. 10, which I had just sketched on account of the curious one-sided development of the prisms near the centre, was very remarkable: these prisms were melted and ran towards the centre of the crystal, but in so doing left a well defined stellate cavity; and when the fluid was refrozen I had under the lens fig. 10a, which was the first nucleate form I ever saw. It is not safe to generalize from a single fact under such circumstances, but I have since seen many apparently identical nuclei, produced without the intervention of human agency.

Fig. 12 shews a peculiarity not very uncommon in certain forms, but only in this and one other instance have I seen the secondary set of rays complete in number, and moderately uniform. They are not always inclined.

February 13th. Before I was able to leave the house this morning, a few specks of snow fell from a sky in which there were but one or two lofty cirri and a light haze. The crystals were examined very shortly afterwards on the iron lid of one of the thermometer boxes.

I shall not readily forget the intense feelings of delight I experienced when the forms collected on that lid first met my view. Figs. 13 to 19 represent a few of the most simple specimens, but they convey no idea of the exquisite delicacy and brilliancy of the objects themselves; and these were almost infinitely exceeded, in beauty as in complexity, by multitudes of others. One peculiar character, however, pervaded the whole; whatever the basal modification might be, the superimposed hexagon was found in them all. It will be noticed, that in this instance the crystals were viewed as opaque objects; and this rendered the peculiarity mentioned much more evident. I have, since, never omitted, when practicable, to view all crystals by both transmitted and reflected light, and would strongly recommend the same course to others as one which affords, in some cases at least, information it would be otherwise difficult to attain.

Fig. 18 contains about 120 hexagons; the size of the crystal was less than the twentieth of an inch, and I have already called this a simple form! In others they were much more numerous, but no increase of number interfered with the symmetry of their arrangement. Of course only one

side of these objects was seen, but there was no reason to doubt that the other was like it.

Associated with these crystals were many well-defined, short, simple, hexagonal prisms, and two truncated pyramids.

Fig. 13 may, perhaps, be considered a connecting link between the nucleate and anucleate forms.

February 14th, 9 a.m. Under this date the note in my register is simply—Again a little snow this morning, in small single hexagonal prisms Hazy. Sky nearly cloudless. Air unusually dry.

February 18th. A very few separate crystals this morning at nine o'clock, hardly less beautiful, though very different from those seen on the 13th. These snows are certainly formed in the lower regions of the atmosphere, and have no connexion with clouds seen at the time. This morning there were but two light clouds near the horizon. Figs. 20, 21 were the only drawings made. These were selected on account of the foliation which had a character very distinct from that seen in figs. 1, 10, 12, 40, or 42. It was much more angular and even.

During the night of the 17th the temperature attained its minimum, and from this time the sky was more clouded.

February 22nd. This afternoon, while enjoying the recreation of skating on the river, about two miles to the *east* of Warrington, the wind commenced blowing in gusts from the south east, and the sky became gradually mottled with light flying clouds. At about five o'clock snow began to fall in separate, thin, spangle-like stars, measuring from the eighth to the twelfth of an inch; sufficiently large and well defined to be seen and admired by all the party.

Near the commencement of this snow storm, fig 22 and several closely allied forms were examined, and about the same time my friend Mr. William Fell, an amateur artist of no ordinary ability, made the drawing from which fig. 23 was copied. This crystal was seen to the *west* of the town, and has been introduced as an additional proof of the relationship which often exists between crystals collected on one occasion at places distant from each other.

The great evidence of change in the characters of these crystals, as compared with those of the previous fortnight, can hardly be overlooked. At the time I was so struck by it as to venture a prediction that the weather was about to break. This anticipation was speedily realized. The clouds became more dense, the snow commenced falling thickly in flakes, and by a little after six o'clock, consisted only of fragmentary acicular and granular snow, which by the next morning lay two inches deep, yielding one-eleventh that depth of water. The next day the thaw set in.

