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V. P. JOURNAL.

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NOTES.

THE CORRESPONDENCE UNIVERSITY—This is an association of experienced instructors, over 40 in number. They have been selected from among the Professors of the best American colleges and universities, but we notice Cambridge, Glasgow, Dublin and Brunswick (Germany) represented.

"Its purpose is to enable students to receive at their homes systematic instruction, at a moderate expense, in all subjects which can be taught by means of correspondence, whether the studies be collegiate, graduate or professional, or preparatory for higher institutions of learning." As it is designed to supplement the work of other educational institutions, and is not conducted for or against the interests of any other organizations, it hopes to be welcomed by the authorities of schools and colleges in the United States and Canada. (Lucien A. Wait, Secretary, Ithaca, N.Y.)

TELPHERAGE.—This is the automatic electric transport of goods and passengers. The promoters of this system are Professors Ayrton and Perry. In a recent lecture in Dublin Professor Ayrton, by means of models, illustrated its working, and showed the advantages of the electric engine over the old system of using the steam locomotive engine for pulling trains along overhead wire ropes.

It is not supposed that Telpher lines will do away with railways, but act as feeders to them. A Telpher line could be

constructed where it would not be worth while to build a railway. It could be used by the farmer to bring his crops to the barn, and at the same time he could draw off electric power to run his thrashing machine. The advancing army could construct a Telpher line just as they now construct a field telegraph. The energies of nature, now going to waste, could be utilized in generating the electric current. In many countries where the expense of building a railway is great, a Telpher line could be constructed and the means for effecting the carriage of goods, and that the cheapest possible, could be supplied by some neighboring stream or windmill.

For light overhead lines a single wire or rail should be used. The load should not be large, but much divided. At Weston, in Hertfordshire, there is a Telpher line in operation. It consists of a single wire, one inch in diameter. Over this 100 tons per hour passes each way.

By a system of "blocking," the promoters have arranged to make collisions "absolutely impossible," and should any car in a series break down, the others cannot run into it.

Among the many discoveries connected with the application of electricity, Telpherage is not likely to take a second place in contributing to the world's material progress. Now the phrases "to telegraph" and "to telephone" are common, but there is no doubt that very soon, and that in our own day, "to telpher" will be a common English expression. This is one of the "splendid possibilities of the future."

PEBBLES.

"Sermons in stones."

"Then let the pebbles on the angry beach fillip the stars."—*Shakespeare.*

WE do not here intend to moralize on nature's treasures or draw sermons from even the shallowest of her fountains. No more do we intend to amplify the figures made use of by the immortal Shakespeare, who seems so unconsciously to have wrapped up so many truths in fewest words. We would here

present a few facts concerning some of the most neglected and unpretentious objects of nature, "the cold gray stones," upon which the ceaseless dashing of the waters have after many, many years been able to accomplish something, imprinting a distinctive and at the same time a common impression. We would watch the course of the formation of pebbles, and especially at this time, of limestone pebbles.

The limestone from which the pebbles have been formed was first laid down in layers by the distributing action of water waves beneath the surface, and owes its origin to animal life. The little animals of various kinds have taken from the water the various elements necessary to build up the strong structure that forms their home. These stony or shelly abodes are massed together in immense quantities, distributed along the ocean's bottom, pressed together by the weight of waters, broken and ground into smaller particles, and, at last, by various causes, are glued together, as it were, into compact masses. The interstices are filled by smaller shells or by fine sand and silt, until at last a layer of hard, solid, compact limestone is formed, which, as years go by, continues to increase in hardness and compactness. Layer on layer is laid down, and by the upheaving of the land or the subsidence of the water, is left exposed as a ledge of limestone rocks on the edge of the lake or ocean. These layers are split and cracked by seams owing to various reasons—the expansive heat of the sun and the contraction during cold weather, the weight of earth and layers above, the general movement of the earth's crust and internal pressure exerted from below. Long parallel seams will thus extend along the layers into which the snow and sleet will be carried, or rain and moisture trickle, which will expand in colder weather, and, by the powerful force of expansion, split and shiver into fine fragments whole masses of rock, which will fall down in the forms of irregular blocks of limestone, or perhaps literally rain down the sides of a high cliff into the sea—a veritable hailstorm of limestones. These small fragments, varying in size from grains to large blocks, will then be subject to the merciless waves,

which will roll them back and forth regularly and quietly, or in times of tempest dash them with great velocity against one another, rub them along the bottom of the sea, or fling them against the rocky walls that return them again to the arms of the waves only to perpetuate this merciless round of pitch and toss, which may be play to the sea, but is death to the stones. Corners are knocked off and rounded, edges are bevelled and gracefully curved, excrescences are removed; and, at last, instead of the rough and jagged limestones, we will behold polished, shiny boulders, pebbles, gravel, sand, and, at last, dust, which the playful winds will pick up and in wild delight, careening across field and meadow, hill and forest, will scatter about in joyful sport to enrich the land or bring down upon itself the execrations of some wayworn traveller as he vainly endeavors to dig out the dirty speck from his irritated eye.

THE TRAMP A-MUSING.

HE seemed a tramp who had seen better days—
A fellow who would muse or worry o'er
The smallest trifles nature 'round displays,
To please the fancy or to grieve us sore.

As towards the town he trudged one day in June,
Enjoying much his free-and-easy gait,
He stopped and said, "I'll reach yon town too soon,
So here a space in nature's park I'll wait."

His heavy load of cares (old clothes, I ween)
He placed most careful in a shady nook,
Where it would by no other tramp be seen,
Then round for *trampers' signs* began to look.

No nicks upon the rails or ciphers bold,
No signs of "danger" or of "dogs ahead,"
No skull-and-crossbones made his blood run cold—
"It's all O.K.," he coolly to him said.

"Here in the shade of this far-spreading oak
Perhaps I may be left alone to think,
In peace and quietness my pipe to smoke,
After a frugal feast and unmixed drink."

Forth from his bosom first he drew a flask
That shone and sparkled in the noonday sun,
Nor did he linger long a grace to ask,
But straight did circumscissile many a bun.

The buns were dry, and so was he, of course;
His bosom friend he clasped with loving look;
Then lips to lips were pressed with sudden force,
And gurglings sounded like a mountain brook.

He opened wide his deep and thoughtful eyes,
And heaved a long-drawn, satisfactory sigh,
That soon gave place to mute and dumb surprise,
As naught but inanition met his eye.

"Gone like the *mountain dew*, vanished like air;
Gone on a mission, thou solace of care,
Gone, not forgotten, and not gone in vain;
Gone, yes, but Richard himself is again."

New life through veins and muscles at the sound
Did seem to flow (no other reason given);
With joy he spied a rail fence round on round
That straggled up some six feet nearer heaven.

As on the fence he reached the topmost rail
And let his eyes glance free and far around,
He caught the beauties of the lovely vale,
And through his well-developed ears each sound.

But with the beauties of the sound and sight—
The earth, the woods, the rolling lake, the sky—
That gleamed and glistened in the golden light,
He caught a wind-driven specimen in his eye.

With easy art, known only to the craft,
He propped his optic open with a stick,
And cried and cried, until he almost laughed,
"How easy 'tis when once you know the trick!"

He placed the speck upon his broad rough palm,
Then took a close and scrutinizing view,
And said in accents slow and sure and calm,
"My friend, I know the *history* of you.

"You've been so long the prey of cruel fate,
Been driven far from friends and pleasant hum;
Your family name is known as *Carbonate*,
Your surname, if I err not, *Calcium*.

But then that name, like mine, is not much used,
For short, you're Limestone called by th' unscientific;
So I, as Tramp, am very much abused,
And classed with terms not always quite deific.

You've *caught my eye*, and called up many tears—
We can with one another sympathize;
Let's now allay and scatter all our fears
(But wait a moment till I wipe my eyes).

You've seen hard times, and so have I, indeed,
If you'll excuse this reference to the past;
But now you've *settled*, got your long-sought need;
Perhaps I'll settle, too, somewhere at last.

When first you saw the light beneath the sea
You little dreamed what fate awaited you;
For then all gay and pleasant seemed to be,
And sorrow yet was quite concealed from view.

But soon the waters settled and rolled back,
And on you poured the sun's hot, shrinking rays;
The cold wintry frosts next made attack,
And forces from beneath did cause amaze.

A mighty thrust of nature broke you out,
The freezing rains did shove with shoulder cold
Into the surging waves, where rolled about
Others, of whom strange stories might be told.

At first you were quite sharp, and keen and rough,
And rather liked the sport of pitch and toss,
But soon of this you felt you had enough,
As sharpness, keenness, suffered much by loss.

But *once in, always in;* there is no retreat;
For those who once have plunged so boldly in
Find that the world's a world of much deceit;
It's hard to stop when once you do begin.

But, to resume (you see I claim the privilege of a tramp
To wander here and there where'er I will)—
Upon your face you carry now the stamp
Of toil and trouble, usage hard and ill.

Ground down by your own friends, companions dear,
You slowly wasted and grew thin and ill—
A pebble small, with constant dread and fear
That smaller you'd become, and smaller still.

By over-worry, grinding slow but sure,
You dwindled down to but a *speck* of lime;
Much longer now this thing cannot endure—
To leave this world of trouble now's the time.

Just as these words came slowly to your mind,
A gentle breeze bore you in arms on high,
And, seeking for some tender spot to find,
Has dropped you in my sympathetic eye.

