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THE

CANADIAN NATURALIST

AND

Quarterly Journal of Science.

ABSTRACT OF PROCEEDINGS OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE,

At its Forty-First Meeting, at Edinburgh, August, 1871.

The Presidency of the Association was resigned by Prof. Huxley, and assumed by Sir William Thompson, who delivered the usual Presidential Address.

After dwelling on the origin of the Association, and the eminent scientific career of several of its early founders, the President gave a review of the present work of the Association, and suggested, in connection with it, the importance of establishing a British Year Book of Science. He also urged upon the Government the necessity for the foundation of National Colleges of Research, on a scale commensurate with the importance of Scientific Education, and in some degree corresponding with similar institutions on the continent of Europe. He then proceeded to give a general sketch of the recent progress of Physical Science, from which we give the following extracts:—

1. SPECTRUM ANALYSIS.

The prismatic analysis of light discovered by Newton was estimated by himself as being "the oddest, if not the most considerable detection, which hath hitherto been made in the operations of nature."

Had he not been deflected from the subject, he could not have failed to obtain a pure spectrum; but this, with the inevitably consequent discovery of the dark lines, was reserved for the nineteenth century. Our fundamental knowledge of the dark lines is due solely to Fraunhofer. Wollaston saw them, but did not discover them. Brewster laboured long and well to perfect the prismatic analysis of sunlight; and his observations on the dark bands produced by the absorption of interposed gases and vapours laid important foundations for the grand superstructure which he scarcely lived to see. Piazzi Smyth, by spectroscopic observation performed on the Peak of Teneriffe, added greatly to our knowledge of the dark lines produced in the solar spectrum by the absorption of our own atmosphere. The prism became an instrument for chemical qualitative analysis in the hands of Fox Talbot and Herschel, who first showed how through it the old "blowpipe test," or generally the estimation of substances from the colours which they give to flames, can be prosecuted with an accuracy and a discriminating power not to be attained when the colour is judged by the unaided eye. But the application of this test to solar and stellar chemistry had never, I believe, been suggested, either directly or indirectly, by any other naturalist, when Stokes taught it to me in Cambridge, at some time prior to the summer of 1852. The observational and experimental foundations on which he built were:—

(1) The discovery by Fraunhofer of a coincidence between his double dark line D of the solar spectrum and a double bright line which he observed in the spectra of ordinary artificial flames.

(2) A very rigorous experimental test of this coincidence by Prof. W. H. Miller, which showed it to be accurate to an astonishing degree of minuteness.

(3) The fact that the yellow light given out when salt is thrown on burning spirit consists almost solely of the two nearly identical qualities which constitute that double bright line.

(4) Observations made by Stokes himself, which showed the bright line D to be absent in a candle-flame when the wick was snuffed clean, so as not to project into the luminous envelope, and from an alcohol flame when the spirit was burned in a watch-glass. And

(5) Foucault's admirable discovery (*L'Institut*, Feb. 7, 1849), that the voltaic arc between charcoal points is "a medium which emits the rays D on its own account, and at the same time absorbs them when they come from another quarter."

The conclusions, theoretical and practical, which Stokes taught me, and which I gave regularly afterwards in my public lectures in the University of Glasgow, were:—

(1) That the double line D, whether bright or dark, is due to vapour of sodium.

(2) That the ultimate atom of sodium is susceptible of regular elastic vibrations, like those of a tuning-fork or of stringed musical instruments; that like an instrument with two strings tuned to approximate unison, or an approximately circular elastic disc, it has two fundamental notes or vibrations of approximately equal pitch; and that the periods of these vibrations are precisely the periods of the two slightly different yellow lights constituting the double bright line D.

(3) That when vapour of sodium is at a high enough temperature to become itself a source of light, each atom executes these two fundamental vibrations simultaneously; and that therefore the light proceeding from it is of the two qualities constituting the double bright line D.

(4) That when vapour of sodium is present in space across which light from another source is propagated, its atoms, according to a well-known general principle of dynamics, are set to vibrate in either or both of those fundamental modes, if some of the incident light is of one or other of their periods, or some of one and some of the other; so that the energy of the waves of those particular qualities of light is converted into thermal vibrations of the medium, and dispersed in all directions, while light of all other qualities, even though very nearly agreeing with them, is transmitted with comparatively no loss.

(5) That Fraunhofer's double dark line D of solar and stellar spectra is due to the presence of vapour of sodium in atmospheres surrounding the sun and those stars in whose spectra it had been observed.

(6) That other vapours than sodium are to be found in the atmospheres of sun and stars by searching for substances producing in the spectra of artificial flames bright lines coinciding with other dark lines of the solar and stellar spectra than the Fraunhofer line D.

The last of these propositions I felt to be confirmed (it was, perhaps, partly suggested) by a striking and beautiful experiment, admirably adapted for lecture illustrations, due to Foucault, which had been shown to me by M. Dubosque Soleil, and the Abbé Moigno, in Paris, in the month of October, 1850. A prism and lenses were arranged to throw upon a screen an approximately pure spectrum of a vertical electric arc between charcoal poles of a powerful battery, the lower one of which was hollowed like a cup. When pieces of copper and pieces of zinc were separately thrown into the cup, the spectrum exhibited, in perfectly definite positions, magnificent well-marked bands of different colours characteristic of the two metals. When a piece of brass, compounded of copper and zinc, was put into the cup, the spectrum showed all the bands, each precisely in the place in which it had been seen when one metal or the other had been used separately.

It is much to be regretted that this great generalization was not published to the world twenty years ago. I say this, not because it is to be regretted that Angström should have the credit of having, in 1853, published independently the statement that "an incandescent gas emits luminous rays of the same refrangibility as those which it can absorb"; or that Balfour Stewart should have been unassisted by it when, coming to the subject from a very different point of view, he made, in his extension of the 'Theory of Exchanges,' (*Edin. Transactions*, 1858-59,) the still wider generalization that the radiating power of every kind of substance is equal to its absorbing power for every kind of ray; or that Kirchoff also should have, in 1859, independently discovered the same proposition, and shown its application to solar and stellar chemistry; but because we might now be in possession of the inconceivable riches of astronomical results which we expect from the next ten years' investigation by spectrum analysis, had Stokes given his theory to the world when it first occurred to him.

2. SOLAR AND STELLAR CHEMISTRY.

To Kirchhoff belongs, I believe, solely the great credit of having first actually sought for and found other metals than sodium in the sun by the method of spectrum analysis. His publication of October, 1859, inaugurated the practice of solar and stellar chemistry, and gave spectrum analysis an impulse to which in a great measure is due its splendidly successful cultivation by the labours of many able investigators within the last ten years.

To prodigious and wearing toil of Kirchhoff himself, and of Angström, we owe large-scale maps of the solar spectrum, incomparably superior in minuteness and accuracy of delineation to anything ever attempted previously. These maps now constitute the standards of reference for all workers in the field. Plücker and Hittorf opened ground in advancing the physics of spectrum analysis, and made the important discovery of changes in the spectra of ignited gases produced by changes in the physical condition of the gas. The scientific value of the meetings of the British Association is well illustrated by the fact that it was through conversation with Plücker at the Newcastle meeting that Lockyer was first led into the investigation of the effects of varied pressure on the quality of the light emitted by glowing gas which he and Frankland have prosecuted with such admirable success. Scientific wealth tends to accumulation according to the law of compound interest. Every addition to knowledge of properties of matter supplies the naturalist with new instrumental means for discovering and interpreting phenomena of nature, which in their turn afford foundations for fresh generalizations, bringing gains of permanent value into the great storehouse of philosophy. Thus Frankland, led, from observing the want of brightness of a candle burning in a tent on the summit of Mont Blanc to scrutinize Davy's theory of flame, discovered that brightness without incandescent solid particles is given to a purely gaseous flame by augmented pressure, and that a dense ignited gas gives a spectrum comparable with that of the light from an incandescent solid or liquid. Lockyer joined him; and the two found that every incandescent substance gives a continuous spectrum—that an incandescent gas under varied pressure gives bright bars across the continuous spectrum, some of which, from the sharp, hard and fast lines observed where the gas is in a state of extreme attenuation, broaden out on each side into nebulous bands as the density is increased, and are ultimately lost in the continuous spectrum when the condensation is pushed on till the gas becomes a fluid no longer to be called gaseous. More recently they have examined the influence of temperature, and have obtained results which seem to show that a highly attenuated gas, which at a high temperature gives several bright lines, gives a smaller and smaller number of lines, of sufficient brightness to be visible, when the temperature is lowered, the density being kept unchanged. I cannot refrain here from remarking how admirably this beautiful investigation harmonizes with Andrew's great discovery of continuity between the gaseous and liquid states. Such things make the life-blood of science. In contemplating them we feel as if led out from narrow waters of scholastic dogma to a refreshing excursion on the broad and deep ocean of truth, where we learn from the wonders we see that there are endlessly more and more glorious wonders still unseen.

Stokes's dynamical theory supplies the key to the philosophy of Frankland and Lockyer's discovery. Any atom of gas, when struck and left to itself, vibrates with perfect purity its fundamental note or notes. In a highly attenuated gas each atom is very rarely in collision with other atoms, and therefore is nearly at all times in a state of true vibration. Hence the spectrum of a highly attenuated gas consists of one or more perfectly sharp bright lines, with a scarcely perceptible continuous gradation of prismatic colour. In denser gas each atom is frequently in collision, but still is for much more time free, in intervals between collisions, than engaged in collision; so that not only is the atom itself thrown sensibly out of tune during a sensible proportion of its whole time, but the confused jangle of vibrations in every variety of period during the actual collision becomes more considerable in its influence. Hence bright lines in the spectrum broaden out somewhat, and the continuous spectrum becomes less faint. In still denser gas each atom may be almost as much time in collision as free, and the spectrum then consists of broad nebulous bands crossing a continuous spectrum of considerable brightness. When the medium is so dense that each atom is always in collision, that is to say, never free from influence of its neighbours, the spectrum will generally be continuous, and may present little or no appearance of bands, or even of maxima of brightness. In this condition the fluid can be no longer regarded as a gas, and we must judge of its relation to the vaporous or liquid states according to the critical conditions discovered by Andrews.

While these great investigations of properties of matter were going on, naturalists were not idle with the newly-recognized power of the spectroscope at their service. Chemists soon followed the example of Bunsen in discovering new metals in terrestrial matter by the old blow-pipe and prism test of Fox Talbot and Herschel. Biologists applied spectrum analysis to animal and vegetable chemistry, and to sanitary investigations. But it is in astronomy that spectroscopic research has been carried on with the greatest activity, and been most richly rewarded with results.

The chemist and the astronomer have joined their forces. An astronomical observatory has now appended to it a stock of reagents such as hitherto was only to be found in the chemical laboratory. A devoted corps of volunteers of all nations, whose motto might well be *Ubique*, have directed their artillery to every region of the universe. The sun, the spots on his surface, the corona and the red and yellow prominences seen round him during total eclipses, the moon, the planets, comets, auroras, nebulæ, white stars, yellow stars, red stars, variable and temporary stars, each, tested by the prism, was compelled to show its distinguishing prismatic colours. Rarely before in the history of science has enthusiastic perseverance directed by penetrative genius produced within ten years so brilliant a succession of discoveries. It is not merely the *chemistry* of sun and stars, as first suggested, that is subjected to analysis by the spectroscope. Their whole laws of being are now subjects of direct investigation; and already we have glimpses of their evolutional history through the stupendous power of this most subtle and delicate test. We had only solar and stellar chemistry; we now have solar and stellar physiology.

3. MOTION OF THE STARS.

It is an old idea that the colour of a star may be influenced by its motion relatively to the eye of the spectator, so as to be tinged with red if it moves from the earth, or blue if it moves towards the earth. William Allen Miller, Huggins, and Maxwell showed how, by aid of the spectroscope, this idea may be made the foundation of a method of measuring the relative velocity with which a star approaches to or recedes from the earth. The principle is, first to identify, if possible, one or more of the lines in the spectrum of the star, with a line or lines in the spectrum of sodium, or some other terrestrial substance, and then (by observing the star and the artificial light simultaneously by the same spectroscope) to find the difference, if any, between their refrangibilities. From this difference of refrangibility the ratio of the periods of the two lights is calculated, according to data determined by Fraunhofer from comparisons between the positions of the dark lines in the prismatic spectrum and in his own "interference spectrum" (produced by substituting for the prism a fine grating). A first comparatively rough application of the test by Miller and Huggins to a large number of the principal stars of our skies, including Aldebaran, a Orionis, b Pegasi, Sirius, a Lyræ, Capella, Arcturus, Pollux, Castor (which they had observed rather for the chemical purpose than for this), proved that not one of them had so great a velocity as 315 kilomètres per second to or from the earth, which is a *most momentous result in respect to cosmical dynamics.* Afterwards Huggins made special observations of the velocity test, and succeeded in making the measurement in one case, that of Sirius, which he then found to be receding from the earth at the rate of 66 kilomètres per second. This, corrected for the velocity of the earth at the time of the observation, gave a velocity of Sirius, relatively to the sun, amounting to 47 kilomètres per second. The minuteness of the difference to be measured. and the smallness of the amount of light, even when the brightest star is observed, renders the observation extremely difficult. Still, with such great skill as Mr. Huggins has brought to bear on the investigation, it can scarcely be doubted that velocities of many other stars may be measured. What is now wanted is, certainly not greater skill. perhaps not even more powerful instruments, but *more instruments and more observers.* Lockyer's applications of the velocity test to the relative motions of different gases in the Sun's photosphere, spots, chromosphere, and chromospheric prominences. and his observations of the varying spectra presented by the same substance as it moves from one position to another in the Sun's atmosphere, and his interpretations of these observations, according to the laboratory results of Frankland and himself, go far towards confirming the conviction that in a few years all the marvels of the sun will be dynamically explained according to known properties of matter.