From the 24th of February to the 5th of March, rain fell on most days. From the 6th to the 9th there was a slight renewal of the frost, and during the morning of the 10th a snow storm commenced, which lasted at intervals until near noon on the 12th, the sky being obscured by dense cloud nearly all the time.

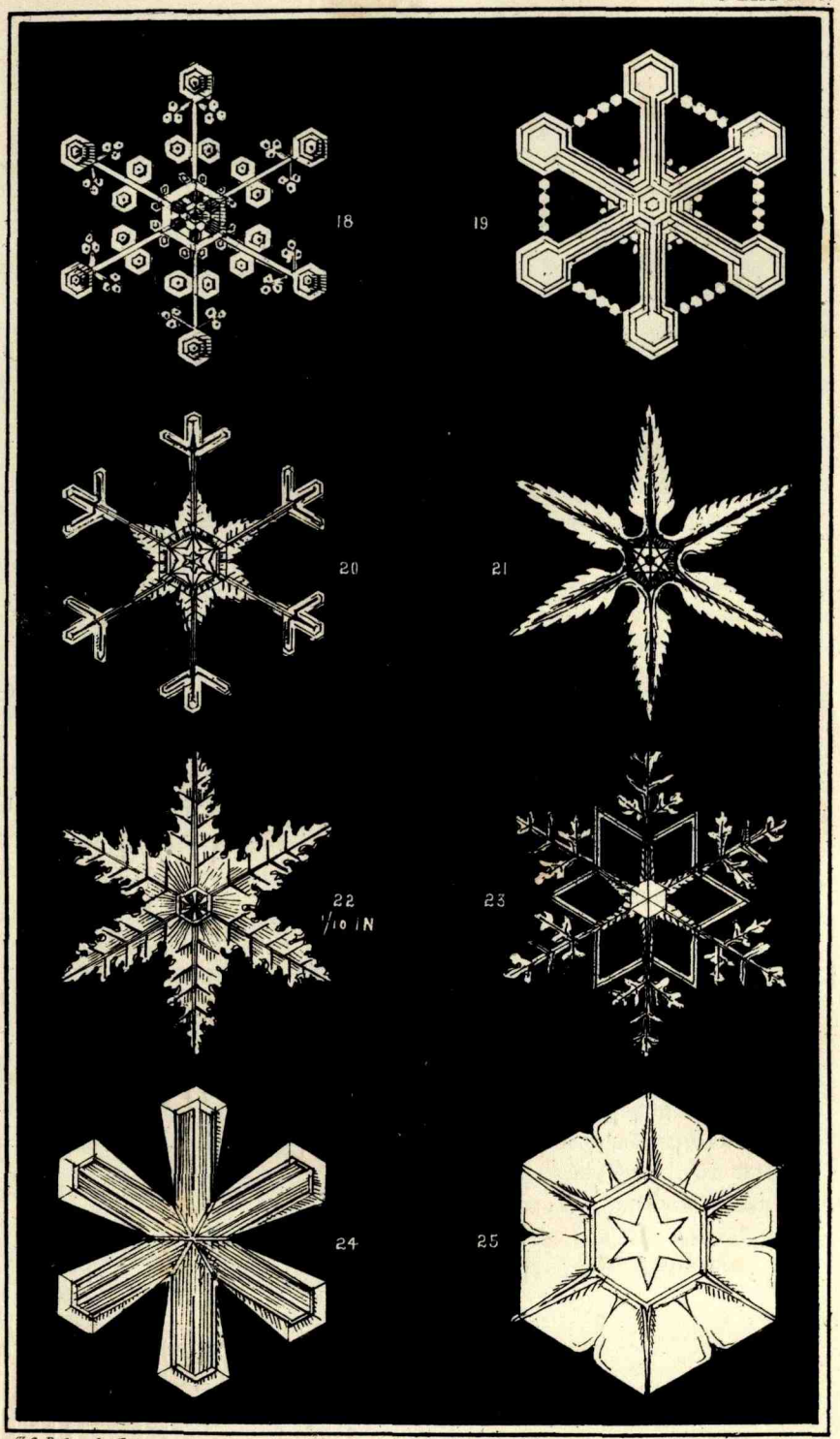
The progress of this storm appears to me peculiarly instructive in connexion with the study of snow crystals. During the two days that it lasted the barometer fell fully an inch, and the temperature rose from 29° to 42°. The wind at first blew lightly from the south-east and south, and we had afterwards a gale from the south-west and west.