Dear friend, you're welcome; type of hopes fulfilled;
Your life has run, you're settled now at last.
Here in my pocket safe your fears be stilled,
Your wanderings o'er, your hardships now be past.

I have a few years yet to run my race
Before I settle down and end my woes;
But soon I hope to turn my hardened face
On those who welcome e'en their bitterest foes."

Thus musing on his fate he fell asleep,
And dreamed of days before he travelled so;
Then sudden roused him, gave a sudden leap,
Shouldered his bag and said, "It's time to go."

KARL.

THE INFINITE AND INFINITESIMAL.

THE earth weighs over 6,000,000,000,000,000,000,000 (six thousand million million million) tons.

The sun weighs as much as 350,000 earths. There are at least 43,000,000 stars in our milky way *visible* through the telescope, varying in size from the moon to the sun.

The interstellar spaces are *filled* with myriads of meteorites invisible to us.

There are countless star clusters beyond the stellar universe rivalling it in size and beauty.

Problem: What is the least possible weight or size of matter in the created universe that surrounds us?

Would you care to visit some of these distant worlds, make a journey through the heavens to the outposts of creation? Then in spirit form bestride a flashing sunbeam and fly through space at the rate of 186,000 miles per second. We will start from the sun. In eight minutes we will pass the earth, a few more minutes and the solar system will be merged into one pale star. In three years and eight months the nearest star will be reached. Star after star in rapid succession then will hurry by, and in 8,000 years the farthest visible star will be at hand. We have gone only in one direction, in a straight line.

Problem: How long would it take to visit every star in our universe?

So much for the *infinite* in time and space; now for the *infinitesimal*:—

"The first experience we make in connection with matter, which seems to afford us a clue to its structure, is that of its divisibility. No body is known to exist, which may not by the application of proper means be divided into parts. Let us cite an experiment in this direction, and see if we can learn anything from it which can aid us in our inquiry into the structure of matter. We take a piece of the polishing plate of Bilin—a stroke of the hammer will shatter it into fragments. We may continue the same operation with each successive smaller fragment until our hammer proves too coarse an instrument for finer division. We select two or three of the minutest particles thus obtained, and grind them in an agate-mortar until all grittiness has disappeared and the resulting powder has become impalpable. If now we examine this powder under a microscope, even a low power reveals it to be composed of particles of different degrees of fineness and of various shapes not differing in any respect from the original substance except in volume. By employing a higher power the appearance of these little grains becomes greatly altered. Each minute grain is seen to be composed of a great number of very regularly shaped little bodies, most of them perfect, some, however, broken. These little bodies have beautiful, delicate grooves chiselled upon their surface, and are recognized as belonging to the graceful diatom *melosira distans*. It would require 6,720 of these little discs laid side by side to fill out a line one inch in length. A cubic inch of the polishing slate of Bilin would consequently contain, in round numbers, 303 billions, 420 millions distinct discs of this diatom, and yet we feel confident that, even if we could separate the original rock into these individual discs, our division has but commenced! For our magnifying power detected among the discs composing each little grain of our impalpable powder, some which had been fractured and fractured into very irregular pieces. However minute in size and regular in form, these dics, then, cannot represent the smallest particles into

which the polishing slate of Bilin may be divided; on the contrary each disc is apparently as divisible as the whole rock, and we see no reason why, had we the proper means, we might not continue the process of division in the case of each diatom into particles beyond even the range of microscopic power. From this experiment, which may be taken as typical, we conclude that our effort in dividing the slate has been limited *only* by the imperfect means at our command, and that each successive degree of subdivision attained by mechanical means furnished particles not differing in properties from the original substance."

Problem: What is the size of the smallest particles of matter? How far separated are such particles?

THE RELATION OF MODERN SCIENCE TO THE FINE ARTS.

NEVER was there such a wide-reaching, all-grasping inquisitiveness abroad in the world as is displayed in modern science. No one of nature's secrets is too small for it to pry into; while its sublime self-confidence shrinks not from explaining the mysteries of a universe.

Throughout the world all things tangible, and many things apparently intangible, are seized by its minions, cross-questioned and put to the rack as heretic never was under the hands of a Spanish inquisitor. So far as physical law holds sway many and important discoveries have rewarded this inquisitiveness. From a physical point of view our whole manner of life has been wonderfully changed for the better by these multitudinous pryings into the nature of things. In spiritual matters, however, if modern science any longer admits that such there be, the results have not been so satisfactory. Whatever the modern scientist cannot put into his crucible, or dissect under his microscope, or touch with his magnets, he must be content to speculate upon like other men, if indeed he does not calmly deny their existence altogether. Metaphysics, religion and

æsthetics, the fundamental principle of the fine arts, have of all things been least affected for good by the advance of modern science. The first two need not be treated of here; the last seems more easily handled if limited to one department, that including drawing and painting. Like all things human, this art, while it has a soul capable of addressing itself to the intellectual and emotional parts of man's being, has also a body subject to physical necessities. There are gross bodily wants of pigments and brushes to be satisfied before the painter's thought can speak from the canvas. By adding to the number and improving the quality of pigments, and by aiding in other ways the "base mechanic" part of the art, painting has gained much from modern scientific research. It has been powerfully influenced, too, both mechanically and intellectually, by the invention and perfection of photography. Finally, in so far as painting is thoughtful as distinguished from emotional, it has felt the stimulus given by the progress of science to all forms of thought, particularly in its new and accurate way of looking at nature.

Passing over the merely mechanical part, we shall consider the effect of photography on art.

A year or two ago, a writer in a popular review had the hardihood to predict that the painter's sun of glory was about to set forever, while the photograph and polarized light were to be the luminaries of the future. This heresy was excellently replied to at the time by that charming writer, our townsman, Mr. Holmes. Unfortunately I cannot just now lay my hands on his article, and must use my own words in speaking of the subject. In order to estimate the effects of their rivalry on art we must consider what powers these upstart children of science really possess. And, first, of polarized light. We must admit that it shows a depth and flashing brilliance of color rivalled only by the gleam of the rainbow against a storm-cloud. The rays of light that have travelled in wedded harmony all the lonely way from the sun through the desert ether, now at the end of their journey, disagree as to their course through some

paltry piece of earthly matter, and come up to our eyes, for the first time separated, and flushed and throbbing from their first quarrel. Certainly art, with her dim and earthy pigments, has nothing to compare with the gem-like richness and brilliance of these colors born of light; yet, by skilful contrasts and economical use of resources, poor art may go far to persuade us she is rich, and, after all, no merely mechanical and thoughtless display of form and color can influence us as art can by interweaving with her work the subtle charm of feeling.

On the other hand, photography would supplant the artist by a perfect reproduction of form and shading. Colors seem beyond its power, if we can judge by the abortive attempts at reproducing them exhibited at the Centennial. But where accuracy of form and shading in a copy are more important than color, the painter finds a dangerous rival in photography. Portrait painting in general has been seriously affected by it and miniature painting almost destroyed. At first sight it might seem that sunlight, working with impartial eye and in accordance with unerring natural law, should produce a picture infinitely more perfect and valuable than can come from the fallible hand and eye of an artist, especially when we remember that all impressions received by the eye, before reaching the hand must pass under the direction of a will never free from the power of passion and prejudice. This is no doubt partly true when there is demanded, by science for instance, a hard and accurate transcript of what is visible at any particular moment; yet only partially true, for some colors take much better than others—*i.e.*, have much more power to produce the necessary chemical changes in the sensitized surface, and hence appear relatively too light in the completed picture. But when the object is to delight and influence those bundles of passions and prejudices called men, the work of the skilful painter, imperfect and distorted though it must be, incomparably surpasses the work of his soulless antagonist, the sunlight. Without doubt the artist omits an infinitude of detail and exaggerates the more interesting and important parts of his subject; but his

work has a soul and lives—the work of the sunbeam is a lifeless corpse. No photograph of man or of place can have the life-like resemblance of a good painting. The very perfection of the photographic picture embarrasses us; we are finite, and the minuteness of detail in nature is infinite. But before going farther it will be worth while to consider to what extent it is possible to represent in a picture the lights and shadows in any natural scene. The highest light the artist can attain is that of white paper in the diffused light of a room; for, of course, no picture is painted to be looked at in direct sunlight. Ivory black may represent the deepest shadow. These are the extremes at the command of the artist. The photographer has a range considerably less—from a white not so pure as white paper to a dark brown. Now, let us compare these with a white cloud at noonday or snow in sunshine and a shadow in a dark night, as the extremes in nature. I take a white cloud as the purest and brightest light in nature; snow is a little bluish; of course, the sun at noon is infinitely brighter, but no artist would attempt to paint it.

How well does the paper represent the cloud? Hold it between you and the cloud as you stand opposite the window and you will be astonished to find your white paper look almost black by contrast. Our whitest white comparatively black before nature's! Again, look at the blackest thing you can find, a cloth coat for instance, by lamplight, against a starlit sky, and you will find it look brighter than the sky, which itself is very much brighter than the shadows under those trees. A calcium light would make the coat stand out almost white against the sky. Our darkest black, then, is a light grey compared with nature's.