4. SOURCE OF THE SUN'S HEAT.

During six or eight precious minutes of time, spectroscopes have been applied to the solar atmosphere and to the corona seen round the dark disc of the Moon eclipsing the Sun. Some of the wonderful results of such observations, made in India on the occasion of the eclipse in August, 1868, were described by Prof. Stokes in a previous address. Valuable results have. through the liberal assistance given by the British and American Governments, been obtained also from the total eclipse of last December, notwithstanding a generally unfavourable condition of weather. It seems to have been proved that at least some sensible part of the light of the "corona" is a terrestrial atmospheric halo or dispersive reflexion of the light of the glowing hydrogen and "helium" round the sun. (Frankland and Lockyer find the yellow prominences to give a very decided bright line not far from D, but hitherto not identified with any terrestrial flame. It seems to indicate a new substance, which they propose to call Helium.) I believe I may say, on the present occasion, when preparation must again be made to utilize a total eclipse of the sun, that the British Association confidently trusts to our Government exercising the same wise liberality as heretofore in the interests of science.

The old nebular hypothesis supposes the solar system and other similar systems through the universe which we see at a distance as stars, to have originated in the condensation of fiery nebulous matter. This hypothesis was invented before the discovery of thermo-dynamics, or the nebulæ would not have been supposed to be fiery; and the idea seems never to have occurred to any of its inventors or early supporters that the matter, the condensation of which they supposed to constitute the Sun and stars, could have been other than fiery in the beginning. Mayer first suggested that the heat of the Sun may be due to gravitation; but he supposed meteors falling in to keep always generating the heat which is radiated year by year from the Sun. Helmholtz, on the other hand, adopting the nebular hypothesis, showed in 1854 that it was not necessary to suppose the nebulous matter to have been originally fiery, but that mutual gravitation between its parts may have generated the heat to which the present high temperature of the Sun is due. Further, he made the important observations that the potential energy of gravitation in the Sun is even now far from exhausted; but that with further and further shrinking more and more heat is to be generated, and that thus we can conceive the Sun even now to possess a sufficient store of energy to produce heat and light, almost at present, for several million years of time future. It ought, however, to be added that this condensation can only follow from cooling, and therefore *that Helmholtz's gravitational explanation of future Sun-heat* amounts really to showing that the Sun's thermal capacity is enormously greater, in virtue of the mutual gravitation between the parts of so enormous a mass, than the sum of the thermal capacities of separate and smaller bodies of the same material and same total mass. Reasons for adopting this theory, and the consequences which follow from it, are discussed in an article 'On the Age of the Sun's Heat,' published in *Macmillan's Magazine* for March, 1862.

For a few years Mayer's theory of solar heat had seemed to me probable; but I had been led to regard it as no longer tenable, because I had been in the first place driven, by consideration of the very approximate constancy of the Earth's period of revolution round the Sun for the last 2,000 years, to conclude that "the principal source, perhaps the sole appreciably effective source of Sun-heat, is in bodies circulating round the Sun at present inside the Earth's orbit"; and because Le Verrier's researches on the motion of the planet Mercury, though giving evidence of a sensible influence attributable to matter circulating as a great number of small planets within his orbit round the Sun, showed that the amount of matter that could possibly be assumed to circulate at any considerable distance from the Sun must be very small; and therefore, "if the meteoric influx taking place at present is enough to produce any appreciable portion of the heat radiated away, it must be supposed to be from matter circulating round the Sun, within very short distances of his surface. The density of this meteoric cloud would have to be supposed so great that comets could scarcely have escaped as comets actually have escaped, showing no discoverable effects of resistance, after passing his surface within a distance equal to one-eighth of his radius. All things considered, there seems little probability in the hypothesis that solar radiation is compensated to any appreciable degree, by heat generated by meteors falling in, at present; and, as it can be shown that no chemical theory is tenable, it must be concluded as most probable that the Sun is at present merely an incandescent liquid mass cooling."

Thus on purely astronomical grounds was I long ago led to abandon as very improbable the hypothesis that the Sun's heat is supplied dynamically from year to year by the influx of meteors. But now spectrum analysis gives proof finally conclusive against it.

Each meteor circulating round the Sun must fall in along a very gradual spiral path, and before reaching the Sun must have been for a long time exposed to an enormous heating effect from his radiation when very near, and must thus have been driven into vapour before actually falling into the Sun. Thus, if Mayer's hypothesis is correct, friction between vortices of meteoric vapours and the Sun's atmosphere must be the immediate cause of solar heat; and the velocity with which these vapours circulate round equatorial parts of the Sun must amount to 435 kilomètres per second. The spectrum test of velocity applied by Lockyer showed but a twentieth part of this amount as the greatest observed relative velocity between different vapours in the Sun's atmosphere.

5. NEBULÆ, COMETS, AND METEORS.

At the first Liverpool Meeting of the British Association (1854), in advancing a gravitational theory to account for all the heat, light, and motions of the universe, I urged that the immediately antecedent condition of the matter of which the Sun and Planets were formed, not being fiery, could not have been gaseous; but that it probably was solid, and may have been like the meteoric stones which we still so frequently meet with through space. The discovery of Huggins, that the light of the Nebulæ, so far as hitherto sensible to us, proceeds from incandescent hydrogen and nitrogen gases, and that the heads of comets also give us light of incandescent gas, seems at first sight literally to fulfil that part of the Nebular hypothesis to which I had objected. But a solution, which seems to me in the highest degree probable, has been suggested by Tait. He supposes that it may be by ignited gaseous exhalations proceeding from the collision of meteoric stones that nebulæ and the heads of comets show themselves to us; and he suggested, at a former meeting of the Association, that experiments should be made for the purpose of applying spectrum analysis to the light which has been observed in gunnery trials, such as those at Shoeburyness, when iron strikes against iron at a great velocity, but varied by substituting for the iron various solid materials, metallic or stony. Hitherto this suggestion has not been acted upon; but surely it is one the carrying out of which ought to be promoted by the British Association.

Most important steps have been recently made towards the discovery of the nature of comets: establishing with nothing short of certainty the truth of a hypothesis which had long appeared to me probable,—that they consist of groups of meteoric stones; accounting satisfactorily for the light of the nucleus, and giving a simple and rational explanation of phenomena presented by the tails of comets which had been regarded by the greatest astronomers as almost preternaturally marvellous. The meteoric hypothesis to which I have referred remained a mere hypothesis, (I do not know that it was ever even published,) until, in 1866, Schiaparelli calculated, from observations on the August meteors, an orbit for these bodies which he found to agree almost perfectly with the orbit of the great comet of 1862, as calculated by Oppolzer; and so discovered and demonstrated that a comet consists of a group of meteoric stones. Prof. Newton, of Yale College, United States, by examining ancient records, ascertained that in periods of about thirty-three years, since the year 902, there have been exceptionally brilliant displays of the November meteors. It had long been believed that these interesting visitants came from a train of small detached planets circulating round the Sun, all in nearly the same orbit, and constituting a belt analogous to Saturn's ring; and that the reason for the comparatively large number of meteors which we observe annually about the 14th of November is, that at that time the earth's orbit cuts through the supposed meteoric belt. Prof. Newton concluded from his investigation that there is a denser part of the group of meteors which extends over a portion of the orbit so great as to occupy about one-tenth or one-fifteenth of the periodic time in passing any particular point, and gave a choice of five different periods for the revolution of this meteoric stream round the sun, any one of which would satisfy his statistical result. He further concluded that the line of nodes, that is to say, the line in which the plane of the meteoric belt cuts the plane of the earth's orbit, has a progressive sidereal motion of about 52″·4 per annum. Here, then, was a splendid problem for the physical astronomer; and, happily, one well qualified for the task took it up. Adams, by the application of a beautiful method invented by Gauss, found that of the five periods allowed by Newton, just one permitted the motion of the line of nodes to be explained by the disturbing influence of Jupiter, Saturn, and other planets. The period chosen on these grounds is 33¼ years. The investigation showed further that the form of the orbit is a long ellipse, giving for shortest distance from the sun 145 million kilomètres, and for longest distance 2,895 million kilomètres. Adams also worked out the longitude of the perihelion and the inclination of the orbit's plane to the plane of the elliptic. The orbit which he thus found agreed so closely with that of Temple's Comet I. 1866, that he was able to identify the comet and the meteoric belt.* The same conclusion had been pointed out a few weeks

* Signor Schiaparelli, Director of the Observatory of Milan, who, in a letter dated 31st of December, 1866, pointed out that the elements of the orbit of the *August* Meteors, calculated from the observed posi-

earlier by Schiaparelli, from calculations by himself, on data supplied by direct observations on the meteors, and independently by Peters, from calculations by Leverrier on the same foundation. It is, therefore, thoroughly established that Temple's Comet I. 1866, consists of an elliptic train of minute planets, of which a few thousands or millions fall to the earth annually about the 14th of November, when we cross their track. We have probably not yet passed through the very nucleus or densest part; but thirteen times, in Octobers and Novembers, from October 13, A.D. 902, to November 14, 1866, inclusive (this last time having been correctly predicted by Prof. Newton), we have passed through a part of the belt greatly denser than the average. The densest part of the train, when near enough to us, is visible as the head of the comet. This astounding result, taken along with Huggins's spectroscopic observations on the light of the heads and tails of comets, confirm most strikingly Tait's theory of comets, to which I have already referred; according to which the comet, a group of meteoric stones, is self-luminous in its nucleus, on account of collisions among its constituents, while its "tail" is merely a portion of the less dense part of the train illuminated by sunlight, and visible or invisible to us according to circumstances, not only of

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tion of their radiant point on the supposition of the orbit being a very elongated ellipse, agreed very closely with those of the orbit of Comet II. 1862, calculated by Dr. Oppolzer. In the same letter Schiaparelli gives elements of the orbit of the November meteors, but these were not sufficiently accurate to enable him to identify the orbit with that of any known comet. On the 21st of January, 1867, M. Leverrier gave more accurate elements of the orbit of the November meteors, and in the *Astronomische Nachrichten* of January 9, Mr. C. F. W. Peters, of Altona, pointed out that these elements closely agreed with those of Temple's Comet (I. 1866), calculated by Dr. Oppolzer, and on February 2, Schiaparelli, having re-calculated the elements of the orbit of the meteors, himself noticed the same agreement. Adams arrived quite independently at the conclusion that the orbit of 33¼ years period is the one which *must* be chosen, out of the five indicated by Prof. Newton. His calculations were sufficiently advanced before the letters referred to appeared, to show that the other four orbits offered by Newton were inadmissible. But the calculations to be gone through to find the secular motion of the node in such an elongated orbit as that of the meteors, were necessarily very long, so that they were not completed till about March, 1867. They were communicated in that month to the Cambridge Philosophical Society, and in the month following to the Astronomical Society.

density, degree of illumination, and nearness, but also of tactic arrangement, as of a flock of birds or the edge of a cloud of tobacco smoke! What prodigious difficulties are to be explained, you may judge from two or three sentences which I shall read from Herschel's Astronomy, and from the fact that even Schiaparelli seems still to believe in the repulsion: "There is, beyond question, some profound secret and mystery of nature concerned in the phenomena of their tails. Perhaps it is not too much to hope that future observation, borrowing every aid from rational speculation, grounded on the progress of physical science generally (especially those branches of it which relate to the ethereal or imponderable elements), may enable us ere long to penetrate this mystery, and to declare whether it is really *matter* in the ordinary acceptation of the term which is projected from their heads with such extraordinary velocity, and if not *impelled*, at least *directed*, in its course, by reference to the Sun, as its point of avoidance." "In no respect is the question as to the materiality of the tail more forcibly pressed on us for consideration than in that of the enormous sweep which it makes round the Sun *in perihelio* in the manner of a straight and rigid rod, *in defiance of the law of gravitation*, nay, even, *of the received* laws of motion." "The projection of this ray. . . . to so enormous a length, in a single day, conveys an impression of the intensity of the forces acting to produce such a velocity of material transfer through space, such as no other natural phenomenon is capable of exciting. It is clear that *if we have to deal here with matter, such as we conceive it*, viz., *possessing inertia—at all*, it must be under the dominion of forces incomparably more energetic than gravitation, and quite of a different nature."

Think now of the admirable simplicity with which Tait's beautiful "sea-bird analogy," as it has been called, can explain all these phenomena.

6. BIOLOGICAL RESEARCH.

The essence of science, as is well illustrated by astronomy and cosmical physics, consists in inferring antecedent conditions, and anticipating future evolutions, from phenomena which have actually come under observation. In biology the difficulties of successfully acting up to this ideal are prodigious. The earnest naturalists of the present day are, however, not appalled or paralyzed by them, and are struggling boldly and laboriously to pass out of the mere "Natural History stage" of their study, and bring zoology within the range of Natural Philosophy. A very ancient speculation, still clung to by many naturalists (so much so that I have a choice of modern terms to quote in expressing it) supposes that, under meteorological conditions very different from the present, dead matter may have run together or crystallized or fermented into "germs of life," or "organic cells," or "protoplasm." But science brings a vast mass of inductive evidence against this hypothesis of spontaneous generation, as you have heard from my predecessor in the Presidential chair. Careful enough scrutiny has, in every case up to the present day, discovered life as antecedent to life. Dead matter cannot become living without coming under the influence of matter previously alive. This seems to me as sure a teaching of science as the law of gravitation. I utterly repudiate, as opposed to all philosophical uniformitarianism, the assumption of "different meteorological conditions"—that is to say, somewhat different vicissitudes of temperature, pressure, moisture, gaseous atmosphere—to produce or to permit that to take place by force or motion of dead matter alone, which is a direct contravention of what seems to us biological law. I am prepared for the answer, "our code of biological law is an expression of our ignorance as well as of our knowledge." And I say, yes; search for spontaneous generation out of inorganic materials; let any one not satisfied with the purely negative testimony of which we have now so much against it, throw himself into the inquiry. Such investigations as those of Pasteur, Pouchet, and Bastian are among the most interesting and momentous in the whole range of Natural History, and their results, whether positive or negative, must richly reward the most careful and laborious experimenting. I confess to being deeply impressed by the evidence put before us by Prof. Huxley, and I am ready to adopt, as an article of scientific faith, true through all space and through all time, that life proceeds from life, and from nothing but life.