The experience of February 22nd had made me anxious to watch the changes which might take place in the crystals of a prolonged snow fall, a better one for the purpose could hardly have occurred, one in which the changes were at once so distinct and numerous. Some of these will be gathered from the following notes.

March 10th, 9 a.m. Flakes of crystallized snow falling. Nearly all the crystals have a stellate centre in the nucleus.

Figs. 25 to 33 were sketched at this time; but in addition to these "lamellar" crystals, in which the rays are all in the same plane, there fell numerous tufted crystals, of the "echinose" genus, with an indefinite number of rays springing in all directions from a concealed nucleus. The rays in these were not uniform, and their number rendered it impossible to make drawings. The distinction between the flakes consisting of tufted and those of lamellar crystals was strikingly evident when they were collected on the glass. The former remained as flakes, while the latter were distributed by the concussion into the most beautiful clusters of from 20 to 50 stars, very uniform in character. To many crystals were attached rather large, thin, overlapping, hexagonal plates, as seen in fig. 34. By noon the lamellar crystals had disappeared.

I have already mentioned that nearly all the crystals had a stellate centre. In one of the echinose specimens, this form was as perfectly repeated in each of the three prisms which terminated a ray, as seen in fig. 34. This was the only occasion in which stars were seen *not* in the centre of a crystal. The play of light on the edges of these stars reminded me of the changed centre of fig. 10, and a more careful examination shewed that, in the present instance also, the stellate centre, and I may add the




T. G. Rylands. Del.

W. J. Harmood. Lith.

other markings, were due mainly to the formation of internal cavities. I cannot describe this better than by referring to fig. 31, where an external coating of ice includes a distinctly foliated form with a cavity around. The thickness of this crystal did not exceed one-four hundredth of an inch.

Is it not probable that these peculiarities result from the snow, in its descent, passing through strata of air variously affected by temperature and moisture? At all events I cannot look upon them as indicating a high degree of crystallization considering the circumstances under which they occurred. I may add, too, that during Captain Scoresby's observations, the thermometer ranged from 10° to 32°; that the most simple, as well as complex forms, were seen at the lowest temperatures; but they are all alike destitute of this class of markings, while the crystals which exhibit the largest amount of them, and which have, some of them, a peculiar affinity to our figs. 28, 29, 30, occurred on May 6th, 1817, the thermometer reading 27°, and apparently, as in the present case, at the breaking up of a period of intense cold; for I find, from his work, that the medium observed temperature of the eleven preceding days was 15·4°, while that of the week following was 30°.

March 11. Two inches of snow during the night, and frequent, often mixed with rain, this morning: only one crystal seen, fig. 35.

At 5 p.m. Snow in large flakes, composed of confused masses of slender spiculæ, fig. 37, each consisting of two or three individuals, longitudinally combined, from one-twentieth to one-fourth of an inch long. At the same time, for a few moments, a number of lenticular rounded hexagons, fig. 36, fell sharply like frozen rain.

March 12, 9 a.m. Snow in flakes from very dense cloud; it consists almost entirely of confused, melted and refrozen forms, amongst which fig. 38 was seen, and two similar ones attached to the ends of a short prism, like wheels on an axle, fig. 39.

10. 20 a.m. A copious fall of snow, in unusually large flakes, many of them measuring 2½ inches by 1½; they are composed entirely of fig. 1.

A quarter of an hour afterwards the wind veered to the west and blew in strong gusts, the snow ceased, and rain fell heavily. The gauge on the following morning contained 0·6 inch.