Let us sum up the results of the comparison. The photographer copies simple light and shade over a limited scale with perfect accuracy; but in its monotint rendering of local color, the green of trees, brown of soil, etc., it shows great partiality for some colors over others, thus destroying the harmony of the effect. On the other hand, the artist is very far from accurate

in minutiæ, but can avoid the complex and, to the spectator, meaningless details of photograph. He has the power of choice so as to give prominence to what is most valuable. Above all, he has at his command the glory and charm of color, which to many eyes has fully as much value as form. In portraiture, where the range of light and shade is comparatively small, and the colors usually not brilliant nor much varied, photography has largely supplanted painting in the slighter and poorer part of its work. In landscape its rivalry of the painter is scarcely perceptible. By making perfect forms when the effect is fleeting, as in hurrying clouds, and by saving laborious sketching from nature when time is precious or the weather inclement, it becomes a most valuable assistant to the artist in his studio. In fine, the camera is a mere copyist, and just in so far as an artist rises to the ideal and seizes the spirit and essence of a subject rather than its mere form, just so far does he rise above the possibility of rivalry by any merely mechanical process.

The main object of science, as I understand it, is to observe phenomena and their causes, and when observed, to arrange them according to their relationships so as to group many facts under one general expression or law of nature. This is a great assistance to memory as well as to the reasoning powers.

The main object of fine art I think to be the portrayal of the pleasing, the beautiful, and the inspiring; and a secondary one, that of conveying information. This secondary aim of art is essentially the same as that of science; thus far they go hand in hand. An artist is very generally sent along with a scientific exploring expedition, because he can with his pencil in a short time record more truths about the outside appearance of a thing than many pages of a written account. Beyond this, however, their relationship is difficult to trace. To fulfil its ends a picture must not only have a pleasing arrangement of forms and colors, but must also be sufficiently like nature to prevent doubts of its truthfulness, which would neutralize its agreeableness to the beholder. A landscape artist's work will

therefore demand some knowledge of the ground covered by meteorology, botany, and geology; and a figure painter will require anatomy in order to satisfy the public. The more intelligent the public, the more deeply read must the artist be. The easiest way to learn the outside look of things in nature is by the study of the corresponding sciences; accordingly we find that late as well as early writers in art have gone deeply into science.

Finally, as students of science, let us beware of allowing the rigid and passionless spirit of our favorite study to harden us against the gentle and refining power of the fine arts. If music and poems and pictures did not bring a few gleams of brightness and beauty into our homes, with our advancing civilization we might fall hopelessly into the soul-strangling arms of an ugly utility. Let not science rail at fine art because pictures cannot be generalized into an algebraic formula, nor the soul's labor embodied in a poem be turned by the law of conservation of energy into heat or electricity. Science is of the intellect; fine art of the feelings; without either, a man is but half a man.

ILLUSIONS.

ONE of the most interesting books in the Humboldt Series is No. 56, *Illusions*, Part I., by James Sully. We have clipped a few paragraphs that may be of some interest. The whole work is indeed fascinating, especially the long chapter on *Dreams*.

CONFUSION OF THE SENSE-IMPRESSION.—The most interesting case of such an error is where the impression is unfamiliar and novel in character. I have already remarked that in the mental life of the adult, perfectly new sensations never occur. At the same time, comparatively novel impressions sometimes arise. Parts of the sensitive surface of the body which rarely undergo stimulation are sometimes acted on, and at other times they receive partially new modes of stimulation. In such

cases it is plain that the process of classing the sensation or recognizing it is not completed. It is found that whenever this happens there is a tendency to exaggerate the intensity of the sensation. The very fact of unfamiliarity seems to give to the sensation a certain exciting character. As something new and strange, it for the instant slightly agitates and discomposes the mind. Being unable to classify it with its like, we naturally magnify its intensity, and so tend to ascribe it to a disproportionately large cause.

For instance, a light bandage worn about the body at a part usually free from pressure is liable to be conceived as a weighty mass. The odd sense of a big cavity in the mouth, which we experience just after the loss of a tooth, is probably another illustration of this principle. And a third example may also be supplied from the recollection of the dentist's patient, namely, the absurd imagination which he tends to form as to what is actually going on in his mouth when a tooth is being bored by a modern rotating drill. It may be found that the same principle helps to account for the exaggerated importance which we attach to the impressions of our dreams.

In persons of very lively imagination, the mere representation of an object or event may suffice to bring about such a semblance of sensation. Thus, M. Taine vouches for the assertion that "one of the most exact and lucid of modern novelists," when working out in his imagination the poisoning of one of his fictitious characters, had so vivid a gustatory sensation of arsenic that he was attacked by a violent fit of indigestion.

In connection with pictorial delusion, I may refer to the well-known fact, that the eye in a portrait seems to follow the spectator, or that a gun, with its muzzle pointing straight outwards, appears to turn as the spectator moves. These tricks of art have puzzled many people, yet their effect is easily understood, and has been very clearly explained by Sir D. Brewster, in the work already referred to (letter v.) They depend on the fact that a painting, being a flat projection only and not a solid, continues to present the front view of an object which

it represents wherever the spectator happens to stand. Were the eye in the portrait a real eye, a side movement of the spectator would, it is evident, cause him to see less of the pupil and more of the side of the eyeball, and he would only continue to see the full pupil when the eye followed him. We regard the eye in the picture as a real eye having relief, and judge accordingly.

The delusions of the conjuror depend on a similar principle. The performer tells his audience that he is about to do a certain thing, for example, take a number of animals out of a small box which is incapable of holding them. The hearers, intent on what has been said, vividly represent to themselves the action described. And in this way their attention becomes bribed, so to speak, beforehand, and fails to notice the inconspicuous movements, which would at once clear up the mystery. Similarly with respect to the illusions which overtake people at spiritualist *séances*. The intensity of the expectation of a particular kind of object excludes calm attention to what really happens, and the slightest impressions which answer to signs of the object anticipated are instantly seized by the mind and worked up into illusory perceptions.

It is to be noted that even when the impression cannot be made to tally exactly with the expectation, the force of the latter often effects a grotesque confusion of the perception. If, for example, a man goes into a familiar room in the dark in order to fetch something, and for a moment forgets the particular door by which he has entered, his definite expectation of finding things in a certain order may blend with the order of impressions experienced, producing for the moment a most comical illusion as to the actual state of things.

It is plain that the fusion of sensations, whatever its exact conditions may be, gives rise to error or wrong interpretation of the sense-impression. Thus, to take the points of two legs of a pair of compasses for one point is clearly an illusion of perception. Here is another and less familiar example. Very cold and smooth surfaces, as those of metal, often appear to be

wet. I never feel sure, after wiping the blades of my skates, that they are perfectly dry, since they always seem more or less damp to my hand. What is the reason of this? Helmholtz explains the phenomenon by saying that the feeling we call by the name of wetness is a compound sensation consisting of one of temperature and one of touch proper. These sensations occurring together so frequently, blend into one, and so we infer, according to the general instinctive tendency already noticed, that there is one specific quality answering to the feeling. And since the feeling is nearly always produced by surfaces moistened by cold liquid, we refer it to this circumstance, and speak of it as a feeling of wetness. Hence, when the particular conjunction of sensations arises apart from this external circumstance, we erroneously infer its presence.

If one reflects how many ghosts and other miraculous apparitions are seen at night, and when the mind is in a more or less somnolent condition, the idea is forcibly suggested that a good proportion of these visions are the *débris* of dreams. In some cases, indeed, as that of Spinoza, already referred to, the hallucination (in Spinoza's case that of "a scurvy black Brazilian") is recognized by the subject himself as a dream-image. I am indebted to Mr. W. H. Pollock for a fact which curiously illustrates the position here adopted. A lady was staying at a country house. During the night and immediately on waking up she had an apparition of a strange-looking man in mediæval costume, a figure by no means agreeable, and which seemed altogether unfamiliar to her. The next morning, on rising, she recognized the original of her hallucinatory image in a portrait hanging on the wall of her bedroom, which must have impressed itself on her brain before the occurrence of the apparition, though she had not attended to it. Oddly enough, she now learnt for the first time that the house at which she was staying had the reputation of being haunted, and by the very same somewhat repulsive-looking mediæval personage that had troubled her inter-somnolent moments. The case seems to me to be typical with respect to the genesis of ghosts, and of the reputation of haunted houses.

LITERATURE OF FRENCH CANADA.