7. ORIGIN OF LIFE.

How, then, did life originate on the earth? Tracing the physical history of the earth backwards, on strict dynamical principles, we are brought to a red-hot melted globe, on which no life could exist. Hence when the earth was first fit for life, there was no living thing on it. There were rocks solid and disintegrated, water, air all round, warmed and illuminated by a brilliant sun, ready to become a garden. Did grass and trees and flowers spring into existence, in all the fulness of ripe beauty, by a fiat of Creative Power? or did vegetation, growing up from seed sown, spread and multiply over the whole earth? Science is bound, by the everlasting law of honour, to face fearlessly every problem which can fairly be presented to it. If a probable solution, consistent with the ordinary course of nature, can be found, we must not invoke an abnormal act of Creative Power. When a lava stream flows down the sides of Vesuvius or Etna it quickly cools and becomes solid; and after a few weeks or years it teems with vegetable and animal life, which for it originated by the transport of seed and ova and by the migration of individual living creatures. When a volcanic island springs up from the sea, and after a few years is found clothed with vegetation, we do not hesitate to assume that seed has been wafted to it through the air, or floated to it on rafts. Is it not possible, and if possible, is it not probable, that the beginning of vegetable life on the earth is to be similarly explained? Every year thousands, probably millions, of fragments of solid matter fall upon the earth —whence came these fragments? What is the previous history of any one of them? Was it created in the beginning of time an amorphous mass? This idea is so unacceptable that, tacitly or explicitly, all men discard it. It is often assumed that all, and it is certain that some, meteoric stones are fragments which had been broken off from greater masses and launched free into space. It is as sure that collisions must occur between great masses moving through space as it is that ships, steered without intelligence directed to prevent collision, could not cross and recross the Atlantic for thousands of years with immunity from collisions. When two great masses come into collision in space it is certain that a large part of each is melted; but it seems also quite certain that in many cases a large quantity of *débris* must be shot forth in all directions, much of which may have experienced no greater violence than individual pieces of rock experience in a land-slip or in blasting by gunpowder. Should the time when this earth comes into collision with any other body, comparable in dimensions to itself, be when it is still clothed as at present with vegetation, many great and small fragments carrying seed and living plants and animals would undoubtedly be scattered through space. Hence and because we all confidently believe that there are at present, and have been from time immemorial, many worlds of life besides our own, we must regard it as probable in the highest degree that there are countless seed-bearing meteoric stones moving about through space. If at the present instant no life existed upon this earth, one such stone falling upon it might, by what we blindly call *natural* causes, lead to its becoming covered with vegetation. I am fully conscious of the many scientific objections which may be urged against this hypothesis, but I believe them to be all answerable. I have already taxed your patience too severely to allow me to think of discussing any of them on the present occasion. The hypothesis that life originated on this earth through moss-grown fragments from the ruins of another world may seem wild and visionary; all I maintain is that this is not unscientific.

8. THE DARWINIAN THEORY.

From the Earth stocked with such vegetation as it could receive meteorically, to the Earth teeming with all the endless variety of plants and animals which now inhabit it, the step is prodigious; yet, according to the doctrine of continuity, most ably laid before the Association by a predecessor in this chair (Mr. Grove), all creatures now living on earth have proceeded by orderly evolution from some such origin. Darwin concludes his great work on 'The Origin of Species' with the following words:—"It is interesting to contemplate an entangled bank clothed with many plants of many kinds, with birds singing on the bushes, with various insects flitting about, and with worms crawling through the damp earth, and to reflect that these elaborately constructed forms, so different from each other, and dependent on each other in so complex a manner, have all been produced by laws acting around us." . . . "There is grandeur in this view of life with its several powers, having been originally breathed by the Creator into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning, endless forms, most beautiful and most wonderful, have been and are being evolved." With the feeling expressed in these two sentences I most cordially sympathize. I have omitted two sentences which come between them, describing briefly the hypothesis of "the origin of species by natural selection," because I have always felt that this hypothesis does not contain the true theory of evolution, if evolution there has been, in biology. Sir John Herschel, in expressing a favourable judgment on the hypothesis of zoological evolution, with, however, some reservation in respect to the origin of man, objected to the doctrine of natural selection, that it was too like the Laputan method of making books, and that it did not sufficiently take into account a continually guiding and controlling intelligence. This seems to me a most valuable and instructive criticism. I feel profoundly convinced that the argument of design has been greatly too much lost sight of in recent zoological speculations. Reaction against the frivolities of teleology, such as are to be found, not rarely, in the notes of the learned commentators on Paley's 'Natural Theology,' has, I believe, had a temporary effect in turning attention from the *solid* and irrefragable argument so well put forward in that excellent old book. But overpoweringly strong proofs of intelligent and benevolent design lie all round us, and if ever perplexities, whether metaphysical or scientific, turn us away from them for a time, they come back upon us with irresistible force, showing to us through nature the influence of a free will, and teaching us that all living beings depend on one ever-acting Creator and Ruler.

The Biological Section was presided over by Prof. Allan Thompson, who delivered the following address:—

I must content myself with endeavouring to express to you some of the ideas which arise in my mind in looking back from the present upon the state of Biological science at the time, forty years since, when the meetings of the British Association commenced—a period which I am tempted to particularise from its happening to coincide very nearly with the time at which I began my career as a public teacher in one of the departments of biology in this city. In the few remarks which I shall make, it will be my object to show the prodigious advance which has taken place not only in the knowledge of our subject as a whole, but also in the ascertained relation of its parts to each other, and in the place which this kind of knowledge has gained in the estimation of the educated part of the community, and the consequent increase in the freedom with which the search after truth is now asserted in this as in other departments of science. And first, in connection with the distribution of the various subjects which are included under this section, I may remark that the general title under which the whole section D has met since 1866, viz, Biology, seems to be advantageous both from its convenience, and as tending to promote the great consolidation of our science, and a juster appreciation of the relation of its several parts. It may be that looking merely to the derivation of the term, it is strictly more nearly synonymous with physiology in the sense in which that word has been for a long time employed, and therefore designating the science of life, rather than the description of the living beings in which it is manifested. But until a better or more comprehensive term be found we may accept that of biology under the general definition of "the science of life and of living beings," or as comprehending the history of the whole range of organic nature—vegetable as well as animal. The propriety of the adoption of such a general term is further shown by a glance at the changes which the title and distribution of the subordinate departments of this section have undergone during the period of the existence of the Association.

HISTORY OF THE SECTION.

During the first four years of this period the Section met under the combined designation of Zoology and Botany, Physiology and Anatomy—words sufficiently clearly indicating the scope of its subjects of investigation. In the next ten years a connection with Medicine was recognised by the establishment of a subsection or department of Medical Science, in which, however, scientific anatomy and physiology formed the most prominent topics, though not to the exclusion of more strictly medical and surgical or professional subjects. During the next decade, or from the year 1845, we find along with Zoology and Botany a sub-section of physiology, and in several years of the same time along with the latter a separate department of Ethnology. But in the eleven years which extended from 1855 to 1865, the branch of Ethnology was associated with Geography in Section F. And more recently, or since the arrangement which was commenced in 1866, the section Biology has included, with some slight variation, the whole of its subjects in three departments. Under one of these are brought all investigations in Anatomy and Physiology of a general kind, thus embracing the whole range of these sciences when without special application. A second of these sub-sections has been occupied with the extensive subjects of Botany and Zoology; while the third has been devoted to the subject of Anthropology, in which all researches having a special reference to the structure and functions or life history of man have been received and discussed. Such I understand to be the arrangement under which we shall meet on this occasion. At the conclusion of my remarks, therefore, the sub-section for Anatomy and Physiology will remain with me in this room; while the sub-section of Zoology and Botany, on the one hand, and of Anthropology on the other, will adjourn to the apartments which have been provided for them respectively.

ANTHROPOLOGY.

With regard to the position of Anthropology, as including Ethnology, and comprehending the whole natural history of man, there may be still some differences of opinion, according to the point of view from which its phenomena are regarded: as by some they may be viewed chiefly in relation to the bodily stucture and function of individuals or numbers of men; or as by others they may be considered more directly with reference to their national character and history, and the affinities of languages and customs; or by a third set of inquirers, who are inclined to devote their principal attention to the facts and views bearing upon the origin of man and his relation to animals. As the first and third of these sets of topics entirely belong to Biology, and as those parts of the second set which do not properly fall under that branch may with propriety find a place under Geography or Statistics, I feel inclined to adhere to the distinct recognition of a sub-section—Anthropology, in its present form; and I think that the suitableness of this arrangement is apparent, from the nature and number of the communications properly falling under such a sub-section which have been received under the last distribution of the subjects.

CONDITION OF BIOLOGICAL RESEARCH.

The beneficial influence of the British Association in promoting biological research is made apparent by the number and importance of the reports on various subjects, as well as of the communications to the sections. Of the latter, the number received annually has been nearly doubled in the course of the last twenty years. Nor can it be doubted that this influence has been materially assisted by the contributions in money made by the Association in aid of various biological investigations; for it appears that out of the whole sum of nearly £34,500 contributed by the Association to the promotion of scientific research, about

£2800 has been devoted to biological purposes, to which it would be fair to add a part at least of the grants for Palæontological researches, many of which must be acknowledged to stand in close relation to Biology. The enormous extent of knowledge and research in the various departments of Biology has become a serious impediment to its more complete study, and leads to the danger of confined views on the part of those whose attention, from necessity or taste, is too exclusively directed to the details of one department, or even, as often happens, to a subdivision of it. It would seem, indeed, as if our predecessors in the last generations, possessed this superior advantage in the then existing narrower boundaries of knowledge, that they were able more easily to overtake the contemplation of a wider field, and to follow out researches in more than one of the sciences. To such combination of varied knowledge, united with their transcendent powers of sound generalization and accurate observation, must be ascribed the wide-spread and enduring influence of the works of such men as Haller, Linnæus, and Cuvier, Von Baer and Joannes Müller. There are doubtless brilliant instances in our own time of men endowed with similar powers; but the difficulty of bringing these powers into effectual operation in a wide range is now so great, that while the amount of research in special biological subjects is enormous, it must be reserved for comparatively few to be the authors of great systems, or of enduring broad and general views which embrace the whole range of biological science. It is incumbent on all those, therefore, who are desirous of promoting the advance of biological knowledge to combat the confined views which are apt to be engendered by the too great restriction of study to one department. However much subdivision of labour may now be necessary in the origin, investigation, and elaboration of new facts in our science (and the necessity for such subdivision will necessarily increase as knowledge extends), there must be secured at first, by a wider study of the general principles and some of the details of collateral branches of knowledge, that power of justly comparing and correlating facts which will mature the judgment and exclude partial views. To refer only to one bright example, I may say that it can scarcely be doubted that it is the unequalled variety and extent of knowledge, combined with the faculty of bringing the most varied facts together in new combination, which has enabled Dr. Darwin (whatever may be thought otherwise of his system) to give the greatest impulse which has been felt in our own times to the progress of biological views and thought; and it is most satisfactory to observe the effect which this influence is already producing on the scientific mind of this country, in opposing the tendency perceptible in recent times to the too restricted study of special departments of natural history. I need scarcely remind you that for the proper investigation and judgment of problems in physiology, a full knowledge of anatomy in general, and much of comparative anatomy, of histology and embryology, of organic chemistry, and of physics, is indispensable as a preliminary to all successful physiological observation and experiment. The anatomist again, who would profess to describe rationally and correctly the structure of the human body, must have acquired a knowledge of the principles of morphology derived from the study of comparative anatomy and development, and he must have mastered the intricacies of histological research. The comparative anatomist must be an accomplished embryologist in the whole range of the animal kingdom, or in any single division of it which he professes to cultivate. The zoologist and the botanist must equally found their descriptions and systematic distinctions on morphological, histological, and embryological data. And thus the whole of these departments of biological science are so interwoven and united that the scientific investigation of no one can now be regarded as altogether separate from that of the others. It has been the work of the last forty years to bring that intimate connection of the biological sciences more and more fully into prominent view, and to infuse its spirit into all scientific investigation. But while in all the departments of biology prodigious advances have been made, there are two more especially which merit particular attention as having almost taken their origin within the period I now refer to, and as having made the most rapid progress in themselves, and have influenced most powerfully and widely the progress of discovery, and the views of biologists in other departments—I mean histology and embryology.

HISTOLOGY.

I need scarcely remind those present that it was only within a few years before the foundation of the British Association that the suggestions of Lister in regard to the construction of achromatic lenses brought the compound microscope into such a state of improvement as caused it to be restored, as I might say, to the place which the more imperfect instrument had lost in the previous century. The result of this restoration became apparent in the foundation of a new era in the knowledge of the minute characters of textureal structure, under the joint guidance of R. Brown and Ehrenberg, so as at last to have entitled this branch of inquiry, to its designation, by Mr. Huxley, of the exhaustive investigation of structural elements. All who hear me are fully aware of the influence which, from 1838 onwards, the researches of Schwann and Schleiden exerted on the progress of Histology and the views of anatomists and physiologists as to the structure and development of the textures, and the prodigious increase which followed in varied microscopic observations. It is not for me here even to allude to the steps of that rapid progress by which a new branch of anatomical science has been created; nor can I venture to enter upon any of the interesting questions presented by this department of the microscopic anatomy; nor attempt to discuss any of those possessing so much interest at the present moment, such as the nature of the organised cell or the properties of protoplasm. I would only remark that it is now very generally admitted that the cell wall (as Schwann indeed himself pointed out) is not a source of new production, though still capable of considerable structural change after the time of its first formation. The nucleus has also lost some of the importance attached to it by Schwann and his earlier followers, as an essential constituent of the cell, while the protoplasm of the cell remains in undisputed possession of the field as the more immediate seat of the phenomena of growth and organisation, and of the contractile property which forms so remarkable a feature of their substance. I cordially agree with much of what Mr. Huxley has written on this subject in 1853 and 1869. The term physical basis of life may perhaps be in some trifling respect objectionable, but I look upon the recognition of protoplasm, as a general term indicating that part of the tissue of plants and animals which is the constant seat of the growing and moving powers as a most important step in the recent progress of histology. To Maechel the fuller history of this in lowest forms is due. To Dr. Beale we owe the fullest investigation of these properties by the use of magnifying powers beyond any that had previously been known, and the successful employment of re-agents which appear to mark out distinction from the other elements of the textures. I may remark, however, in passing, that I am inclined to regard contractile protoplasm, whether vegetable or animal, as in no instance entirely amorphous or homogeneous, but rather as always presenting some minute molecular structure which distinguishes it from parts of glassy clearness. Admitting that the form it assumes is not necessarily that of a regular cell, and may be various and irregular in a few exceptional instances, I am not on that account disposed to give up definite structure as one of the universal characteristics of organisation in living bodies. I would also suggest that the term formative and nonformative, or some others, should be substituted for those of living and dead, employed by Dr. Beale to distinguish the protoplasm from the cell-wall or its derivation, as those terms are liable to introduce confusion.