There has been little snow since. A few flakes, consisting of imperfect angular concretions, fell on the 17th, and a little powdery hail on the 23rd, amongst which were seen several small stars resembling fig. 4. On this occasion the form of the included crystal was detected. It is that shewn in fig. 40. This may be called a modification of figs. 1, 5, 12, &c., being seen in all intermediate shapes, with and without the lateral expansions.

On the 28th, at 8.30 a.m., a few flakes appeared at intervals for about twenty minutes, composed entirely of fig. 40, and 41 without the nucleus which, in this instance, certainly resulted either from partial thawing, or the adhesion of a small rain drop. For a few moments the crystals were heavily granuled; engaged air bubbles were seen in them all.

On the 3rd of April, at 9 a.m., there were a few, rarely perfect, white, opaque crystals, generally simply pinnate, with broad close rounded pinnæ, fig. 42. A single example, also opaque, with more distant ramifications, and a ring centre, fig. 43, was seen at the same time.

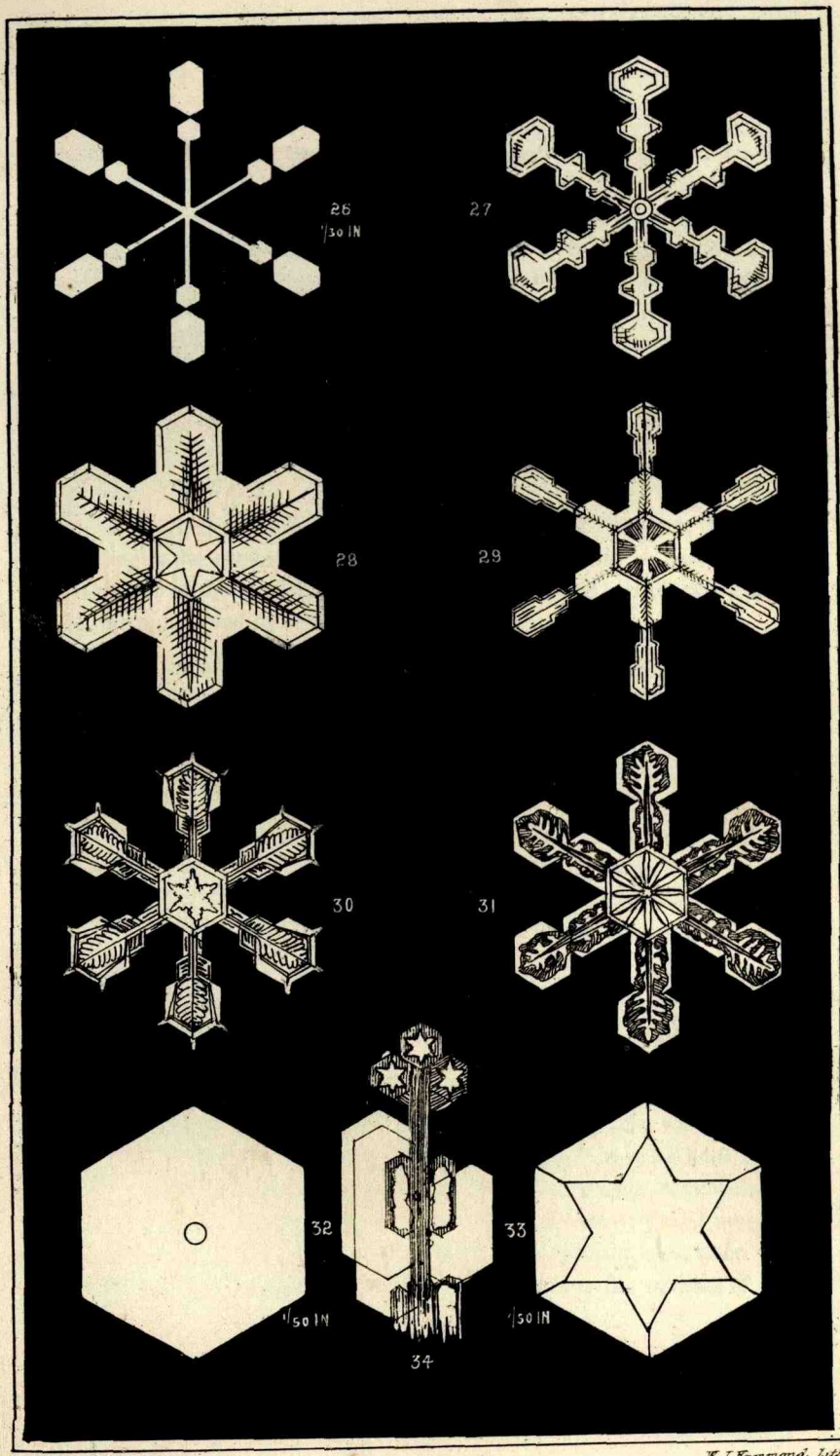
On the 10th of April, at 4 p.m., hail fell thickly, for a few minutes, in hard, opaque, amorphous masses, often a quarter of an inch across. This was the last frozen precipitation of the season up to the present time.