AND now the poets. Here French Canada can afford to smile in the assurance that she will never sink into oblivion, *caret quia vate sacro.* This department is well stored, and with works of superior excellence. The Canadian French are fond of music and song, a gayety of temperament particularly susceptible of the tender passions, greedy of adventure, and keenly imaginative. All these qualities point to a thirst for the poetical element, and the want has been abundantly supplied. The roll is a lengthy one of those who have voiced the aspirations of their countrymen, sung of their joys and sorrows, celebrated their glories, described the simple life of their village homes, and interpreted the meaning of their destinies. They are the two Garneaus, father and son, Lenoir, Fiset, Chauveau, Donnelly, Prudhomme, Marchand, Poisson, Routhier, Chapman and Lajoie. The latter has immortalized himself by a single ballad, "Un Canadien Errant," just as Sir George Cartier would be remembered by his "O Canada, mon Pays, mes Amours," even if he had not been one of the Fathers of Confederation. Blain de St. Aubin has also written many songs, set to music by himself. Among the poets of a higher flight, or who have produced more ambitious works, I give the first place, after much reflection, to Cremazie. He was a man of creative genius, who would have made his mark in any country, and had circumstances allowed him to cultivate his great talents in quietude of mind, he would have written poems of sublime worth. As it is, barring a few weak lines here and there, which he never had the heart to revise, his "Vieux Soldat," "Drapeau de Carillon," and "Les Morts" are perfect, and stir the soul like the blast of clarions. Cremazie deserves a monument at the hands of his countrymen, and that monument ought to be a national edition of his works. Following closely is Frechette, a poet in the loftiest sense of the term, and still in the maturity of his powers. He has done his full share

toward spreading the knowledge of his country abroad, by winning from the French Academy the Monthyon Award, an honor somewhat equivalent to the Oxford University Prize Poem. Cremazie is the Hugo, Frechette the Lamartine of Canada. The Beranger is Sulte. This poet is, perhaps, more distinctively national than any of the others, because he confines himself to the songs of the people. His 'Patineuse" is a little gem. Lemarg has written a number of long poems, but, in my opinion, the best of them is his translation of "Evangeline." You will doubtless smile when I venture the statement that some of the lines are an improvement on the original, but I am happy to add that Longfellow himself concurred in this view. At least one clergyman has not deemed it derogatory to cultivate the muse in the intervals of his parochial ministrations, and it is some satisfaction to be able to say that he is almost as good a poet as he is a faithful pastor. "Au Foyer de mon Presbytère," by the Abbé Gingras, is a dainty little volume, by no means faultless, indeed, chiefly through lack of revision, but containing many tender and striking passages, with a novelty of treatment such as might be expected from the heart of a celibate priest.

JOHN LESPERANCE.

LIVINGSTONE.

A VALEDICTORY.

ABOUT fifty years ago, in the large cotton works of Blantyre, on the beautiful banks of the Clyde, there might be seen a long, slim, loose-jointed lad doing faithful service at a spinning-jenny. A very interesting lad; bright, and earnest, and thoughtful; one of those rare spirits whom anyone, even a passing observer, would be sure to single out from his companions. But go a little nearer, and watch more closely, and there you will see spread out before him an open book, page after page from which he drinks in eagerly as he passes and

repasses at his humble toil. From the spinning-jenny he hastens away to the village night-school. And thus on every day until, at the age of sixteen years, he has read many books of travel, volumes of science, and is master of Virgil and Horace.

"The child is father of the man." How true it is! And in the case of our hero these words are full of promise, they are rich with prophetic meaning. The son of a hardy race in the Hebrides, who proudly boasted that for six generations not one of them had ever been found guilty of a single act of dishonesty; the child of a loving, godly father, "whose kindliness entwined the heart-strings of his children around him;" and of a pious, devoted mother, whose bright example never ceased to shine out before him as a guiding star in his life; thus the very noblest qualities of manhood were his by birthright. And even the poverty and hardship against which he struggled so gallantly only gave to that noble character a more perfect symmetry and a richer beauty. What wonder that, in the near future, he was to find a far wider field of labor, and become the dispenser of the most glorious blessings that man can bring to man! For so it was. Such a field of labor he did find. Not in his own beloved land—the land of Scott and Burns—the breezy, invigorating land of the north; but in that "Great Unexplored Region" of the south; in the very place where, of all places in the world, both the climate and the habits of the people seemed most forbidding; there he scattered seeds of blessing that shall bud and blossom into eternity; there he crowned himself with honor and glory immortal.

A grand work, a *mighty* work was his. It was to solve the famous problem of the Nile. Famous, indeed, that problem. It had an interest for Nero and Julius Cæsar, and even for Alexander the Great. In this nineteenth century, however, we have seen the most wonderful enthusiasm centring in that secret of the ages. Said Baker, when he discovered the Albert Nyanza: "It is impossible to describe the triumph of that moment. Here was the reward for all our labor—for the years

of tenacity with which we had toiled through Africa. England has won the sources of the Nile!" And when, in 1863, Speke and Grant found other lakes, and sent home to London the pithy telegram, "The Nile is settled," like words of magic the news went flashing all over the land, "The mystery of Old Nile is solved!" This, however, was only true in part. At that very time Livingstone was right on their heels. With amazing devotion to the task he set before him, *he* passed upward from the south, traced the ultimate sources to their fountain-heads, and indicated the dividing line between them and the parent streams of the mighty Congo and Zambesi.

But this was by no means the "be all and end all" of his great work of exploration. How could it be? If the child was father of the man, surely the man is born of the child. How he loved to ramble in those early days! With what intensity of zeal he used to climb the rugged steep and top the highest mountain in his eager study of plants and rocks! And has he not the same spirit now? Will gorges and glens untravelled, and swamps deadly with pestilence, and the prospect of meeting natives untried and unknown, strike terror to his heart, and smother the lofty purpose in its very conception? Surely not. Behold the grand possibilities that lie before him! Why, to him it may be given to uplift the veil which, from the morning of creation, has held in deep dark mystery the entire inner life of a mighty continent, and to prepare the way for the future development of its vast internal resources.

To him it was given. He went where foot of white man never trod before. He encountered difficulties no man ever dreamed of before. At one time he finds himself in grass twelve feet high, the burning sun directly over his head, and the rain standing in pools of water. Then he is hemmed in by the Arabs, deceived by Portuguese, betrayed by Moslems, and robbed by his own followers. But his ready skill, his burning zeal, his untiring energy are only equalled by the peculiar gentleness and kindliness of his nature, and before these every barrier is broken down, every mountain becomes a plain. That

wonderful march by which he forced his way to the western coast, and swept back again from ocean to ocean, was the invincible onward march of a king. Nothing could chill his ardor, nothing could stay his progress.

And then the fulness of information he sent out to an admiring world! What accuracy of geological and geographical observation! What graphic delineation of local customs and social habits! Tedious and toilsome journeys, deeds of heroic daring, rich and rare discoveries, enrapturing scenes from primeval nature—all pictured by a master-hand in his own charming simplicity of style.

A grand work, a *humane* work was his. It was the abolition of African slavery. In this he was moved by the very same spirit which broke out in that fine old protest of Cowper:

> "There is no flesh in man's obdurate heart,
> It does not feel for man. . . .
> . . . . . .
> He finds his fellow guilty of a skin
> Not colored like his own; and having power
> To enforce the wrong, for such a worthy cause
> Dooms and devotes him as his lawful prey;
> . . . . . .
> Chains him, and tasks him, and exacts his sweat
> With stripes, that Mercy, with a bleeding heart,
> Weeps when she sees inflicted on a beast.
> Then what is man? And what man, seeing this,
> And having human feelings, does not blush,
> And hang his head, to think himself a man?
> I would not have a slave to till my ground,
> To carry me, to fan me when I sleep,
> And tremble when I wake, for all the wealth
> That sinews bought and sold have ever earned.
> No: dear as freedom is—and in my heart's
> Just estimation, prized above all price—
> I had much rather be myself the slave,
> And wear the bonds, than fasten them on him."

And where is the man, whose heart beats at all in sympathy with the great heart of humanity, who will not re-echo this lofty sentiment?

But with Livingstone it was not a mere sentiment. He knew full well that if ever the curse was to be removed, it would be by giving to the world the simple, plain facts of the case. And yet, as he witnessed from day to day the horrible nature of this traffic in human souls, is it any wonder that his pleading for African freedom became a passion that stirred his warm, impulsive spirit to its very depths? And so the whole burden of his proclamation was this: "Be it known unto you, O ye highly-favored people of Christian lands, that the accursed slave-trade is the cause of insecurity in Africa. I cannot possibly tell you the evils of this monstrous exhibition of 'man's inhumanity to man.' To-day, I see harmless and helpless victims, who never heard of Arabs before, 'awakened by the thunder of gunpowder,' some are most foully butchered, and others literally dragged away by the unrelenting slave-dealer. To-morrow, I find, strewn along the way, the unburied bodies of scores of these, who have actually died of a broken heart. Mothers are seen toiling painfully along, bearing their infant children upon their backs, until they sink down beneath the load, and their children starve and perish beside them. And now, O ye highly-favored Christian lands, when shall this come to an end? How shall these terrible wrongs be avenged? Arise, O ye nations, send help to the suffering, speed on to the rescue of the innocent, and stay the cruel hand of the fell destroyer." Such an appeal from such a man could not be in vain. Though, unlike Wilberforce, he did not live to hear the first glad songs of new-found freedom, his work lived after him, and the seed sown in tears has since been reaped in joy.

A grand work, a *Christian* work was his. It was to bring the blessed light of the gospel to those who were sitting in darkness and the shadow of death. Christ for the world and the world for Christ: this was the burning thought of his heart from the very beginning. And he never got beyond it. It is well known, indeed, that he went out to his chosen and cherished field of labor the third time, not as a servant of the London Missionary Society, but as "Her Majesty's Consul" to

Africa. And we are very far from asserting that he ever became the most distinguished man whose name has graced the pages of modern history *simply* as a preacher of righteousness. But this we do assert, that the large heart, the broad and liberal mind, the devoted, enthusiastic spirit of the true Christian teacher he never lost; and, in the highest and best sense, his whole career was that of a noble Christian missionary. Do you say he was only a pioneer? He was a pioneer by necessity. And what of it? All honor to the man who casts up the highway and gathers out the stones! All honor to the pioneer missionary! The very highest honor to that man who dared every kind of danger, and set even death at defiance, that he might bring the knowledge of the glory of God to those who had been so long despised and forgotten! It was as if the great sun had risen for the first time, and flooded that land all over with sudden light and beauty. It was like the visit of an angel from heaven. Nay, to those poor benighted savages, after ages of deepest darkness, when they had almost forgotten even to feel after God, if haply they might find Him, literally as the coming of the Son of Man Himself was the advent, the life and work of Dr. David Livingstone in the great heart of Central Africa.