EMBRYOLOGY.

To the discoveries in embryology and development I might have been tempted to refer more at large, as being those which have had, of all modern research, the greatest effect in extending and modifying biological views, but I am warned from entering upon a subject in which I might trespass too much on your patience. The merits of Wolff as the great first pioneer in the accurate observation of the phenomena of development were clearly pointed out by Mr. Huxley in his presidential address of last year. Under the influence of Dollinger's teaching, Pander, and afterwards Von Baer and Rathke established the foundations of the modern history of embryology. It was only in the year 1827 that the ovum of mammals was discovered by Von Baer; the segmentation of the yolk, first observed by Prevost and Dumas in the frog's ovum in 1824, was ascertained to be general in succeeding years; so that the whole of the interesting and important additions which have followed, and have made embryological development a complete science, have been included within the eventful period of the life of this Association. I need not say how distinguished the Germans have been by their contributions to the history of animal development. The names of Bischoff, Reichart, Kolliker, and Remak are sufficient to indicate the most important of the steps in recent progress, without attempting to enumerate a host of others who have assisted in the great work thus founded. I am aware that the mere name of development suggests to some ideas of painful nature as associated with the theory of evolution recently promulgated. To one accustomed during the whole of his career to trace the steps by which every living being, including man himself, passes from the condition of an almost imperceptible germ, through a long series of changes of form and structure into their perfect state, the name of development is rather suggestive of that which seems to be the common history of all living beings; and it is not wonderful therefore that such a one should regard with approval the more extended view which supposes a process of development to belong to the whole of nature. How far that principle may be carried, to what point the origin of man or any animal can by history, facts or reasoning be traced in the long unchronicled history of the world, and whether living beings may arise independently of parents or germs of previously existing organisms, or may spring from the direct combination of the elements of dead matter, are questions upon which we may expect this section may endeavour to guide the hesitating opinion of the time. I cannot better express the state of opinion in which I find myself than by quoting the words of Professor Huxley from his address of last year, p. lxxxiii.:—"But though I cannot express this conviction of mine too strongly (viz., the occurrence of abiogenesis), I must carefully guard myself against the supposition that I intend to suggest that no such thing as abiogenesis ever has taken place in the past, or ever will take place in the future. With organic chemistry, molecular physics, and physiology yet in their infancy, and every day making prodigious strides, I think it would be the height of presumption for any man to say that the conditions under which matter assumes the properties we call 'vital,' may not some day be artificially brought together. And again, if it were given me to look beyond the abyss of geologically recorded time, to the still more remote period when the earth was passing through physical and chemical conditions, which it can no more see again than a man can recall his infancy, I should expect to be a witness of the evolution of living protoplasm from living matter." I will quote further a few wise words from the discourse to which many of you must have listened last evening with admiration. Sir Wm. Thomson said—"The essence of science, as is well illustrated by astronomy and cosmical physics, consists in inferring antecedent conditions, and anticipating future evolutions, from phenomena which have actually come under observation. In biology, the difficulty of successfully acting up to this ideal are prodigious. Our code of biological law is an expression of our ignorance as as well as of our knowledge. Search for spontaneous generation out of inorganic materials; let any one not satisfied with the purely negative testimony, of which we have now so much against it, throw himself into the inquiry. Such investigations as those of Pasteur, Pouchet and Bastian are among the most interesting and momentous in the whole range of natural history; and their results, whether positive or negative, must richly reward the most careful and laborious experimenting." The consideration of the finest discoverable structures of the organised parts of living bodies is intimately bound up with that of their chemical composition and properties. The progress which has been made in organic chemistry belongs not only to the knowledge of the composition of the constituents of organised bodies, but also in the manner in which that composition is chemically viewed. Its peculiar feature, especially as related to biological investigation, consists in the results of the introduction of the synthetic method of research, which has enabled the chemist to imitate or to form artificially a greater and greater number of the organic compounds. In 1828 the first of these substances was formed by Wohler, by a synthetic process, as cyanate of ammonia; and still, though some no doubt entertained juster views, the opinion prevailed among chemists and physiologists that there was some great and fundamental difference in the chemical phenomena and laws of organic and inorganic nature. But now this supposed barrier has been in a great measure broken down and removed, and chemists, with almost one accord, regard the laws of combination of the elements as essentially the same in both classes of bodies, whatever differences may exist in actual composition, or in the reaction of organic bodies in the more complex and often obscure conditions vitality as compared with the simpler and, on the whole, better known phenomena of a chemical nature observed in the mineral kingdom. Thus, by the synthetic method, there have been formed among the simpler organic compounds a great number of alcohols, hydrocarbons, and fatty acids. But the most remarkable example of the synthetic formation of an organic compound is that of the alkaloid conia, as recently obtained by Hugo Schiff by certain reactions from butyric aldehyde, itself an artificial product. This substance, so formed, and its compounds, possess all the properties of the natural conia—chemical, physical, and physiological—being equally poisonous with it. The colouring-matter of madder, or alizarine, is another organic compound which has been formed by artifical processes. It is true that the organised or containing solid, either of vegetable or animal bodies, has not as yet yielded to the ingenuity of chemical artifice; nor, indeed, is the actual composition of one of the most important of these, albumen and its allies, fully known. But as chemists have only recently began to discover the track by which they may be led to the synthesis of organic compounds, it is warrantable to hope that ere long cellulose and lignine may be found; and, great as the difficulties with regard to the albumenoid compounds may at present appear, the synthetic formation of these is by no means to be despaired of, but, on the contrary, may with confidence be expected to crown their efforts. From all recent research, it appears to result that the general nature of the properties belonging to the products of animal and vegetable life, can no longer be regarded as different from those of minerals, in so far at least as they are the subject of chemical investigation. The union of elements and their separation, whether occurring in an animal, a vegetable or a mineral body, must be looked upon as dependent on innate powers or properties belonging to the elements themselves; and the phenomena of change of composition of organic bodies occurring in the living state are not the less chemical because they are different from those observed in organic nature. All chemical actions are liable to vary according to the conditions in which they occur, and many instances might be adduced of most remarkable variations of this kind, observed in the chemistry of dead bodies from very slight changes of electrical, calorific, mechanical, and other conditions. But because these conditions are infinitely more complex and far less known in living bodies, it is not necessary to look upon the actions as essentially of a different kind, to have recourse to the hypothesis of vital affinities, and still less to shelter ourselves under the slim curtain of ignorance implied in the explanation of the most varied chemical phenomena by the influence of a vital principle.

EVOLUTION OF SPECIES.

On the subjects of zoological and botanical classification and anthropology, it would be out of place for me now to make any observations at length. I will only remark, in regard to the first, that the period now under review has witnessed a very great modification in the aspect which the affinities of the bodies belonging to these two great kingdoms of nature bear to each other, and the principles on which in each groups of bodies are associated together in classification; for, in the first place, the older view has been abandoned that the complication of structure rises in a continually increasing and continuous gradation from one kingdom to the other, or extends in one line from one group to another in either of the kingdoms separately. Evolution into a gradually increasing complexity of structure and function no doubt exists in both, so that types of formation must be acknowledged to pervade, accompanied by typical resemblance of the plan of formation of a most interesting nature; but it has become more and more apparent in the progress of morphological research that the different groups form rather circles, which touch one another at certain points of greatest resemblance, rather than one continuous line, or even a number of lines, which partially pass each other. Certain simpler bodies of the two kingdoms of nature thus exhibit the increasing resemblance to each other, until at last the differences between them wholly disappear, and we reach a point of contact at which the properties become almost indistinguishable, as in the remarkable Protista of Haeckel and others. I fully agree, however, with the view stated by Professor Wyville Thomson in his introductory lecture, that it is not necessary on this account to recognize with Haeckel a third intermediate kingdom of nature. Each kingdom presents, as it were, a radiating expansion into groups for itself, so that the relations of the two kingdoms might be represented by the divergence of lines spreading in two different directions from a common point. Recent observations on the chorda dorsalis of some Ascidians (or supposed notochord) tend to revive the discussion at one time prevalent, but long in abeyance, as to the possibility of tracing a homology between the vertebrate and invertebrate animals; and, should this correspondence be confirmed and extended, it may be expected to modify greatly our present views of zoological affinities and classification, and be an additional proof of the importance of minute and embryological research in such determinations. The recognition of homological resemblance of animals, to which in this country the researches of Owen and Huxley have contributed so largely, form one of the most interesting subjects of contemplation in the study of comparative anatomy and zoology in our time; but I must refrain from touching on so seductive and difficult a subject.

NATURAL SCIENCE IN SCHOOLS.

There is another topic to which I can refer with pleasure as connected with the cultivation of biological knowledge in this country, and that is the introduction of instruction in natural science into the system of education of our schools. As to the feasibility of this in the primary schools, I believe most of those who are intimately acquainted with the management of these schools have expressed their decidedly favourable opinion—it being found that a portion of the time now allotted to the three great requisites of a primary education might with advantage be set apart, for the purpose of instructing the pupils in subjects of common interest, calculated to awaken in their minds a desire for knowledge of the various objects presented by the field of nature around them. As to the benefit which may result from this measure to the persons so instructed, it is scarcely necessary for me to say anything in this place. It is so obvious that whatever knowledge, though easily acquired, and even of the most elementary kind, tends to enlarge the range of observation and thought, *must have some effect in removing its recipients from grosser influences*, and may even give information which may prove useful in social economy and in the occupations of labour. Nor need I point out how much more extended the advantages of such instruction may prove if introduced into the system of our secondary schools, and more freely combined than heretofore with the two exclusively literary and philosophical study which has so long prevailed in the approved British education. Without disparagement to those modes of study as in themselves necessary and useful, and excellent means of disciplining the mind to learning, I cannot but hold it as certain that the mind which is entirely without scientific cultivation is but half prepared for the common purposes of modern life, and is entirely unqualified for forming a judgment on some of the most difficult and yet most common and important questions of the day, affecting the interests of the whole community. I refer with great pleasure to the cogent arguments addressed yesterday by Dr. Bennet to the medical graduates of the University, in favour of the establishment of physiology as a subject of general education in this country with reference to sanitary conditions. It is gratifying, therefore, to perceive that the suggestions made some time ago in regard to this subject by the British Association, through its committee, have already borne good fruit, and that the attention of those who preside over education in this country, as well as of the public themselves, is more earnestly directed to the object of securing for the lowest as well as the highest classes of the community that wholesome combination of knowledge derived from education, which will duly cultivate all the faculties of the mind, and thus fit a greater and greater number for applying themselves with increased ability and knowledge to the purposes of their living and its improved condition. If the law of the survival of the fittest be applicable to the mental as well as to the physical improvement of our race (and who can doubt that it must be so), we are bound by motives of interest and duty to secure for all classes of the people that kind of education which will lead to the development of the highest and most varied mental power. And no one who has been observant of the recent progress of the useful arts and its influence upon the moral, social, and political condition of our population, can doubt that that education must include instruction in the phenomena of external nature. including, more especially, the laws and conditions of life; and be, at the same time, such as will adapt the mind to the ready reception of varied knowledge. It is obvious too, that while this more immediately useful or beneficial effect on the common mind may be produced by the diffusion of natural knowledge among the people, biological science will share in the gain accruing to all branches of natural science, by the greater favour which will be accorded to its cultivators, and the increased freedom from prejudice with which their statements are received and considered by learned as well as by unscientific persons.

SPIRITUALISM.

I cannot conclude these observations without adverting to one aspect in which it might be thought that biological science has taken a retrograde rather than an advanced position. In this, I do not mean to refer to the special cultivators of biology in its true sense, but to the fact that there appears to have taken place of late a considerable increase in the number of persons who believe, or who imagine that they believe, in the class of phenomena which are now called spiritual, but which have been long known—since the exhibitions of Mesmer, and indeed, long before his time—under the most varied forms, as liable to occur in persons of an imaginative turn of mind and peculiar nervous susceptibility. It is still more to be deplored that many persons devote a large share of their time to the practice—for it does not deserve the name of study or investigation—of the alleged phenomena, and that a few men of acknowledged reputation in some departments of science have lent their names, and surrendered their judgment, to the countenance and attempted authentication of the foolish dreams of the practitioners of spiritualism, and similar chimerical hypotheses. The natural tendency to a belief in the marvellous is sufficient to explain the ready acceptance of such views by the ignorant; and it is not improbable that a higher species of similar credulity may frequently act with persons of greater cultivation, if their scientific information has been of a partial kind. It must be admitted, further, that extremely curious and rare, and to those who are not acquainted with nervous phenomena, apparently marvellous phenomena, present themselves in peculiar states of the nervous system—some of which states may be induced through the mind and may be made more and more liable to recur, and greatly exaggerated by frequent repetition. But making the fullest allowance for all these conditions, it is surprising that persons otherwise appearing to be within the bounds of sanity, should entertain a confirmed belief in the possibility of phenomena, which, while they are at variance with the best established physical laws, have never been brought under proof by the evidences of the senses, and are opposed to the dictates of sound judgment. It is so far satisfactory in the interests of true biological science that no man of note can be named from the long list of thoroughly well-informed anatomists and physiologists, who has not treated the belief in the separate existence of powers of animal magnetism and spiritualism as wild speculations, devoid of all foundation in the carefully tested observation of facts. It has been the habit of the votaries of the systems to which I have referred to assert that scientific men have neglected or declined to investigate the phenomena with attention and candour; but nothing can be farther from the truth than this statement. Not to mention the admirable reports of the early French academicians, giving the account of the negative result of an examination of the earlier mesmeric phenomena by men in every way qualified to pronounce judgment on their nature, I am aware that from time to time men of eminence, and fully competent, by their knowledge of biological phenomena, and their skill and accuracy in conducting scientific investigation, have made the most patient and careful examination of the evidence placed before them by the professed believers and practitioners of so-called magnetic, phreno-magnetic, electro-biological, and spiritualistic phenomena; and the result has been uniformly the same in all cases when they were permitted to secure conditions by which the reality of the phenomena, or the justice of their interpretation, could be tested—viz., either that the experiments signally failed to educe the results professed, or that the experimenters were detected in the most shameless and determined impostures. I have myself been fully convinced of this by repeated examinations. But were any guarantee required for the care, soundness, and efficiency of the judgment of men of science on these phenomena and views, I have only to mention, in the first place the revered name of Faraday, and in the next that of my life-long friend Dr. Sharpley, whose ability and candour none will dispute, and who I am happy to think, is here among us, ready from his past experience of such exhibitions, to bear his weighty testimony against all cases of *levitation*, or the like, which may be the last wonder of the day among the mesmeric or spiritual pseudo-physiologists. The phenomena to which I have at present referred, be they false or real, are in great part dependent upon a natural principle of the human mind, placed, as it would appear, in dangerous alliance with certain tendencies of the nervous system. They ought not to be worked upon without the greatest caution, and they can only be fully understood by the accomplished physiologist who is also conversant with psychology. The experience of the last hundred years tends to show that there will always exist a certain number of minds prone to adopt a belief in the marvellous and striking in preference to that which is easily understood and patent to the senses; but it may be confidently expected that the diffusion of a fuller and more accurate knowledge of vital phenomena among the non-scientific classes of the community may lead to a juster appreciation of the phenomena in question, and a reduction of the number among them who are believers in the impossible. As for men of science who persist in submitting to such strange perversion of judgment, we can only hope that the example of their less instructed fellow-countrymen may lead them to allow them themselves to be guided more directly by the principles of common sense than by the erratic tendencies of a too fervid imagination.