Such is the substance of the notes made on each occasion. Did time permit, it would be interesting further to enquire, by considering the whole interval as a single period, how far there is any connexion apparent between the characters of the crystals and of the season generally; and also to what conclusions these observations tend. A few words on these subjects must suffice.

That the past winter has been an unusually severe one I need not say. The cold was both intense and of long duration. The frost penetrated more than two feet below the surface of the ground; and situations, usually considered sufficiently secure from its effects, on this occasion afforded slight protection against its searching power. Sheets of water rarely frozen were capable of sustaining almost any weight. Remnants of the ice were seen on the 25th of March.

With the exception of one short interval, the temperature declined more or less regularly from the 5th of January to the 18th of February, and then rose until the 2nd of March; from the 5th to the 11th of this latter month the weather was again cold, and indeed, with the exception of five days, the thermometer was below the average until the 9th of April.

More than ordinary interest attaches to all observations made during such a winter; and it is probable that few in this country will be as prolific of snow crystals. Even in this respect, however, our climate may have its advantages, and may lead us neither less speedily nor securely to some of




T. G. Rylands Del.

W. J. Hammond, Lith.

the truths we seek. Of the almost endless variety of perfect forms seen, the illustrations contain figures of above 40. These are arranged very nearly in order as the crystals occurred, and thus afford a ready means of comparison. I may add that fig. 9, and others seen at the same time, had structurally much in common with fig. 27 and its neighbours; and that the modifications of fig. 1, 5, 12, &c., which were seen only at the beginning and end of the winter, appeared almost alone in the first and last proper snow.

So far as any conclusions are warranted from a series of observations so limited, a few of those confirmed or suggested may be briefly stated in the following summary:—

Though we have no nucleate forms before the 13th of February, these do not appear to be confined to any particular temperature, at least in the lower regions of the atmosphere; and the same may be said of such plane forms as are bounded by right lines.

A distinction appears necessary between the two classes of markings mentioned: those arising from the external addition of superimposed forms, and those from internal lines or simple variation of thickness; the one indicating a high, and the other a much lower degree of activity in the crystallizing forces.

In this, as in other similar cases, undisturbed and gradual accumulation results in the most perfect development, but the amount of moisture precipitated has also an important influence in determining the character of the crystals produced. There would seem to be in all cases a point at which the amount of precipitation is sufficient to overcome the crystallizing power. One of the most remarkable differences between the snows of N. lat. 78° and those now under examination consists, if I may so speak, in the position of this limit of crystallization. In the former, a copious and continuous fall, producing several inches of snow in a few hours, retained the character of its crystals unimpaired throughout, while in the latter, under similar circumstances, a few minutes, or at most an hour, was sufficient to change perfect crystals into the most simple rudimentary snow. This was especially noticed on the 22nd of February, and several times on the 10th, 11th, and 12th of March. In summer, also, when we may assume a much greater difference of temperature in the volumes of air

which, by their union, produce a frozen precipitation, and therefore one in larger quantity, we have almost uniformly icy hail in rounded or fragmentary masses; while in winter such hail is of rare occurrence in these latitudes, and is never seen in the arctic regions. On the contrary, cloudless skies on the calm mornings of the 13th and 18th of February produced the most perfect crystals seen, apparently from the lower regions of the air.