But, lo! the scene is changed. See! a steamer puffing with hot haste into the port of Zanzibar. And a band of eager men rushing quickly from its side, and away up through the country! They have only one inquiry, one earnest inquiry: "Where is he? Can't you tell us what has become of him? Not a word have we heard for months. All England is impatient, and America is impatient, and the whole civilized world is full of impatient anxiety. Give us news, give us news!"

News came—sad news. It settled the doubts and fears of the millions who were looking on, but still the news was sad, very, very sad. And then the body came—the cold and lifeless body of him they sought—the mournful, weary burden of his last and most faithful followers, who had actually carried it over a thousand miles from the interior—from the reeking

sloughs and choking vapors of Bangweolo, where the simple-minded, brave-spirited, grand old man had wasted and sickened and died. Sad news! The mighty Livingstone is fallen!

And then the steamer went puffing back again, bearing its precious burden home. And, not many days after, another of Britain's greatest and most honored dead was laid in Westminster Abbey, while all the hearts of all the nations bowed in mute and reverent sorrow.

"All is over and done;
Render thanks to the Giver,
Scotland, for thy son.
Let the bell be toll'd,
Render thanks to the Giver,
And render him to the mould.
Under the cross of gold
That shines over city and river,
Where he shall shine forever
Among the wise and the bold."

—WM. ELLIOTT, B.A.

A NEW PROFESSORSHIP.

(*Second Paper.*)

ITS RELATION TO THE WORK OF THE MINISTRY.

PRESIDENT ELIOT has said that "the education of the preacher drifts him away from his age." For scarcely any other is it so serious a thing to loose a strong living hold on real life. This drifting has been the source of many erroneous theories in theology and many impracticable schemes of philanthropy. Better than all dogmatic theology, better than all Church history and history of doctrine, is a grasp upon two or three of the simple truths of the gospel and a keen insight into human character and the needs and inner movements of the human heart. The gospel, we have been taught, is adapted to man, and what but the study of "the man and the book" can reveal with scientific clearness the many points

of adaptation? Instead of this, in the present non-practical system of education, we are taught to distinguish between sub-lapsarianism and supra-lapsarian, and the Arian and Sabellian heresies; we attempt to find the latitude and longitude of God before we can take the measure of man. The faculty of reading men can be trained like any other faculty. If it is generally feeble, the more reason why the means of training should be provided.

Those preachers who wield the greatest power over their people and the reading Christian public are profound students of human nature. F. W. Robertson sits on a throne to-day because of his keenness here. He pierces through the joints of the harness and probes to the secret motives. Phillips Brooks, Spurgeon, Beecher, Cardinal Newman, Bushnell and Moody owe their knowledge of making sermons "fit" to their deep and intimate acquaintance with the human heart. No service which the preacher can render men equals that he performs for them when he tells them things about themselves which they know or which they do not know, reads to them their wants and feelings, and comforts them with the very reading. This can be done only by the sympathetic study of human life.

Now as these great teachers mentioned above shed light upon many a preacher's problem met in pastoral work, and as they are exciting hundreds to independent study in this fruitful field of human experience, so a professor might lead his students into these mazes and throw some scientific light upon them. Under his guidance the great characters of literature might be studied, not as works of the dramatist's or novelist's art, but as representative characters to be analyzed with special reference to pastoral work and the probable types of spiritual experience they would exhibit under the sway of a true or a diluted Christianity. Science would sharpen the natural faculties and send the theological student out into the world trained to observation and enriched by a mass of facts which would prevent him feeling that he had dropped from another world into the whirl of active life. As the mineralogist from the practical

training of the laboratory leaves college ready at once to deal with metals, so the preacher would feel that he was equipped for the work of laying his hand upon men and influencing them for good. As in the mineral so in men, the elements are the same the world over, the combinations numberless. The only perfect training school for the navigator is the sea, but the science of the schools is no encumbrance to him when he walks the decks. A little spiritual science would not burden the pastor in the inquiry room.

It is a grander thing to be a doctor of humanity than a doctor of divinity. Every true preacher, like his Master, is a physician. Yet how much quackery have we here. A medical man by ignorance may slay a life, but a pastor by bad advice may slay an immortality. Nevertheless, how many things are said in the pulpit which are spoken in utter misconception of the wants and feelings of others. Men want gospel, but its various truths are often poured down them indiscriminately. The truth which at one time may heal a soul, at another time may be death to it. Many preachers are mere experimenters on souls. The present theological teaching sends the student out from college equipped for his work as imperfectly as a medical student would be who had studied botany and chemistry and had mastered the *materia medica*, but who had not studied physiology, pathology and therapeutics. We are taught the names of our remedies, but of the practical application of them we learn nothing till, after many mistakes, we learn in the serious school of experience.

Why should not the theological student be taken into the moral dissecting room under the lead of Shakespeare and the great preachers, of George Eliot and Mrs. Browning? Why should he not be taught to detect the causes of many morbid feelings which manifest themselves in some Christian lives, that intelligently he might prescribe the means of cure? Should he not be trained to spiritual diagnosis? Sometimes the remedy for a spiritual difficulty will be prayer, sometimes fresh air, a book of humor or fiction, or gleeful society. In other cases he

should advise a completer consecration to Christian activities or the perfect absorption of some passage of the Bible with a view to its transmutation into life.

There is the fact that when attention is concentrated upon the passion of anger in one's self it dies. With some other feelings the reverse is true; but in the case of temper this is one of the ways of escape which the Master of human life has provided lest we should be tempted above that we are able to bear. Yet how many spiritual practitioners tell their people this and kindred facts of supreme practical moment? And so the people perish for lack of knowledge. There is no way of trusting God so legitimate, none that brings more effectual aid, than obeying the natural laws revealed in our constitution.

We are drilled in dogmatic theology and in homiletics, and for three years we bow down and worship the letter, while no door, except the haphazard door of classroom, is ever opened to bring us into living contact with the Spirit, and to beget a keen and reverent study of that world of experience which is to be our true parish, our hospital, our harvest-field.

Would not a microscopic study of Macbeth, along the line of conscience, simultaneously with the study of other characters in whom the powerful workings of this mysterious faculty are seen, furnish a conception which would help the preacher in the inquiry room, and which would be to him a vision of power when he stands in his pulpit? It is true that every well-instructed Christian youth knows something of the laws of conscience, of faith, and of regeneration; but there is not enough clearness, mastery of detail, and intimate acquaintance with the subtle windings of the human heart to fit them to deal with particular cases and special difficulties.

What pastor has not noticed that the same style of Christian experience will descend from parent to child, through several generations, with a certain color of eyes and shape of nose? Does not this lay greater emphasis upon Christian home-life, and would it not be helpful in some cases where there are hereditary difficulties in Christian life, if the sufferers could be shown the far-off causes of their fears and directed to the

special line of religious culture which would produce a cure? *Heredity and Christian life* is a wide and vital theme.

Environment is very powerful in toning the inner life. Who has not noticed that a peculiar and very distinguishable tone is given to Christian experience by Arminian as opposed to high Calvinistic theology? The experience of persecuted Churches is apt to have elements which can never be revealed in churches which are merely Sunday clubs. It is a strange fact that the noblest ideas of God, of man's destiny and place in nature, have come from people raised on the bare earth and under the shelter of the pitiless heavens; and the meanest theories have risen among those whose lives have been surrounded with all the luxury and splendor of wealth. The healthiest theologies are to be found among those who stand in the heat and sweat of Christian toil among the degraded, and the most hurtful come from those who sit in their easy-chairs sucking their theologies and their meerschaums and filling the luxurious rooms with tobacco fumes and sentimentalism. *Christian life and environment* is another fruitful line of investigation.

Many good and beautiful souls are in darkness and doubt because of a lack of Christian activity. They lead "lives of indolence, and therefore sad." Imaginative dreaming is their curse, and sensational novel-reading will magnify the evil tenfold. They dream, but do not. To these Hamlets, often royally endowed, all the "uses of the world" are "flat, stale and unprofitable;" while many a soldier and sailor, with far narrower natures, have Christian experiences of abounding joy, because they carry the habits of prompt obedience, learned in their callings, into their religious life. Dawdlers are always doubters. Ribot's "Diseases of the Will" would suggest causes and cures for some spiritual ailments. The preacher should master the subjects of soul-hygiene and spiritual pathology.

There are clouds which darken Christian experiences, which are the exhalations of wrong physical states. There are departments of medical science with which every pastor should be acquainted. The keenest eyes are needed for spiritual diagnosis, for there are evil influences which come upon the

souls of men, which seem to be vindictive spirits from the pit itself, the source of which is the other end of the pneumogastric nerve. By kind-hearted and sagacious treatment in pointing out the causes of feelings which often cause serious perplexity, the preacher can deliver earnest souls from the grasp of their foes. A man, expert in giving such aid, would grow more influential and beloved as he grew older and more experienced. As the grip of the preacher weakened the grip of the pastor would grow stronger. The edge of the tomb would be the first "dead line" he would meet.

The phenomena of mob-excitements and revivals should be studied. Our feelings and convictions are contagious. Soul touches soul, and the influences are for good or evil. The divine mingles with the human, and both work according to the same laws, viz., the laws of the organism which is the theatre of their operation. If these are mastered they can be used for the benefit of all who are willing to submit to the conditions.