Extracts from the President's (T. Andrews, F.R.S.) Address in the Chemical Section on the

PROGRESS OF CHEMICAL RESEARCH.

Proceeding to touch on questions of general chemistry at present attracting attention, the learned Professor spoke first of the relations which subsist between the chemical composition and refractive power of bodies for light. He then proceeded—A happy modification of the ice calorimeter has been made by Bunsen. The principle of the method—to use as a measure of heat the change of volume which ice undergoes in melting—had already occurred to Herschel, and, as it now appears, still earlier to Hermann; but their observations had been entirely overlooked by physicists, and had led to no practical results. Bunsen has, indeed, clearly pointed out that the success of the method depends upon an important condition, which is entirely his own. The ice to be melted must be prepared with water free from air, and must surround the source of heat in the form of a solid cylinder frozen artificially *in situ*. Those who have worked on the subject of heat know how difficult it is to measure absolute quantities with certainty, even where relative results of great accuracy may be obtained. The ice calorimeter of Bunsen will therefore be welcomed as an important addition to our means of research. Roscoe has prosecuted the photo-chemical investigations which Bunsen and he began some years ago. For altitudes above 10 degrees, the relation between the sun's altitude and the chemical intensity of light is represented by a straight line. Till the sun has reached an altitude of about 20 degrees, the chemical action produced by diffused daylight exceeds that of the direct sunlight; the two actions are then balanced, and at higher elevations the direct sunlight is superior to the diffused light. The supposed inferiority of the chemical action of light under a tropical sun to its action in higher latitudes proves to be a mistake. According to Roscoe and Thorpe, the chemical intensity of light at Para, under the equator, in the month of April, is more than three times greater than at Kew in the month of August. Hunter has given a great extension to the earlier experiments of Saussure on the absorptive power of charcoal for gases. Cocoanut charcoal, according to Hunter's experiments, exceeds all other varieties of wood charcoal in absorptive power, taking up at ordinary pressures 170 volumes of ammonia and 69 of carbonic acid. Methylic alcohol is more largely absorbed than any other vapour at temperatures from 90° to 127°, but at 159° the absorption of ordinary alcohol exceeds it. Cocoanut charcoal absorbs 44 times its volume of the vapour of water at 127°. The absorptive power is increased by pressure. Last year two new processes for improving the manufacture of chlorine attracted the attention of the section; one of them has already proved to be a success, and I am glad to be able to state that Mr. Deacon has recently overcome certain difficulties in his method, and has obtained a complete absorption of the chlorine. May we hope to see oxygen prepared by a cheap and continuous process from atmospheric air? With baryta the problem can be solved very perfectly, if not economically. Another process is that of Tessier de Mothay, in which the manganate of potassium is decomposed by a current of superheated steam, and afterwards revived by being heated in a current of air. A company has lately been formed in New York to apply this process to the production of a brilliant house light. A compound Argand burner is used, having a double row of apertures—the inner row is supplied with oxygen, the other with coal gas or other combustible. The applications of pure oxygen, if it could be procured cheaply, would be very numerous, and few discoveries would more amply reward the inventor. Among other uses, it might be applied to the production of ozone, free from nitric acid by the action of the electrical discharge, and to the introduction of that singular body in an efficient form into the arts as a bleaching and oxidising agent. Tessier de Mothay has also proposed to prepare hydrogen gas on the large scale by heating hydrate of lime with anthracite. We learn from the history of metallurgy that the valuable alloy which copper forms with zinc was known and applied long before zinc itself was discovered. Nearly the same remark may be made at present with regard to manganese and its alloys. The metal is difficult to obtain, and has not in the pure state been applied to any useful purpose; but its alloys with copper and other metals have been prepared, and some of them are likely to be of great value. The alloy with zinc and copper is used as a substitute for German silver, and possesses some advantages over it. Not less important is the alloy of iron and manganese prepared according to the process of Henderson, by reducing in a Siemens' furnace a mixture of carbonate of manganese and oxide of iron. It contains from 20 to 30 per cent. of manganese, and will doubtless replace to a large extent the spiegeleisen now used in the manufacture of Bessemer steel. The classical researches of Roscoe have made us acquainted for the first time with metallic vanadium. Berzelius obtained brilliant scales which he supposed to be the metal, by heating oxychloride in ammonia, but they have proved to be a nitride. Roscoe prepared the metal by reducing its chloride in a current of hydrogen, as a light gray powder, with a metallic lustre under the microscope. It has a remarkable affinity both for nitrogen and silicon. Like phosphorus, it is a pentad, and the vanadates correspond in composition to the phosphates, but differ in the order of stability at ordinary temperatures, the soluble tribasic salts being less stable than the tetrabasic compounds. Sainte Claire Deville, in continuation of his researches on dissociation, has examined the conditions under which vapour of water is decomposed by metallic iron. The iron, maintained at a constant temperature, but varying in different experiments, from 150° C. to 1600° C., was exposed to the action of the vapour of water of known tension. It was found that for a given temperature the iron continued to oxidise till the tension of the hydrogen formed reached an invariable value. In these experiments, as Deville remarks, the iron behaves as if it emitted a vapour (hydrogen), obeying the laws of hygometry. An interesting set of experiments has been made by Lothian Bell on the power possessed by spongy metallic iron of splitting up carbonic oxide into carbon and carbonic acid, the former being deposited in the iron. A minute quantity of oxide of iron is always formed in this reaction. In organic chemistry, the labours of chemists have been of late largely directed to a group of hydrocarbons, which were first discovered among the products of the destructive distillation of coal or oil. The central body round which these researches have chiefly turned is benzol, whose discovery will always be associated with the name of Faraday. Baeyer has prepared artificially picoline, a base isomeric with aniline, and discovered by Anderson in his very able researches on the Pyridine series. Of the two methods described by Baeyer, one is founded on an experiment of Simpson, in which a new base was obtained by heating tribromallyl with an alcoholic solution of ammonia. By pushing further the action of the heat, Baeyer succeeded in expelling the whole of the bromine from Simpson's base, in the form of hydrobromic acid, and in obtaining picoline. The same chemist has also prepared artificially collidine, another base of the Pyridine series. In this list of remarkable synthetical discoveries, another of the highest interest has lately been added by Schiff—the preparation of artificial coniine. He obtained it by the action of ammonia on butyric aldehyde. The artificial base has the same composition as coniine prepared from hemlock. It is a liquid of an amber-yellow colour, having the characteristic odour and nearly all the usual reactions of ordinary coniine. Its physiological properties, so far as they have been examined, agree with those of coniine from hemlock, but the artificial base has not yet been obtained in large quantity, nor perfectly pure.

Valuable papers on alizarine have been published by Perkin and Schunk. The latter has described a new acid—the anthraflaric—which is formed in the artificial preparation of alizarine. Madder contains another colouring principle, purpurine, which, like alizarine, yields anthracene when acted on by reducing agents, and has also been prepared artificially. These colouring principles may be distinguished from one another, as Stokes has shown, by their absorption bands; and Perkin has lately confirmed by this optical test the interesting observation of Schunk that finished madder prints contain nothing but pure alizarine in combination with the mordaunt employed. Hofmann has achieved another triumph in a department of chemistry which he has made peculiarly his own. In 1857, he showed that alcohol bases, analogous to those derived from ammonia, could be obtained by replacement from phosphuretted hydrogen, but he failed in his attempts to prepare the two lower derivatives. These missing links he has now supplied, and has thus established a complete parallelism between the derivatives of ammonia and of phosphuretted hydrogen. The same able chemist has lately described the aromatic cyanates, of which one only—the phenylic cyanate—was previously known, having been discovered about twenty years ago by Hofmann himself. He now prepares this compound by the action of phosphoric anhydride on phenylurethane, and by a similar method he has obtained the tolylic, xylylic, and napthylic cyanates. Stenhouse had observed many years ago that, when aniline is added to furfurol, the mixture becomes rose-red, and communicates a fugitive red stain to the skin, and also to linen and silk. He has lately resumed the investigation of this subject, and has obtained two new bases—furfuraniline and furfurtoluidine—which like rosaniline, form beautifully coloured salts, although the bases themselves are nearly colourless, or of a pale brown colour. The interesting work of Dewar on the oxidation of picoline must not be passed over without notice. By the action of the permanganate of potassium on that body, he has obtained a new acid, which bears the same relation to pyridine that phthalic acid does to benzol. Thorpe and Young have published a preliminary notice of some results of great promise which they have obtained by exposing paraffin to a high temperature in closed vessels. By this treatment it is almost completely resolved into liquid hydrocarbons whose boiling points range from 18° C. to 300° C. Those boiling under 100° have been examined, and consist chiefly of olefines. In connection with this subject, it may be interesting to recal the experiments of Pelouze and Cahours on the Pennsylvanian oils, which proved to be a mixture of carbolizdrogers belonging to the marsh gas series. An elaborate exposition of Berthelot's method of transforming an organic compound into a hydrocarbon containing a maximum of hydrogen, has appeared in a connected form. The organic body is heated, in a sealed tube with a large excess of a strong solution of hydriodic acid, to the temperature of 275°. The pressure in these experiments Berthelot estimates at 100 atmospheres, but apparently without having made any direct measurements. He has thus prepared ethyl hydride from alcohol, aldehyde, &c., hexyl hydride from benzol. Berthelot has submitted both wood charcoal and coal to the reducing action of hydriodic acid, and among other interesting results, he claims to have obtained in this way oil of petroleum. By the action of chloride of zinc upon codeia, Matthiessen and Burnside have obtained apocodeia, which stands to codeia in the same relation as apomorphia to morphia, an atom of water being abstracted in its formation. Apocodeia is more stable than apomorphia; but the action of reagents upon the two bases is very similar. As regards their physiological action, the hydrochlorate of apocodeia is a mild emetic, while that of apomorphia is an emetic of great activity. Other bases have been obtained by Wright by the action of hydrobromic acid on codeia. In two of these bases, bromotetra-codeia and chlorotetra-codeia, four molecules of codeia are welded together, so that they contain no less than seventy-two atoms of carbon. They have a bitter taste, but little physiological action. The authors of these valuable researches were indebted to Messrs. Macfarlane for the precious material upon which they operated. We are indebted to Crum Brown and Fraser for an important work on a subject of great practical, as well as theoretical, interest—the relation between chemical constitution and physiological action. It has long been known that the ferrocyanide of potassium does not act as a poison on the animal system; and Bunsen has shown that the kakodylic acid, an arsenical compound, is also inert. Crum Brown and Fraser found that the methyl compounds of strychnia-brucia and thebaia are much less active poisons than the alcoloids themselves; and the character of their physiological action is also different. The hypnotic action of the sulphate of methyl-morphium is less than that of morphia. But a reverse result occurs in the case of atropia, whose methyl and ethyl derivatives are much more poisonous than the salts of atropia itself.

THE POST-PLIOCENE GEOLOGY OF CANADA,

By J. W. DAWSON, LL.D., F.R.S., F.G.S.

PART II.—LOCAL DETAILS.

Before entering into the special consideration of this Second Part of the subject, I desire to call attention to some additional facts bearing on two of the most remarkable properties of the Post-pliocene deposits of the Northern Hemisphere, namely their general similarity of arrangement, and their local diversities.

In the first part of this memoir, taking the Post-pliocene of the Lower St. Lawrence as a type, I showed that it has its parallel, with but slight general difference, in the wide-spread superficial deposits of the interior of North America surrounding the great lakes, and that the Post-pliocene deposits of Scotland and Scandinavia almost precisely resemble those of Canada in the general sequence of deposits. Since that part was published, additional illustrations have been afforded by papers in the Geological Magazine by Mr. Hull, and Mr. Mackintosh, by papers and discussions on the Eskers of Ireland, at the meeting of the British Association, and by an able monograph on the Estuary of the Forth, by Mr. David Milne Home. Mr. Hull, who is a "Land Glacialist," arranges the deposits of the Drift Period in the British area in the following three groups, in descending order, in accordance with Prof. Ramsay's observations in England, and his own in Ireland.

1. Upper Boulder-clay, which he regards as "generally marine." In Canada, this is represented by the loose boulders and partial boulder deposits of the Upper Saxicava Sand.

2. Shelly marine sands and gravels belonging to the greatest depression of the land, and representing our Saxicava Sand and Leda Clay.

3. Lower Boulder-clay, which represents the true or principal Boulder-clay of Canada. This Mr. Hull attributes "chiefly to land ice."

In Ireland, it would thus seem that the principal sub-divisions of the Post-pliocene can be recognized, and Mr. Kinahan has described the remarkable ridges of gravel called eskers which run across the country in a North-east and South-west direction. Like our Canadian eskers or "Boar's backs," they are now admitted to be of marine origin, and are attributed to current action and to the waves, though floating ice has no doubt, as in Canada, contributed in some cases to their formation.

Mr. Milne Home gives a graphic description of the Post-pliocene deposits in the neighbourhood of the Frith of Forth, and many of his numerous sections might have just as well been taken from Canadian deposits. He thus sums up the causes of the phenomena, assuming that at the beginning of the period the land was submerged.