Lastly, there is little, beyond what has been stated, and their frequency, to distinguish between the snows observed by Captain Scoresby within 12° of the north pole, and the Lancashire snows of the past winter. "Snow," says that able author,* "is so very common in the arctic regions that it may be boldly stated, that in nine days out of ten during the months of April, May, and June, more or less snow falls. * * When the temperature of the air is within a degree or two of the freezing point, and much snow falls, it frequently consists of large irregular flakes, such as are common in Britain; sometimes it exhibits small granular, or large rough white concretions; at others it consists of white spiculæ, or flakes composed of coarse spiculæ, or rude stellated crystals formed of visible grains. But in severe frosts, though the sky appears perfectly clear, lamellar flakes [crystals] of snow, of the most regular and beautiful forms, are always seen floating in the air and sparkling in the sunbeams, and the snow which falls in general is of the most elegant texture and appearance.†"

In conclusion allow me to say, that, as a systematic examination of the snows of a season, the present one, so far as I am aware, stands almost alone. Under such circumstances, great imperfection is unavoidable. My aim has been to record intelligibly what was observed carefully, under a deep and increasing impression that an important contribution to our knowledge of the climatal relations of various regions, is to be obtained from a more minute investigation of their snows.

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* Account of the Arctic Regions, vol. i, p. 425.

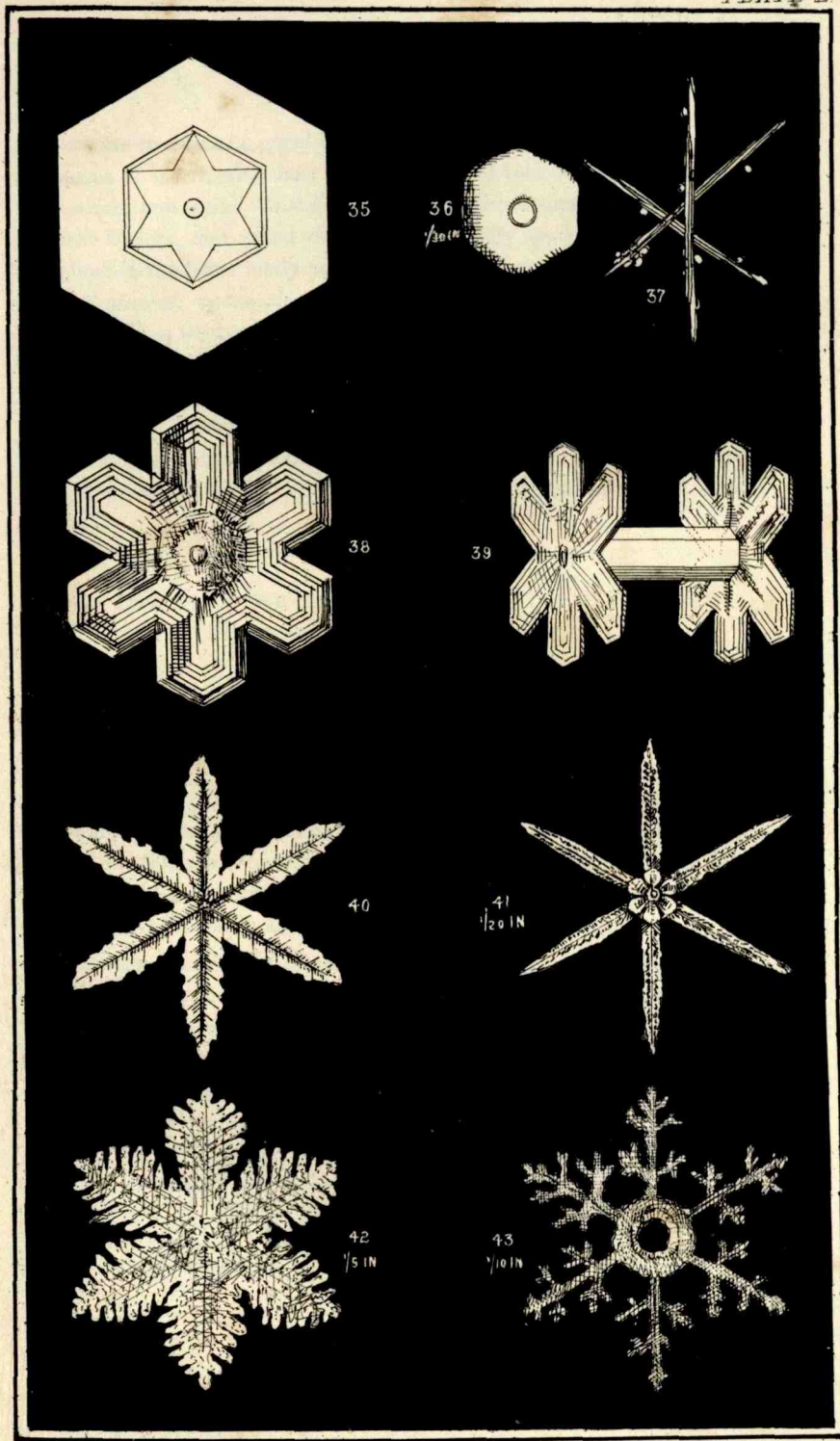
† In the work just quoted the snow crystals figured are classed under five "genera," which may be described as follows:—