This science would reach its noblest plane in Christology—the scientific study of the inner life of the "deep, transparent man" of Galilee. The law that all the individuals of any species must be judged by its highest specimen, lays double importance upon the study of the character of Jesus as the Perfect Man, the Ideal of all humanity, and the Revelation of the truest human life. The life of Christ has a scientific as well as a religious significance. The great *desideratum* in any science is a perfect specimen. The lines of normal development can then be traced, the true balance of parts determined, and what is the healthy action of every function. This science, of which Bacon spoke, has its perfect specimen. It is universally acknowledged that the character of Jesus is faultless in its symmetry, while lacking neither breadth nor force. His intellectual, emotional and spiritual natures were subjected to extreme tests, yet no flaw was revealed. He had seasons of overflowing joy and of overwhelming sorrow, yet there is no frivolity in the glow and flashes of His joyousness and no taint of morbidness in the mysterious depths of His

depressions. His intellectual faculties worked together with perfect harmony, and the rest of His nature exhibited a perfect union of contrasted virtues. There was dignity so perfect that it did not need the aid of stiffness, and there was sweet humility; there was pity and justice, tenderness and severity; there was courage which quailed *never*, yet false daring there was none, for He kept within the limits of prudence. There is rebuke for the proudest and relentless unmasking of the hypocrite, yet no kinder words than His were ever spoken to the child and the suffering invalid. His gentleness has become proverbial, yet the force of His character has won the respect of the world's men of force and intellect—the Napoleons and Washingtons, the Carlyles and Gladstones. None but a natural king can appreciate the kingliness of Jesus. He beat His music out with the ease and grace of a perfect master, and, behold! it is the music of heaven. How healthy and natural is the tone of His whole life! The clear air of this heaven-kissing Judean hill is the healthiest atmosphere known to literature. During the years the theological student is pouring over his Greek Testament, *why should not the study of the human side of Christ's character be pursued at least with as much attention as the study of Hamlet or any other character of literature?* It would increase the student's appreciation of that wonderful character which even the Christian world has never held in an enthusiasm of admiration at all worthy of its matchless beauty. Amid so many abnormal types of Christian experience he would find here a touchstone by which to try them all. If the Church would drink deep of this study of the life of Christ, morbidness, now so prevalent and so admired in some quarters, would no longer be fashionable. Whining sentimentalism would be superseded by healthy earnestness and holy joyfulness. The normal Christian life is songful. Love sings while it suffers and bears the burdens of others.

What an Ideal would grow before the students! The daring adventurers, the great generals and all men of heroic endeavor and magnificent achievement, whose lives so often captivate the

youthful imagination, would hide their diminished heads before this Light of Life. A professor of noble soul and varied experience could do most enduring work, as it would be his part to awaken an enthusiastic devotion to the nobleness of the noblest life, and to call the students to purity of thought, lofty heroism of life, and sympathy with all ranges of humanity that, according to the measure of their success, they might *realize* the transcendant character of Jesus, as Shakespeare first realized the characters he portrayed with such a master-hand. Then Christ would be lifted up in our pulpits, as He seldom is now, as the glory of religion, the supreme fact of science, and the Light of the world. The exceeding beauty of His life could not fail to kindle the aspiration of men when described by those who had felt its loveliness, while His word of cheer and promise and humanness of His divine sympathy would rescue them from utter despair. Thus He would draw all men unto Him.

PHAM.

MYSTERY OF CREATION.

I

AS science advances, man's mind becomes more venturesome and unsatisfied with a knowledge of the present: the phenomena of the past are carefully scanned and nature's laws made manifest. From the present the future history of events is foretold and the buried past revived under the light of modern speculation and careful scientific reasoning. No subject seems too great for man's mind to grapple with, and effects which once defied investigation have now been reduced to simplicity, and robbed of a great amount of so-called supernaturalism. As we reflect upon the wonderful truths and laws that have been discovered within the past few years, as we have watched the tiny brooklet of science swelling to a mighty stream, we cannot help stopping to wonder what will be the progress that will mark the scientific eras yet to come.

The subject which we have chosen is one which has agitated

the minds of the greatest philosophers of every age. It carries us as far back into the past as science ever yet has dared to go, and leads to a point beyond which science ne'er can hope to set her foot during man's short existence upon the earth, and when standing on the boundary line between the Infinite and the Finite we are inevitably compelled to recognize the presence of a God.

Through all ages philosophers have brought forward their theories and hypotheses concerning the origin of the world and the other heavenly bodies, but impossibility and absurdity are stamped upon the front of most of them, and only since the discovery of the laws of gravity have any hypotheses worthy of notice been brought forward. As astronomy advanced, the regularity and uniformity of the solar system became more and more apparent, and this suggested to the minds of former philosophers and astronomers the possibility of some common cause. This uniformity consists in the fact that all the planets of the solar system rotate in the same direction upon their axes and also revolve around the sun in orbits lying nearly in the same plane as the sun's equator. This could not have been the result of chance.

The Nebular Hypothesis is one which has found many supporters (and also opponents) among the great scientists of the past and present. It was first suggested by Kant, who assumed "that all the material out of which the bodies of our solar system were formed, were in the beginning of things resolved in their original elements and filled all the space of the universe in which these bodies move." It was that chaos which Milton has described as

> " . . . . . a dark,
> Illimitable ocean, without bound,
> Without dimension, where length, breadth, and height,
> And time and place are lost."

Naturally some parts would be denser than others, and round these would be gathered the rarer matter of the spaces intervening. In this way, by the union of these masses of nebulous matter, would be formed large round bodies—the origin of our

present solar system. The motions of these bodies would arise from the repulsive forces acting among the particles of matter which would give a rotary motion. The next great mind to grapple with this question was Herschel, whose attention was called to the subject through his investigations into the nebulæ themselves. Here seemed to be the great workshop of the Creator, where could be observed the different stages of the formation of worlds, from the raw, diffused nebulæ to the star-clusters, where condensation was complete. Modern research and improved telescopes have resolved many of these masses of nebulæ into star-clusters, but spectrum analysis has stepped in, and in a clear and conclusive manner has shown that some of these nebulæ are still in a diffused, gaseous state, thereby strengthening Herschel's views.

The next scientist is LaPlace, to whom is generally attributed the honor of being the founder of the Nebular Hypothesis. While he reasoned somewhat after the manner of Kant, his starting-point is somewhat different and is as follows. He begins with *the sun already formed and already in rotary motion*, and also surrounded by an immense, far-extending atmosphere of vaporous matter; and it is from this atmosphere that he evolves the other solar bodies in a manner somewhat similar to that adduced as follows by Kant. This mass of matter being intensly hot begins to cool, and as a natural consequence begins to contract, and thereby the rotary motion is accelerated, since it is a law of mechanics that if a body be revolving in any orbit, and the diameter of this orbit be lessened, the rate of speed will be increased, and increase of motion results in increase of centrifugal force or tendency of the matter to fly away from the centre. We would now have two forces acting in opposite directions, viz., the *attractive force* of the molecules for each other drawing every particle towards the centre of the mass, and the *centrifugal force* driving every particle away from the centre. As the motion increased, the centrifugal force increased, while the attractive force remained constant, and so eventually a time would come when the centrifugal force would overcome the

attractive force, and a mass of the exterior molecules would be left behind in the form of a ring, revolving as before around the centre of gravity. This would be repeated and a second ring left behind, till at last the sun in the centre would be surrounded by a series of rings all revolving with the sun in the same direction. These rings, of course, would continue to cool and contract; and if the rings were perfectly uniform it would split up into millions of little bodies, so closely packed together as to appear like continuous rings, as in the case of Saturn, or form into a group of small planets, as seen in the interplanetary space between Mars and Jupiter. Or if some portion were much denser than the rest it would congregate around itself the rarer mass and form one large revolving globe, as in the case of the large planets, which would in time throw off its rings and form its moons and satellites. The zodiacal light has been by some explained as being a mass of this nebulous matter revolving around the sun, but too rare and volatile to form a ring or planet. According to Kant the sun was not formed till after the other planets, but according to LaPlace it was the first. Had the sun not been formed of a dense material it would have been flattened out into a flat disk-like body instead of a sphere, but being already a sphere some of its motion was communicated to the planets and also lessened by friction.

We will now endeavor briefly to discuss some of the points connected with this subject.

1st. *Original Condition of all Matter.*—A great many persons look upon the original condition of matter as one of intense heat, which has been gradually dissipated throughout the infinitude of space—that intense heat was one of the prime conditions of matter. This we cannot agree with, as heat itself is nothing else than a mode of motion, and matter must have existed before it could be set in motion; so that we are inclined to the opinion that matter in its primordial state was *cold*, diffused in a rare gaseous state throughout all space, and possessed of the attributes of attraction which became manifested in a certain form of motion. In fact, does not the Bible say that "darkness was

upon the face of the deep?" The result of collisions and frictions necessarily resulting from this process of aggregation would be an indefinite supply of heat and light. Heat would be radiated and the mass cooled and slowly contracted, and this contraction would generate more heat in accordance with the principle of contraction of gaseous bodies. "The more heat a gaseous body loses the hotter it will become." In this way some maintain that the constant heat of the sun is kept up. The reason is as follows:—If a globular gaseous mass is condensed to half its original diameter, the central attractive force exercised will be increased fourfold (since it varies inversely as the square of the distance), while the surface area will be reduced fourfold (since areas of spheres are as squares of diameters). Thus the pressure for each unit of area will be 16 times greater than before, while the density is only 8 times greater than before (since density varies inversely as cube of diameter). Therefore if the forces of elasticity and gravitation were in equilibrium in the original condition, the temperature must be *doubled* if they shall remain in equilibrium, *i.e.*, the temperature varies inversely as the diameter.