"The ocean over and around Scotland was full of icebergs and shore ice, which spread fragments of rocks over the sea bottom and often stranded, ploughing through beds of mud, sand, gravel, and blocks of stone, and mingling them together in such a way as to form the 'Boulder-clay.' The land thereafter gradually emerged, during which time the long ridges or embankments of gravel called 'kames' were formed."

Mr. Mackintosh's observations go mainly to show that in England, as in Canada, even the lower drift and rock striation are due to a great extent to floating ice and not to glaciers, and he extends this conclusion even into the lake district of England.

It is also worthy of remark that the long-received doctrine that glaciers are powerful eroding agents, which the author showed in a paper in this journal, in 1866, to be without foundation, is only now beginning to be discredited in England. I shall refer to this in the sequel, and in the meantime may direct attention to an interesting paper on the subject by Mr. Bonney, F.G.S., in the Journal of the Geological Society for August, 1871.

It would further appear that after the glacial period, in the Post-glacial, the British land rose to a level higher than that which it at present exhibits, then sunk again, and re-emerged in the modern period. Evidences of this later submergence have not been recognized in Canada, but in the inland area they have been detected by Hilgard and by Andrews.

Since the publication of the first part of this memoir, Prof. Hilgard has discussed the subject of the southern drifts of the Mississippi valley at the meeting of the American Association at Indianapolis; and I am indebted to that gentleman and to Prof. Andrews, of Chicago, for much information on these deposits and their relation to those of more northern regions.

It appears that the oldest Post-pliocene deposit in the south is that called by Prof. Hilgard the "Orange Sand." This deposit is spread over the States of Mississippi, Alabama, Tennessee, and parts of Louisiana, Kentucky, and Arkansas, and in some places attains an elevation of 700 feet. It contains water-worn fragments of northern rocks, and is supposed by Prof. Hilgard to have been deposited by rapid currents of water, possibly fresh, as the deposit contains no marine fossils.

Above this, according to Prof. Hilgard, is found in places a swamp, lagoon or estuary formation designated the "Port Hudson group." Succeeding this is the "Bluff or Loess" group, a deposit of fine silt, limited almost or entirely to the Valley of the Missisippi. Its maximum thickness is seventy-five feet.

On this rests a very widely distributed bed, the "Yellow Loam," not more than twenty feet thick, but much more extensively distributed laterally than the former, and reaching an elevation of 700 feet.

Under the names of "Second Bottoms or Hummocks," and "First Bottoms," are known terraced deposits of clay belonging to the present river valleys, but indicating in the case of the Second Bottoms a greater amount of water than at present.

It is obvious that all of the above are aqueous deposits, and there seems to be no evidence whatever in the region referred to, of the action of land ice, though the stones and few boulders in the Orange sand are very probably due to floating ice. There seems reason to believe that the Orange sand is continuous with the Boulder-drift of the north-west; and if this is, as stated by Newberry and others, a later deposit than the Erie clay, then it is probable that no representative of the latter exists to the southwest, or that the Orange sand represents the whole of the northern deposits. In any case it represents northern currents of water, though whether salt water admitted by the depression of the land, or fresh water resulting from the melting of glaciers, it is not easy to decide, as very great difficulties attend either view in the present state of our knowledge of the deposit. Whatever the conditions of deposit of the Orange sand, it would seem to have been succeeded by a land surface, and this by a depression to the extent of 700 feet or more, before the modern elevation of the land. If this last elevation corresponds with that of the terraces of the St. Lawrence, then the former one must have occurred in the St. Lawrence valley in the interval between the deposit of the Leda clay and the close of the Post-pliocene. This question we shall have occasion to consider in the sequel, in connection with the second depression of the European land above referred to.

Since the publication of the first of these papers, Dr. Newberry has kindly sent me a paper of his published as early as 1862, in which he states the remarkable fact, quoted above from his more recent Report on Ohio, that the drainage of the great lake basins, open in the early Post-pliocene period, was obstructed by the glacial deposits, and has been only partially restored. He also desires me to state that he refers the old drainage not exclusively to the action of glaciers, but to the "ice period, or an earlier epoch." I am happy to make these corrections; the latter more especially, as it brings our theoretical views more into harmony. Dr. Newberry, however, for whose conclusions on such subjects I have the highest respect, still, in his latest expressions of opinion, adheres to the action of land ice in producing the glacial striation, which from his descriptions is, I should suppose, quite as definite and strongly marked as that in the St. Lawrence valley.

The grand series of Post-pliocene changes was thus uniform in Europe and America, pointing to great general causes of subsidence and re-elevation; but locally there is the most extreme irregularity in these deposits, giving great uncertainty to their arrangement. Some of these differences we shall have occasion to notice under the following geographical subdivisions.

1. *Newfoundland and Labrador.*

In the Journal of the Geological Society of London, for February, 1871, is a communication from Staff-commander Kerr, R. N., of the Coast Survey, in which he gives the directions of twenty-eight examples of grooved and scratched surfaces observed in the southern part of Newfoundland. The course of the majority of these is N.E. and S.W., ranging from N.8° E. to N. 64° E. The remainder are N.W. and S.E., most of them with a predominating Easterly direction. Boulders are mentioned, but no marine beds. The author refers the glaciation to land ice, supposing certain submerged banks across the mouths of the bays to be terminal moraines.

The latest information on the Post-pliocene of Labrador is that given in a paper by Dr. Packard in the memoirs of the Boston Society of Natural History for 1867. The deposits are said to consist of boulders, Leda clay and sand, and raised beaches, which, on the authority of Prof. Hind, are stated to reach an elevation of 1200 feet above the sea. The hills to a height of 2500 feet are rounded as if by ice action. Some higher hills present a frost-shattered surface at their summits. No directions of striæ are given, and they appear to be rare. Mr. Campbell, author of "Frost and Fire," mentions examples with course N. 45° E. in the Strait of Belle Isle. It is remarkable that true Boulder-clay is rare in Labrador, though loose boulders are abundant in the valleys and on the inland table land. Dr. Packard attributes the absence of Boulder-clay to denudation. This may be the cause, but it is to be observed that, on that view of the origin of Boulder-clay which attributes it to ice-laden arctic currents, there must always have been in the course of such currents areas of denudation as well as areas of deposition, and an elevated table-land like that of Labrador, in a high northern latitude, may well have been of the former character.

The Leda clay occurs in several places. In 1860, I published a list of species collected by Capt. Orlebar; and Packard has greatly added to the number, giving a list which will be referred to farther on. Dr. Packard very truly remarks that the faun. of the Labrador clays is very similar to that now found on the coast, and called by him the Syrtensian fauna. In the latter we have a few southern forms, absent in the clay, but this is all. Further, the Labrador Post-pliocene fauna is identical or nearly so with that of similar deposits in South Greenland, described by Möller and Rink. Thus the climatal conditions of the arctic current on the coast of Labrador seem to have in no respect differed in the Post-pliocene from those which obtain at present. The Leda clay with its characteristic fossils is found as high as 500 feet above the level of the sea.

Raised beaches and terraces, whether cut into sand and clay or the hard metamorphic rocks of the coast, are as common in Labrador as along the shores of the River St. Lawrence. Their precise altitudes are not given, but they appear to be very numerous and to rise to a great height above the sea. One feature of some interest is their consisting in some places of large stones and boulders, evidencing very powerful action of coast ice and currents. Packard speaks of many of these beaches as moraines modified by the sea, but he gives no reason for this except the general belief that extensive glaciers existed in Labrador in the Post-pliocene, of which, however, there seems little direct evidence. From the descriptions of Prof. Hind,* however, it would seem that traces of local glaciers in the river valleys, similar to those referred to above in the case of the Saguenay and the Murray River, exist, and these might now be restored by a slight increase of cold and a moderate elevation of the land.

On the island of Anticosti, Messrs. Hyatt, Verrill and Shaler found *Saxicava arctica* in clay at an elevation of fifteen feet above the level of the sea.

Before proceeding up the St. Lawrence Valley into Canada proper, I may cross to the south side of the Gulf of St. Lawrence and notice the drift deposits of Prince Edward Island, Nova Scotia and New Brunswick, and their connection with those of the State of Maine.

2. *Prince Edward Island.*

The Triassic and Upper Carboniferous rocks of this island consist almost entirely of red sandstones, and the country is low and undulating, its highest eminences not exceeding 400 feet. The prevalent Post-pliocene deposit is a Boulder-clay, or in some places boulder loam, composed of red sand and clay derived from the waste of the red sandstones. This is filled with boulders of red sandstone derived from the harder beds. They are more or less rounded, often glaciated, with striæ in the direction of their longer axis, and sometimes polished in a remarkable manner, when the softness and coarse character of the rock are considered. This polishing must have been effected by rubbing with the sand and loam in which they are embedded. These boulders are not usually large, though some were seen as much as five feet in length. The boulders in this deposit are almost universally of the native rock, and must have been produced by the grinding of ice on the outcrops of the harder beds. In the eastern and middle portion of the Island, only these native rocks were seen in the clay, with the exception of pebbles of quartzite which may have been derived from the Triassic conglomerates. At Campbellton, in the western part of the Island, I observed a bed of Boulder-clay filled with boulders of metamorphic rocks similar to those of the mainland of New Brunswick.

* Trans. Geol. Society, 1864.

Striæ were seen only in one place on the North-eastern coast and at another on the South-western. In the former case their direction was nearly S.W. and N.E. In the latter it was S. 70° E.

No marine remains were observed in the Boulder-clay; but at Campbellton, above the Boulder-clay already mentioned, there is a limited area occupied with beds of stratified sand and gravel, at an elevation of about fifty feet above the sea, and in one of the beds there are shells of *Tellina Grœnlandica*.

On the surface of the country, more especially in the western part of the island, there are numerous travelled boulders, sometimes of considerable size. As these do not appear in situ in the Boulder-clay, they may be supposed to belong to a second or newer boulder drift similar to that which we shall find to be connected with the Saxicava sand in Canada. These boulders being of rocks foreign to Prince Edward Island, the question of their source becomes an interesting one. With reference to this, it may be stated in general terms, that the majority are Granite, Syenite, Diorite, Felsite. Porphyry, Quartzite and coarse slates, all identical in mineral character with those which occur in the metamorphic districts of Nova Scotia and New Brunswick, at distances of from 50 to 200 miles to the South and South-west; though some of them may have been derived from Cape Breton on the East. It is further to be observed that these boulders are most abundant and the evidences of denudation of the Trias greatest in that part of the Island which is opposite the deep break between the hills of Nova Scotia and New Brunswick, occupied by the Bay of Fundy, Chiegnecto Bay and the low country extending thence to Northumberland Strait, an evidence that this boulder drift was connected with currents of water passing up this depression from the South or South-west.

Besides these boulders, however, there are others of a different character; such as Gneiss, Hornblende schist, Anorthosite and Labradorite rock, which must have been derived from the Laurentian rocks of Labrador and Canada, distant 250 miles or more, to the Northward. These Laurentian rocks are chiefly found on the North side of the island, as if at the time of their arrival the island formed a shoal, at the North side of which the ice carrying the boulders grounded and melted away. With reference to these boulders, it is to be observed that a depression of four or five hundred feet would open a clear passage for the arctic current entering the Straits of Belle Isle, to-the Bay of Fundy; and that heavy ice carried by this current would then ground on Prince Edward Island, or be carried across it to the Southward. If the Laurentian boulders came in this way, their source is probably 400 miles distant in the Strait of Belle Isle. On the North shore of Prince Edward Island, except where occupied by sand dunes, the beach shows great numbers of pebbles and small boulders of Laurentian rocks. These are said by the inhabitants to be cast up by the sea or pushed up by the ice in spring. Whether they are now being drifted by ice direct from the Labrador coast, or are old drift being washed up from the bottom of the gulf, which north of the island is very shallow, does not appear. They are all much rounded by the waves, differing in this respect from the majority of the boulders found inland.

The older Boulder-clay of Prince Edward Island, with native boulders, must have been produced under circumstances of powerful ice-action, in which comparatively little transport of material from a distance occurred. If we attribute this to a glacier, then as Prince Edward Island is merely a slightly raised portion of the bottom of the Gulf of St. Lawrence, this can have been no other than a gigantic mass of ice filling the whole basin of the gulf, and without any slope to give it movement except toward the centre of this great though shallow depression. On the other hand, if we attribute the Boulder-clay to floating ice, it must have been produced at a time when numerous heavy bergs were disengaged from what of Labrador was above water, and when this was too thoroughly enveloped in snow and ice to afford many travelled stones. Farther, that this Boulder-clay is a submarine and not a subaerial deposit, seems to be rendered probable by the circumstance that many of the boulders of sandstone are so soft that they crumble immediately when exposed to the weather and frost.

The travelled boulders lying on the surface of the Boulder-clay evidently belong to a later period, when the hills of Labrador and Nova Scotia were above water, though lower than at present, and were sufficiently bare to furnish large supplies of stones to coast ice carried by the tidal currents sweeping up the coast, or by the Arctic current from the North, and deposited on the surface of Prince Edward Island, then a shallow sand-bank. The sands with sea-shells probably belonged to this period, or perhaps to the later part of it, when the land was gradually rising. Prince

Edward Island thus appears to have received boulders from both sides of the gulf of St. Lawrence during the later Post-pliocene period; but the greater number from the South side, perhaps because nearer to it. It thus furnishes a remarkable illustration of the transport of travelled stones at this period in different directions, and in the comparative absence of travelled stones in the lower Boulder-clay, it furnishes a similar illustration of the homogeneous and untravelled character of that deposit, in circumstances where the theory of floating ice serves to account for it, at least as well as that of land-ice, and in my judgment greatly better.

3. *Nova Scotia and New Brunswick.*

In these Provinces the circumstances are entirely different from those in Prince Edward Island, the country consisting of Carboniferous and Triassic plains, with ranges of older hills, often metamorphic, and attaining elevations of 1200 feet or more. It may, perhaps, be best in the first instance to present a summary of the phenomena, as I have given them in my Acadian Geology, and to add such additional facts and inferences as the present state of the subject may require.

The beds observed may be arranged as follows, in descending order.