1. Lamellar. (*Stelliform*; rays in one plane.)
2. Echinose. (Rays in several planes.)
3. Acicular. (Spiculæ, or six sided prisms.)
4. Pyramidal. (Six sided pyramids.)
5. Rotate. (Lamellar crystals attached to a prism, as in fig. 39.)

Examples of all these genera will be found in the foregoing observations.

# SNOW CRYSTALS.

PLATE E.




T. G. Rylands, Del.

W. J. Hammond, Lith.

If we are to arrive at sound conclusions on this most interesting subject, no means of information may be neglected. I believe this to be one full of promise, and quite "within the scope of the assumed *duties*" of the Historic Society, and would therefore respectfully apply to it a suggestion contained in the letter lately published by one of ourselves—*what we need is more general, systematic, and combined observation.* If the present communication, written, I trust, in the spirit of that admirable letter, shall be the means of forwarding, in this respect, the high objects for which we are associated, and to which each member should feel himself individually committed; if it shall induce more vigilant attention hereafter to these minute but altogether admirable works of Him who "giveth snow like wool, and casteth forth his ice like morsels," it will receive an ample reward.

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## On Institutions for the Deaf and Dumb: their Objects, Difficulties, and Advantages.*

*By David Buxton, Esq.,*

PRINCIPAL OF THE LIVERPOOL SCHOOL FOR THE DEAF AND DUMB.

(Read April 19th, 1855.)

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Whenever the history of the present century shall be written, it will record a succession of the most signal triumphs of mind over the obstructions of matter, which have ever been achieved by man, since the Almighty Creator of the world made it subject to his dominion, and commanded him "to replenish the earth, and *to subdue it.*" (Genesis i. 28.)

To the accomplishment of these results, we have not only employed the marvellous discoveries of our own times, but have appropriated and improved upon those which had been transmitted to us from former ages. Some of these had been left by their authors, after many a weary year of painful speculation and research, little better than crude and impracticable theories.

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* The present paper originated in the offer of a Prize by the Lord Bishop of St. David's, for the best Essay upon this subject, in connexion with an Esteddfod, for the promotion of a literary object, which was held at Morriston, Glamorganshire, in September last. It was previously agreed that, if not published in the Principality, the paper should be at the disposal of the writer, for presentation to the *Historic Society.* As it received the award, it is now published, with the simple omission of some local allusions, and the substitution of other details, which seemed more appropriate to this place.