2nd. *Cause of Rotary Motion.*—Kant accounted for it by the action of forces among the particles of matter, others by saying that it was the result of condensation. But mechanics prove to us that in any system the sum total of the rotary motion cannot be affected by the mutual action of the separate parts, but that any increase in the sum total of rotation must result from external causes. To obviate this difficulty some have explained the causes of rotary motion by imagining the original state of nebulous matter to be discontinuous, that is, in the form of clouds which would rush together and collide, and the result would be that the mass thus formed would, on account of the resultant of the different forces which must act in some direction, begin to revolve about some axis. But would this produce rotary motion? It seems to us to be on the same plan as the former theory, only the molecules are in the form of large clouds. There must have been a centre of gravity of the

masses as a whole, and towards this all must gravitate, and only action and reaction would result and would not produce rotary motion. Besides, which is the more reasonable to suppose, that matter was equally scattered throughout all space, or that it existed in the form of clouds? The former, in our opinion, would be most reasonable and likely, and would the better agree with the general idea of uniformity that is all-pervading. LaPlace, in setting forth his hypothesis, saw the difficulty, and so starts out with matter already in motion.

The impossibilities and contradictions apparent in the attempted explanations of rotary motion in the Nebular Hypothesis do not detract from its value, as some suppose, since in any hypothesis we must have some starting-point, some limit beyond which science can never go, and where motion takes its rise from the Creator. If asked what could produce rotary motion, the only answer could be, in our opinion, that it has resulted not from any *physical* or *natural* cause, but from *supernatural* cause, and that as all phenomena are now based upon the underlying principle of motion, and that motion cannot be evolved out of matter alone, so we conclude that this original rotary motion must have resulted directly from the Creator, who evolved out of His own being and power the matter which was to be set in motion.

3rd. *Formation of Rings.*—This is a matter which presents some difficulty. We could have a spherical mass of nebulous matter over 6,000,000,000 miles in diameter, requiring several cubic miles to weigh a single grain, all set into rotary motion. There would exist the force of gravity tending to preserve its spherical form, and the centrifugal force caused by the rotary motion tending to bulge out its equator and flatten its poles. The mass cooled and contracted and the rotary motion and centrifugal force increased. According to LaPlace, when these two opposing forces counterbalanced each other at the outer limit of the revolving mass, the outer portions were separated from the rest, leaving the ring behind. Some contend that, since there is no cohesion between particles of vapor, this throwing

off of rings would be impossible; that instead of there being left a series of rings, each being distant from the centre about twice as far as its next neighbor, there would be formed a series of rings infinite in number and joined together. Others say that the result of all the motion would be that the matter would rather assume the form of one large ring than several rings with a sphere at the centre. The rate of rotation is constant, so that the present rate of revolution of Neptune about the sun must be nearly the same as the previous rate of rotation of the cosmical mass at the time of the throwing off of the ring out of which Neptune has been formed. Neptune's rate of revolution is about *1-11 sec. per hour*. The earth's rotation is *15° per hour*, and its oblateness is very slight. Therefore some contend that the rotation of the cosmical mass would not have been sufficient to produce much oblateness, and hence would not have been powerful enough to throw off rings. To this two objections present themselves to our mind, viz.: 1st, the density of the cosmical mass would have been very much less than that of the earth, and, besides, the volume of the moon has been left out of the account, as it, according to the Nebular Hypothesis, once formed a ring around the earth's equator, and hence added materially to the oblateness. The possibility of ring formation is one of the most vital points in the Nebular Hypothesis and hence it is one that is most assailed by its opponents. Opinions are very conflicting, and it is indeed true that the views of LaPlace in regard to it may need modification, if not entire change. According to his hypothesis, the cause of the decrease in size of the planets as we approach the sun is, that as the mass contracted it became denser, and hence more difficult to throw off rings, and the rings thrown off would contain less and less of nebulous matter. These rings would continue to revolve in the same direction as the parent mass, and, as they broke up and formed into planets, would not only possess this revolutionary motion, but, since the outer portions of the ring had a greater motion than the inner portion, as the planet was formed the outer part would move faster than the inner, and the result would be rotary motion.

SUNBEAMS.

I.

AFTER the gloomy fury of a storm has passed by, and the last mutterings of the thunder are dying in the distance, how beautiful it is to see a rainbow against the black retreating ranks of cloud. Nature smiling through her tears. Homer, as well as the Bible, mentions the rainbow as a sign of good to men; and in all ages it has been thought a happy omen. The Greek mythology made Iris the messenger of the gods.

Interesting as the rainbow is, and carefully as it must have been looked at, no one suspected it of being decomposed sunlight. Men could hardly imagine that white light, the emblem of purity, could be a compound, a mixture, even of such heavenly tints as those of the rainbow. And yet the rainbow is nature's spectrum wherein she analyzes her own light, giving man a hint of how he may inquire into her secrets.

About two hundred years ago Newton brought his wonderful powers of penetration to bear on the subject of light. He admitted a ray of sunlight through a round hole in the shutter of his darkened room; putting a triangular glass prism in its track he examined carefully the strip of color which fell on the screen opposite. Light in passing from one medium to another is bent out of its course unless it falls perpendicularly upon the surface of the second medium. A common illustration of this is the crooked look of a stick thrust into water. Newton showed by his experiment that light was made up of several colors, and that these colors were differently bent or refracted by passing from one medium to another, red being least affected and violet most. He proved, too, that a prism held similarly to the first in the path of one of these colors did not divide it up into any simpler colors, but only spread out the same tint a little more widely. If the second prism was held upside down,

however, the work of the first was undone, and a round ray of white light sped on as before.

If Newton had let in the light through a very narrow slit instead of a round hole, it is altogether probable that spectrum analysis would have been a century in advance of its present state. Wollaston did this about a hundred and thirty years after, and found to his astonishment that the spectrum, as Newton had seen it, was interrupted by a number of fine dark lines. Ten years after Fraunhofer, a German optician, carefully mapped 576 of these lines and marked some of the most important ones A, B, C, etc. From him they are called Fraunhofer's lines, and the use of letters to mark them is still retained. These mysterious dark lines which dimmed the brightness of the solar spectrum were a matter of great wonder to men of science till their origin was discovered.

Meantime light was examined from other sources than the sun: moonlight and the light of the planets gave the same spectrum as sunlight, since it was merely a reflection of the same light; but the fixed stars gave different spectra. Artificial lights, also, were studied. It was found that if a solid was gradually heated before the slit of a spectroscope, at red heat the red end of the spectrum appeared, and as the temperature rose, orange, yellow, green, blue and violet, were seen one after the other, till, at white heat, a perfect spectrum was produced like that of the sun, but without the dark lines. Heated liquids acted in all respects like solids, but gases gave only a few bright lines with sometimes a very faint continuous spectrum.

Hydrogen gives only three bright lines—one in the red, one in the green and one in the indigo; other gases give much more complicated spectra. We have been particularly struck with the beauty of nitrogen spectrum, as well as that of chlorine. If solids or liquids are heated to vapor and rendered incandescent, their spectra are similar to those of gases.

A little chloride of sodium or common salt dropped into the colorless flame of a spirit lamp gives two bright yellow lines close together. After turning the telescope from red to violet

of a continuous spectrum, it is rather disappointing to find nothing but two yellow lines to relieve the darkness in the sodium spectrum. Other metals give much more striking spectra. Magnesium and thallium, among others, give magnificent lines in green. The wonderful beauty of some spectra, when a number of splendidly colored lines flash out vividly before the eye, cannot be described to one who has not seen it. Sometimes instead of lines there are broad bands of color with one edge sharply defined, but falling off into darkness at the other, like the gradual melting of the gorgeous tints of sunset into the dusky sky above. These are called candelated spectra. No richly tinted and sparkling ruby or emerald can vie with the red and green which gleam out, fairly trembling and living in some of the bright line spectra.

But mere beauty of appearance did not satisfy scientific observers. They were searching for the hidden causes and relations of these phenomena. They soon saw that the prism was a keener analyst than the chemist in his laboratory, for quantities of a substance altogether too minute to be detected by the chemist's reagents, quickly announced their presence in the spectrum. In fact, sometimes this new method of analysis was altogether too discriminating. So infinitesimal a portion of common salt was necessary to give the soda lines that observers were quite put off the scent. They found that sulphur and a great many other substances gave the soda lines. Even the slamming of a dusty book near the flame, or the use of a cotton wick in the spirit lamp, sufficed to call up these ubiquitous yellow lines. Talbot concluded that they must be lines of water, since, in his opinion, no other substance could be so widely disdributed. Kirchhoff and Bunsen, two celebrated men with the spectroscope, to test the matter, burnt a small quantity of chlorate of soda with milk sugar, in a far corner of their experimenting room, and found that within a few minutes the previously non-luminous flame of their alcohol lamp became tinged with yellow, and the sodium lines appeared in the spectrum. From the size of the room and the

amount burnt, they calculated that if one grain of soda were divided into 180,000,000 parts, one of these parts would give the yellow lines. Since more than two-thirds of the earth's surface is covered with sea water, which is a solution of sodium chloride, and the salt spray is continually dashing into the air, so that a little of the spray is evaporated, leaving minute particles of the salt floating in the atmosphere, it is not to be wondered at that earlier observers were confounded by the continual recurrence of the yellow lines.