1. Gravel and sand beds, and ancient gravel ridges and beaches, indicating the action of shallow water, and strong currents and waves. Travelled boulders occur in connection with these beds.
2. Stratified clay with shells, showing quiet deposition in deeper water.
3. Unstratified Boulder-clay, indicating, probably, the united action of ice and water.
4. Peaty deposits, belonging to a land surface preceding the deposit of the Boulder-clay.

As the third of these formations is the most important and generally diffused in Nova Scotia and New Brunswick, we shall attend to it first, and notice the relation of the others to it.

The Unstratified Drift or Boulder clay varies from a stiff clay to loose sand, and its composition and colour generally depend upon those of the underlying and neighbouring rocks. Thus, over sandstone it is arenaceous, over shales argillaceous, and over conglomerates and hard slates pebbly or shingly. The greater number of the stones contained in the drift are usually, like the paste containing them, derived from the neighbouring rock formations. These untravelled fragments are often of large size, and are usually angular, except when they are of very soft material, or of rocks whose corners readily weather away. It is easy to observe, that on passing from a granite district to one composed of slate, or from slate to sandstone, the character of the loose stones changes accordingly. It is also a matter of familiar observation, that in proportion to the hardness or softness of the prevailing rocks, the quantity of these loose stones increases or diminishes. In some of the quartzite and granite districts of the Atlantic coast, the surface seems to be heaped with boulders with only a little soil in their interstices, and every little field, cleared with immense labour, is still half-filled with huge white masses popularly known as "elephants." On the other hand, in the districts of soft sandstone and shale, one may travel some distance without seeing a boulder of considerable size. The boulders are as usual often glaciated or marked with ice-striæ.

Though the more abundant fragments are untravelled, it by no means follows that they are undisturbed. They have been lifted from their original beds, heaped upon each other in every variety of position, and intermixed with sand and clay, in a manner which shows convincingly that the sorting action of running water had nothing to do with the matter; and this applies not only to stones of moderate size, but to masses of ten feet or more in diameter. In some of the carboniferous districts where the Boulder-clay is thick, as for example, near Pictou Harbour, it is as if a gigantic harrow had been dragged over the surface, tearing up the outcrops of the beds, and mingling their fragments in a rude and unsorted mass.

Besides the untravelled fragments, the drift always contains boulders derived from distant localities, to which in many cases we can trace them; and I may mention a few instances of this to show how extensive has been this transport of detritus. In the low country of Cumberland there are few boulders, but of the few that appear some belong to the hard rocks of the Cobequid hills to the Southward; others may have been derived from the somewhat similar hills of New Brunswick. On the summits of the Cobequid hills and their Northern slopes, we find angular fragments of the sandstones of the plain below, not only drifted from their original sites, but elevated several hundreds of fee above them. To the Southward and Eastward of the Cobequids, throughout Colchester, Northern Hants, and Pictou, fragments from these hills, usually much rounded, are the most abundant travelled boulders, showing that there has been great driftage from this elevated tract. Near the town of Pictou, where a thick bed of a sandy boulder deposit occurs, this is filled with large masses of sandstone derived from the outcrops of the beds on higher ground to the north; but with these are groups of travelled stones often in the lower part of the mass. Near the steam ferry wharf, in the town of Pictou, I observed one such group, consisting of the following, all large boulders and lying close together—two of red syenite, six of gray granite, one of compact grey felsite, one of hard conglomerate, two of hard-grit. The two last were probably Lower Carboniferous, the others derived from the altered Silurian deposits. All may have been drifted by one berg or ice-floe from the flanks of the Cobequid range of hills. In like manner, the long ridge of trap rocks, extending from Cape Blomidon to Briar Island, has sent off great quantities of boulders across the sandstone valley which bounds it on the South and up the slopes of the slate and granite hills to the Southward of this valley. Well characterized fragments of trap from Blomidon may be seen near the town of Windsor; and I have seen unmistakeable fragments of similar rock from Digby neck, on the Tusket River, thirty miles from their original position. On the other hand, numerous boulders of granite have been carried to the Northward from the hills of Annapolis, and deposited on the slopes of the opposite trappean ridge; and some of them have been carried round its Eastern end, and now lie on the shores of Londonderry and Onslow. So also, while immense numbers of boulders have been scattered over the South coast from the granite and quartz rock ridges immediately inland, many have drifted in the opposite direction, and may be found scattered over the counties of Antigonish, Pictou, and Colchester. These facts show that the transport of travelled blocks, though it may here as in other parts of America, have been principally from the Northward, has by no means been exclusively so; boulders having been carried in various directions, and more especially from the more elevated and rocky districts to the lower grounds in their vicinity. Professor Hind has shown the existence of a similar relation between the boulders of New Brunswick and the hilly ranges of that country.

The following are the directions of the diluvial scratches in a number of localities in different parts of Nova Scotia:—

Point Pleasant and other places near Halifax, exposure south, very distinct striæ, . . .	S. 20° E. to S. 30° E.
Head of the Basin, exposure south, but in a valley, . . .	E. & W. nearly.
La Have River, exposure S.E., .	S. 20° W.
Petite River, exposure S. . .	S. 20° E.
Bear River, exposure N., .	S. 30° E.
Rawdon, exposure N., . .	S. 25° E.
The Gore Mountain, exposure N., two sets of striæ, respectively .	S. 65° E. & S. 20° E.
Windsor Road, exposure not noted,	S.S.E.
Gay's River, exposure N., .	Nearly S. & N.
Musquodoboit Harbour, exposure S.,	Nearly S. & N.
Near Pictou, exposure E., in a valley,	Nearly E. & W.
Polson's Lake, summit of a ridge, .	Nearly N. & S.
Near Guysboro', exposure not noted,	Nearly S. & N.
Sydney Mines, Cape Breton, exposure S	S. 30° W.*

The above instances show a tendency to a Southerly and South-easterly direction, which accords with the prevailing course in most parts of North-eastern America. Local circumstances have, however, modified this prevailing direction; and it is interesting to observe that, while S.E. is the prevailing direction in Acadia and New England, it is exceptional in the St. Lawrence valley, where the prevailing direction is S.W. Professor Hind has given a table of similar striation in New Brunswick, showing that the direction ranges from N. 10° W. to N. 30° E., in all except a very few cases. On Blue Mountains, 1650 feet above the sea, it is stated to be N. and S. As in Nova Scotia, N. W. and S. E. seems to be the prevailing course. In a paper published in the Canadian Naturalist, Vol. VI., No. 1, Mr. Matthew gives a table of striation in the southern part of New Brunswick, in which the South-east direction is decidedly predominant, though there are also some in the South-west direction. In this paper will also be found many interesting facts as to the Boulder-clay of New Bruns-

* The above courses are *magnetic*, the average variation being about 18° W.

wick, though the agency of a continental glacier is invoked to explain some facts which in the sequel we shall find to admit of a different interpretation.

The travelled and untravelled boulders are usually intermixed in the drift. In some instances, however, the former appear to be most numerous near the surface of the mass, and their horizontal distribution is also very irregular. In examining coast sections of the drift, we may find for some distance a great abundance of angular blocks, with few travelled boulders, or both varieties are equally intermixed, or travelled boulders prevail; and we may often observe particular kinds of these last grouped together, as, for instance, a number of blocks of granite, greenstone, syenite, etc., all lying together, as if they had been removed from their original beds and all deposited together at one operation. On the surface of the country where the woods have been removed, this arrangement is sometimes equally evident; thus hundreds of granite boulders may be seen to cumber one limited spot, while in its neighbourhood they are comparatively rare. It is also well known to the farmers in the more rocky districts, that many spots which appear to be covered with boulders have, when these are removed, a layer of soil comparatively free from stones beneath. These appearances may in some instances result from the action of currents of water, which have in spots carried off the sand or clay, leaving the boulders behind; but in many cases this is manifestly the original arrangement of the material, the superficial layer of boulders belonging to a more recent driftage than that of the underlying mass in which boulders are often much less abundant.

Boulders or travelled stones are often found in places where there is no other drift. For example, on bare granite hills, about 500 feet in height, near St. Mary's River, there are large angular blocks of quartzite, derived from the ridges of that material which abound in the district, but which are separated from the hills on which the fragments lie by deep valleys.

In Nova Scotia I have observed no beds with marine shells, though the Boulder-clay is often covered with beds of stratified sand and gravel; and the only evidence of organic life, during the boulder period, or immediately before it, that I have noticed, is a hardened peaty bed which appears under the Boulder-clay on the North-west arm of the River of Inhabitants in Cape Breton. It rests upon gray clay similar to that which underlies peat bogs, and is overlaid by nearly twenty feet of Boulder-clay. Pressure has rendered it nearly as hard as coal, though it is somewhat tougher and more earthy than good coal. It has a shining streak, burns with considerable flame, and approaches in its characters to the brown coals or more imperfect varieties of bituminous coal. It contains many small roots and branches, apparently of coniferous trees allied to the spruces. The vegetable matter composing this bed must have flourished before the drift was spread over the surface.

In New Brunswick, stratified clays holding marine shells have been found overlying the Boulder-clay, or in connexion with it, especially in the Southern part of the Province, where deposits of this kind occur similar to those found in Canada and in Maine, though apparently on a smaller scale. These deposits, as they occur near St. John, consist of gray and reddish clays, holding fossils which indicate moderately deep water, and are, as to species, identical with those occurring in similar deposits in Canada and in Maine. They would indicate a somewhat lower temperature than that of the waters of the Bay of Fundy at present, or about that of the Northern part of the Gulf of St. Lawrence.

In Bailey's Report on the Geology of Southern New Brunswick, Professor Hartt has given a list of the fossils of these beds, as seen at Lawlor's Lake, Duck Cove, and St. John, which I re-published with some additions in Acadian Geology.

These New Brunswick beds are strictly continuous with, and equivalent to those which extend along the coast of New England, and thence ascend into the Valley of Lake Champlain, while on the other side they may be considered as perfectly representing in character and fossils the Leda clay of Eastern Canada. They are remarkably like both in mineral character and fossils to the Clyde beds of Scotland, which are probably their equivalents. The points of resemblance of the Leda clay of the coast of Maine, and that of the St. Lawrence, and Labrador, were noticed by me in my paper of 1860, already referred to, and have been more fully brought out by Dr. Packard, who describes the Leda clay as it occurs at several localities from Eastport to Cape Cod. Along this whole coast it retains its Labradoric or Gulf of St. Lawrence aspect, though with the introduction of some more Southern species, and the gradual failure of some more arctic forms. South of Cape Cod, as in the modern sea, the Post-pliocene beds assume a much more Southern aspect in their fossils, the boreal forms altogether disappearing. For a very full exhibition of these facts, I may refer to Dr. Packard's paper.

The stratified sand and gravel of Nova Scotia rests upon and is newer than the Boulder-clay, and is also newer than the stratified marine clays above referred to. Its age is probably that of the Saxicava Sand of the St. Lawrence valley. The former relation may often be seen in coast sections or river banks, and occasionally in road cuttings. I observed some years ago an instructive illustration of this fact, in a bank on the shore a little to the Eastward of Merigomish harbour. At this place the lower part of the bank consists of clay and sand with angular stones, principally sandstones. Upon this rests a bed of fine sand and small rounded gravel with layers of coarser pebbles. The gravel is separated from the drift below by a layer of the same sort of angular stones that appear in the drift, showing that the currents which deposited the upper bed have washed away some of the finer portions of the drift before the sand and gravel were thrown down. In this section, as well as in most others that I have examined, the lower part of the stratified gravel is finer than the upper part, and contains more sand.

In some cases we can trace the pebbles of the gravels to ancient conglomerate rocks which have furnished them by their decay; but in other instances the pebbles may have been rounded by the waters that deposited them in their present place. In places, however, where old pebble rocks do not occur, we sometimes find, instead of gravel, beds of fine laminated sand. A very remarkable instance of the connexion of superficial gravels with ancient pebble rocks occurs in the county of Pictou. In the coal formation of this county there occurs a very thick bed of conglomerate, the outcrop of which, owing to its comparative hardness and great mass, forms a high ridge extending from the hill behind New Glasgow across the East and Middle Rivers, and along the South of the West River, and then, crossing the West River, re-appears in Rogers' Hill. The valleys of these three rivers have been cut through this bed, and the material thus removed has been heaped up in hillocks and beds of gravel, along the banks of the streams, on the side toward which the water now flows, which happens to be the North and North-east. Accordingly, along the course of the Albion Mines Railway and the lower parts of the Middle and West Rivers, these gravel beds are everywhere exposed in the road-cuttings, and may in some places be seen to rest on the Boulder-clay, showing that the cutting of these valleys was completed after the drift was produced. Similar instances of the connexion of gravel with conglomerate occur near Antigonish, and on the sides of the Cobequid mountains, where some of the valleys have at their Southern entrances immense tongues of gravel extending out into the plain, as if currents of enormous volume had swept through them from North to South.

The stratified gravels do not, like the older drift, form a continuous sheet spreading over the surface. They occur in mounds and long ridges, or eskers, sometimes extending for miles over the country. One of the most remarkable of these ridges is the "Boar's Back," which runs along the West side of the Hebert River in Cumberland. It is a narrow ridge, perhaps from ten to twenty feet in height, and cut across in several places by the channels of small brooks. The ground on either side appears low and flat. For eight miles it forms a natural road, rough indeed, but practicable with care to a carriage, the general direction being nearly North and South. What its extent or course may be beyond the points where the road enters on and leaves it, I do not know; but it appears to extend from the base of the Cobequid mountains to a ridge of sandstone that crosses the lower part of the Hebert river. It consists of gravel and sand, whether stratified or not I could not ascertain, with a few large boulders. Another very singular ridge of this kind is that running along the West side of Clyde river in Shelburne county. This ridge is higher than that on Hebert river, but, like it, extends parallel to the river, and forms a natural road, improved by art in such a manner as to be a very tolerable highway. Along a great part of its course it is separated from the river by a low alluvial flat, and on the land side a swamp intervenes between it and the higher ground. Shorter and more interrupted ridges of this kind may also be seen in the country Northward and Eastward of the town of Pictou. In sections they are seen to be stratified, and they generally occur on low or level tracts, and in places where if the country were submerged, the surf or marine currents and tides might be expected to throw up ridges. The presence of boulders shows that ice grounded on these ridges, and it, probably by its pressure, in some instances, modified their forms. These eskers, or "horse-backs," must not, however, be confounded with glacier moraines, to which in structure they bear no resemblance whatever.