Our ideas of the distribution of various substances have been greatly changed by this method of analysis. Lithium, for instance, which was formerly supposed to exist only in a few rare minerals, is found to be distributed in small quantities over very wide areas. A drop of milk, or a drop of blood from your veins, or, if you are a smoker, the stump of your cigar, will give you the two lines in the red and orange which distinguish the lithium spectrum. Over wide tracts of country every green leaf or particle of soil gives the lithium reaction, though ordinary chemical analysis could not detect a thousand times the amount.

When pure, lithium tinges the flame a beautiful red, but a very slight mixture of the ever-present sodium renders it undistinguishable by the eye, and similarly with potassium or strontium, which redden the flame; but if any mixture of easily volatile metals is examined by the spectroscope, that great unraveller of the tangled skein of light lays each thread of color in its proper place and tells us in an instant what metals are there.

Many of the metals require the intense heat of the electric spark to volatilize them and show their spectra. A powerful battery is used, and the terminals between which the spark passes are made of the metal to be examined. A hundred years ago it was believed that witches could travel in an astonishing way through the midnight sky so long as they had a broomstick to stride. It seems as though electricity could not travel through a vacancy without something to go astride of;

and so to bridge the gulf between the points it tears off particles of the metal which are vaporized and give the spectrum of the metal. As the air between the points is also heated, the lines of oxygen and nitrogen, as well as hydrogen, from the moisture always present in the air, appear in the spectrum and are called the air lines. Some observers have used these as a kind of scale from which to measure the position of the lines of the metal. Almost every known substance has been analyzed in this way, and as a result at least four new metals have been discovered.

Rubidium and caesium were found by Bunsen about 20 years ago in the water of a spring at Dürkheim, in the Palatinate. The salts left, after evaporating some of this water, gave by the spectroscope a few bright lines which he had never seen before. He placed so much reliance on his new method of analysis that he immediately set to work to evaporate 44 tons of the water. The result was that every ton of water yielded about three grains of caesium chloride and about four tons of rubidium chloride, making about two hundred grains of the mixed metals from the 44 tons. They belong to the alkaline metals, and cannot be distinguished from potassium by the usual reagents. To show how comparatively clumsy the ordinary methods of analysis are, we may quote the following from Roscoe:—

"A mineral termed *pollux* was analyzed many years ago and supposed to contain potassium, but the chemist was unable to make up his analysis to 100 parts, and could not find out how an error had crept in. Since the discovery of the new metals it has been found that it was not really potassium at all which was present in this mineral, but the new metal caesium, the want of agreement of the former analysis being wholly attributable to the difference of the combining weights of these two bodies, that of potassium being only 39.1, while caesium is 133."

Thallium was next discovered by Crookes. It gives a bright green line. Its combining weight is very near that of lead,

which it resembles in appearance. A little piece cut off and laid in the hand had so much the look of lead that we should certainly have called it that if we had not been told otherwise.

Indium was afterward discovered by the two lines in the indigo from which it takes its name.

Thallium is the only one of the new metals which has been put to any practical use. It has been employed to make green flame in fireworks. As it costs immensely more than gold, this may not be thought very practical.

It was a great advance in spectrum analysis when it was found that substances absorb the light which they give out. If a note be sung near a piano, the wire corresponding to that note may be seen to vibrate, and the same note may be heard coming from it, showing that it has in a manner absorbed the waves of sound before giving them out. A sodium flame held before a brighter sodium flame looks opaque, but before any other flame transparent, showing that it absorbs only its own kind of light. Liquids also absorb each its own kind of light. If a tube containing some diluted arterial blood is held before the slit of a spectroscope so that the light entering the slit must first pass through the solution, the spectrum shows two dark absorption bands toward the red end of the spectrum; venous blood gives only one band. These bands are different from the absorption bands of a solution of magenta or any red solution looking like blood, so that the spectroscope gives a sure test of blood. Blood containing a very small quantity of carbon monoxide gas in solution exhibits a very peculiar set of bands. The poisoning effect of burning charcoal is chiefly due to this gas, and can therefore be readily detected. By means of a train of prisms fitted to a microscope, the one-thousandth part of a grain of the red coloring matter in a blood stain shows the bands. The spectroscope has already several times given important evidence in murder cases.

The earth's atmosphere has been suspected of making the Fraunhofer lines by absorption, since in the evening, when the sun's rays have to pass through a greater thickness of air,

bands and lines are seen which do not appear when the sun is higher. Jupiter's spectrum shows absorption bands, some like those of our atmosphere, but one altogether different, probably indicating some gas or vapor not existing in our atmosphere. Mars seems to show the same absorption bands as our own atmosphere; but they have not been observed in Venus, nor does the moon show them. Almost any transparent medium seems to be opaque to some rays of the white light which passes through it. We have seen two dark lines like those of Fraunhofer in the spectrum of chlorine in a Geissler's tube. They must have been formed by the absorption of the light by the glass of the tube.

The most important result of the discovery that vapors and gases absorb the same light as they give out is, however, in the explanation of the lines in the solar spectrum. Let us quote from Kirchhoff's own account of his investigations in this direction: "In order to test in the most direct manner possible the frequently-asserted fact of the coincidence of the sodium lines with the lines D, I obtained a tolerably bright solar spectrum, and brought a flame colored by sodium vapor in front of the slit. I then saw the dark lines D change into bright ones. The flame of a Bunsen's lamp threw the bright sodium lines upon the solar spectrum with unexpected brilliancy. In order to find the extent to which the intensity of the solar spectrum could be increased without impairing the distinctness of the sodium lines, I allowed the full sunlight to shine through the flame, and to my astonishment I saw the dark lines D appear with an extraordinary degree of clearness.

"I then exchanged the sunlight for the Drummond's or oxy-hydrogen lime-light, which, like that of all incandescent solid or liquid bodies, gives a spectrum containing no dark lines.

"When this light was allowed to fall through a suitable flame colored by common salt, *dark* lines were seen in the spectrum in the position of the sodium lines." As far as he had gone, Kirchhoff now had a spectrum like that of the sun,

continuous and crossed by dark lines. He concluded that there was vapor of sodium in the atmosphere of the sun, and that it absorbed the light represented by those two lines and left that part of the spectrum dark. He and others have since compared the bright lines given by most of our elements with the dark lines in the solar spectrum, and sixteen of them have been found to exist in the sun's atmosphere. The lines of iron are especially numerous and distinct, 450 of them having been recognized. Who has sufficient imagination to conceive of an atmosphere in which oxygen and nitrogen are not found, but which is principally made up of iron, copper, zinc, and other metals, with hydrogen floating on top? Who can represent to himself a climate where one day a rain of molten iron may hiss down white hot from a sky of metal, and next day a fearful shower of melted copper? Dante's Inferno or Milton's Paradise Lost contains no picture of terrors which can even faintly image the state of affairs in such a region; and yet out of this huge, seething, flaming globe, wherein the elements are put to torture in a furnace a thousandfold hotter than any furnace on earth—out of this centre, whose dreadfulness is only dimly shadowed by the greatest poet's vision of hell, spring the mild and beneficent rays of light and heat, without which our world and its sister planets would revolve in darkness and death for ever. Byron's wild dream of darkness would come true.

We cannot forbear giving a few lines of that poem:

> "I had a dream which was not all a dream:
> The bright sun was extinguished, and the stars
> Did wander darkling in the eternal space,
> Rayless and pathless; and the icy earth
> Swung blind and blackening in the moonless air.
> Morn came and went and came, and brought no day;
> And men forgot their passions in the dread
> Of this their desolation; and all hearts
> Were chilled into a selfish prayer for light."

Then follows a fearful description of what passed till all life was dead and

"The world was void;
The populous and the powerful was a lump—
Seasonless, herbless, treeless, manless, lifeless—
A lump of death, a chaos of hard clay.
. . . . . .
The winds were withered in the stagnant air,
And the clouds perished. Darkness hath no need
Of aid from them. She was the universe."

This is, in our opinion, one of the most terrible poems in the English language. Who can avoid an interest in a science which gives us our surest information as to the possibility or probability that the event just described may take place?

INTERIOR AFRICAN SEA.

Many persons have supposed that the French Commission which was appointed to examine De Lesseps' project condemned it, but this is a mistake. The Yellow Book, published by the Ministry of Foreign Affairs, shows: 1. That the exactness of the scientific labors on which the project is based is beyond all question. 2. That the execution of the canal which is to be the feeder of the future sea presents no difficulty. 3. That the work would be durable, since, even if we admit the most unfavorable hypotheses with regard to evaporation and saturation, the sea would have an assured existence of more than one thousand years. 4. That in no point of view could the sea be injurious, but that, on the contrary, it would favour the development of colonization, by ameliorating the climate, diminishing malaria, and increasing the fertility. 5. Opinions have been divided as to the importance of the new route, which would be opened to commerce, to the industry and security of Algeria; however, no one has been able, from any of these points of view, completely to deny the utility of the submersion of the basin of the Chotts. General Favé and others have eloquently set forth the capital importance of the interior sea, as well in a colonial as in a military point of view.—*Comptes Rendus.*