It is probably to this more modern part of the Post-pliocene, if not to a more recent period following the elevation of the land, that the bones of the mastodon found in Cape Breton, and described in "Acadian Geology," belong.

For many additional facts relating to the Post-pliocene of New Brunswick, I may refer to the valuable paper by Mr. Matthew, already mentioned.

4. *Lower St. Lawrence—North Side.*

Descriptions of the Post-pliocene deposits of this region are contained in several of my papers above cited, but I shall here give a summary of these, with the corrections and additional facts obtained within the past few years.

Saguenay River.—I have already, in part first, referred to the glacial striation of this region, and perhaps no better example could be found of those lateral valleys along which ice seems to have been poured into the St. Lawrence from the North. The gorge of the Saguenay is a narrow and deep cut, running nearly N.W. and S.E., or at right angles to the course of the St. Lawrence, and of the Laurentian ridges. It extends inland more than forty-five miles, and then divides into two branches, one of which is occupied by the continuation of the river to Lake St. John, the other by Ha-Ha Bay and a valley at its head. In the lower part of its course, as far as Ha-Ha Bay, this gorge is from 50 to 140 fathoms deep, below the level of the tide in the St. Lawrence, and in some places the cliffs on its banks rise abruptly to 1500 feet above the water level, so that its extreme depth is nearly 2400 feet, while its width varies from about a mile to a mile and a-half. The striated surfaces and the roches moutonnées seen in this gorge and on the hills on its sides, to a height of at least 300 feet, shew that in the glacial period a powerful stream of ice must have flowed down this gorge into the St. Lawrence, though whether it was occupied by a glacier or constituted a fiord leading from one, like many in Greenland, or was a strait traversed by bergs, does not appear. Possibly, with different levels of the land, these conditions may have alternated. I cannot imagine anything more like what the Saguenay may have been at this time, than the view of Franz Joseph Fiord in East Greenland, brought home by the second German expedition to that country, in the present year,* and which, with other discoveries of that

* Copied in the "Leisure Hour" for November, 1871.

expedition soon to be published by Dr. Petermann, will go far to remove the prevailing error as to Greenland being covered with a universal glacier; whereas it seems to be a rocky and mostly snow-clad country, with very large glaciers in its valleys.

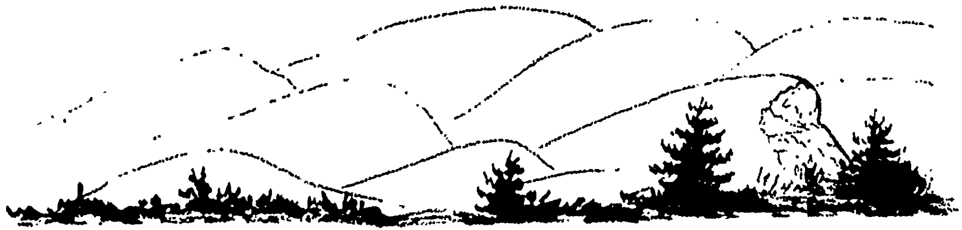
The strikes of the gneiss on the opposite sides of the Saguenay indicate that it occupies a line of transverse fracture, constituting a weak portion of the Laurentian ridges, and this has evidently been smoothed and deepened by water and ice under conditions different from the present, in which it is probable that the channel is being gradually filled with mud. Its excavation must have taken place before the deposition of the thick beds of marine clay (Leda clay) which appear near its mouth and in its tributaries, sometimes passing into Boulder-clay below, and capped by sand and gravel. It is indeed not improbable that in the later Post-pliocene it was in great part filled up with such deposits, which have been swept away in the course of the re-elevation of the land.

At Tadoussac, at the mouth of the Saguenay, where the underlying formation is the Laurentian gneiss, the Post-pliocene beds attain to great thickness, but are of simple structure and slightly fossiliferous. The principal part is a stratified sandy clay with few boulders, except in places near the ridges of Laurentian rocks, when it becomes filled with numerous rounded blocks and pebbles of gneiss. This forms high banks eastward of Tadoussac. It contains a few shells of *Tellina Grœnlandica* and *Leda truncata*, and a little inland, at Bergeron River, it also contains *Cardium Islandicum*, *Astarte elliptica*, and *Rhynchonella psittacea*. It resembles some of the beds seen on the South side of the river St. Lawrence, and has also much of the aspect of the Leda clay, as developed in the valley of the Ottawa. On this clay there rest in places thick beds of yellow sand and gravel.

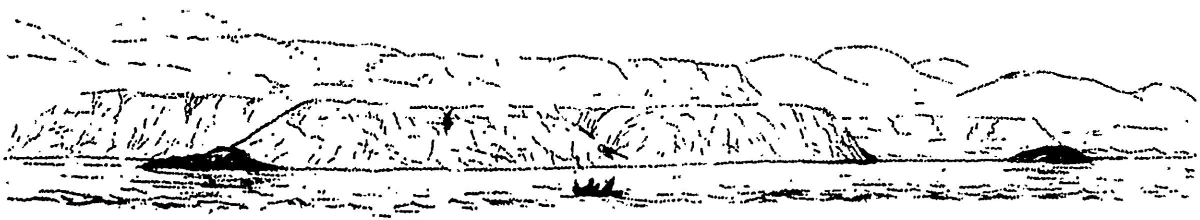
At Tadoussac these deposits have been cut into a succession of terraces which are well seen near the hotel and old church. The lowest, near the shore, is about ten feet high; the second, on which the hotel stands, is forty feet; the third is 120 to 150 feet in height, and is uneven at top. The highest, which consists of sand and gravel, is about 250 feet in height. Above this the country inland consists of bare Laurentian rocks. These terraces have been cut out of deposits, once more extensive, in the process of elevation of the land; and the present flats off the mouth of the Saguenay, would form a similar terrace as wide as any of the others, if the country were to experience another elevatory movement. On the third terrace I observed a few large Laurentian boulders, and some pieces of red and gray shale of the Quebec group, indicating the action of coast-ice when this terrace was cut. On the highest terrace there were also a few boulders; and both terraces are capped with pebbly sand and well rounded gravel, indicating the long-continued action of the waves at the levels which they represent.

Murray Bay, &c.—At Murray Bay, Petit Mal Bay, and Les Eboulements, as noticed above, the system of Post-pliocene terraces is well developed. On the West side of Murray Bay, the Silurian rocks of White Point, immediately within the pier, form a steep cliff, in the middle of which is a terraced step marking an ancient sea level. At the end nearest the pier the sea has again cut back to the old cliff, leaving merely a narrow shelf; but toward the inner side this shelf rapidly expands into the sandy flat along which the main road runs, and which is continuous with the lower plain extending all the way to the head of the bay. In this flat the upper portion of the Post-pliocene deposit seems to consist principally of sand and gravel, resting on stony clay. In the former, which corresponds to the Saxicava sand of Montreal, I found only a few valves of *Tellina Grœnlandica* which is still the most abundant shell on the modern beach. In the latter, corresponding to the Leda clay, which is best seen in some parts of the shore at low tide, I found a number of deep water shells of the following species, all of which, except *Spirorbis spirillum* and *Aphrodite Grœnlandica*, have been found in these deposits at Quebec and Montreal.

Fusus tornatus.
Trophon Scalariforme.
Margarita helicina.
Cylichna occulta.
Pecten Islandicus.
Tellina calcarea.
Leda truncata.
Saxicava rugosa.
Aphrodite Grœnlandica.
Mytilus edulis.
Mya arenaria.
Balanus Hameri.
Spirorbis spirillum.
S. citrea.
Serpula vermicularis.



Roches Moutonneés — Mouth of the Saguenay.
In Gneiss, at Elevation of 300. Feet.



Clay & Sand Terraces — Tadousac

A. L. D. del LEGGO & Co Lith Montreal.

These shells imply a higher beach than that of this lower flat, which is not more than 30 feet above the present sea level. Accordingly above this are several higher terraces, the heights of which on the west side of bay are given in Section I. The second principal terrace, which forms a steep bank of clay some distance behind the main road, is 116 feet in height, and is of considerable breadth, and has on its front in some places an imperfect terrace at the height of 81 feet. It corresponds nearly in height with the shoulder over which the road from the pier passes. Upon it, in the rear of the property of Mr. Du Berger, is a little stream which disappears under ground, probably in a fissure of the underlying limestone, and returns to the surface only on the shore of the bay. Above this is a smaller and less distinct terrace 139 feet high. Beyond this the ground rises in a steep slope, which in many places consists of calcareous beds, worn and abraded by the waves, but showing no distinct terrace; and the highest distinct shore mark which I observed, is a narrow beach of rounded pebbles at the height of more than 300 feet; but above this there is a flat at the height of 448 feet. This beach appears to become a wide terrace further to the North, and also on the opposite side of the bay. It probably corresponds with the highest terrace observed by Sir W. E. Logan, at Bay St. Paul, and estimated by him at the height of 360 feet.

As already stated, three of the principal terraces at Murray Bay correspond nearly with three of the principal shore levels at Montreal; and in various parts of Canada, two principal lines of old sea beaches occur at about 100 to 150 feet, and 300 to 350 feet above the sea, though there are others at different levels.

In the Post-pliocene period the valley of the Murray Bay river has been filled, almost or quite to the level of the highest terrace, with an enormously thick mass of mud and boulders, washed from the land and deposited in the sea bed during the long period of Post-pliocene submergence. Through this mass the deep valley of the river has been cut, and the clay, deprived of support and resting on inclined surfaces, has slipped downward, forming strangely shaped slopes, and outlying masses, that have in some instances been moulded by the receding waves, or by the subsequent action of the weather, into conical mounds, so regular that it is difficult to convince many of the visitors to the bay that they are not artificial. Sir W. E. Logan in his report on the district has in my view given the true explanation of these mounds, which may be seen in all stages of formation on the neighbouring hill sides. Their effect to a geological eye is to give to this beautiful valley an unfinished aspect, as if the time elapsed since its elevation had not been sufficient to allow its slopes to attain to their fully rounded contour. This appearance is no doubt due to the enormous thickness of the deposit of Post-pliocene mud, to the uneven surfaces of the underlying rock, and possibly also in part to the earthquake shocks which have visited this region.

At the mouth of the Murray Bay River, the Boulder-clay, which rests directly on the striated rock surfaces, and which is a true till, filled with the Laurentian stones and boulders of the inland hills, though resting on Silurian limestone, is evidently marine, since it contains shells of *Leda truncata*; and many of the stones are coated with Bryozoa and *Spirorbes*. It is also observable that on the N.E. sides of the limestone ridges the boulders are more numerous and larger. Above the Boulder-clay may in some places be seen a stratified sandy clay, which further up the river attains to a great thickness. It contains *Saxicava rugosa*, *Tellina Grœnlandica*, and *Tellina calcarea*, as well as *Leda truncata*. The most recent deposit is a sand or gravel, often of considerable thickness, and in some of the beds of gravel the pebbles are more completely rounded than those of the modern beach.

I have already, in Section I, stated my reasons for believing that the upper part of the valley of the Murray Bay River may have been the bed of a glacier flowing down from the inland hills toward the St. Lawrence. N.W. and S.E. striæ attributable to this glacier were seen at an elevation of 800 feet, and the marine beds were traced up to almost the same height, above which, to a height of about 1200 feet, loose boulders were observed and glaciated rock surfaces, but no marine deposits. It is probable, therefore, that at a time when the sea extended up to an elevation of 800 feet, the higher part of the valley may have been filled with land ice. Whether the bergs from this, drifting down toward the St. Lawrence, produced the N.W. striation observed at a lower level, or whether at a previous period, when the land was higher, the ice extended farther down, may admit of doubt. Certainly no land ice has extended to a lower level than about 800 feet, since the deposition of the marine boulder and Leda clay.

Very large boulders occur in this vicinity. One observed on the beach on the east side of the Bay, is an oval mass of lime felspar, thirty feet in circumference, lying like most other large boulders in this region, with its longer axis to the N.E.

Les Eboulements.—At this place the Laurentian hills rise to a great height near the shore, and the Post-pliocene beds present the exceptional feature of resting on soft decomposed Silurian shale (Utica shale). This rock might indeed be mistaken for drift, but for its stratification, and it must have been decomposed to a great depth by subaerial action and subsequently submerged and covered by the Post-pliocene beds. Its preservation is the more remarkable that the clay overlying it contains very large Laurentian boulders, which must have been quietly deposited by floating ice. Only a few shells of *Tellina Grœnlandica* were observed in these clays.

The remarkable series of terraces seen at this place, and noticed in part first, rising to 900 feet in height, are all cut out of the Post-pliocene beds and decomposed shale, and even the highest presents large boulders. In examining such terraces it is always necessary to distinguish between the clays out of which the terraces have been cut and the more modern deposits resting on the terraces. Both may contain fossils, but those of the original clay are in this region mostly of deeper water species than those in the overlying superficial beds.

I attribute the preservation of the thick beds of Boulder-clay and the decomposed shale at Les Eboulements, to the fact that no transverse valley exists here, and that a point of high Laurentian land projects to the North-East, so as to shelter this place from forces acting in that direction. I have observed this appearance on the lee or South-west side of other projecting masses of hard rock, and as the decomposed shale must be a monument remaining from the Pliocene elevation of the land, it shews that no powerful eroding force had acted between that time and the period of the N. E. arctic ice-laden currents.

It is perhaps deserving of notice that the thick beds of soft material at Les Eboulements have been cut into many irregular forms by modern subærial causes of denudation, and also by landslips, which last have been in part connected with the earthquake shocks with which this part of the coast has been visited more than any other district of Canada.

Above Les Eboulements, Bay St. Paul presents features similar to those of Murray Bay, and then the Laurentian land of Cape Tourment comes boldly forward to the shore of the River. Above this the conditions are similar to those observed in the neighbourhood of Quebec.

(To be continued.)

ON THE "COLONIES" OF M. BARRANDE.

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The doctrine of "Colonies," propounded by M. Barrande, has been long before the palæontological world, and is known, at any rate by name, to all students of geology. It is doubtful, however, if there is as clear a comprehension of this subject as its importance would render desirable; and it may, therefore, be of interest to discuss briefly the leading facts upon which this theory is based. In so doing, I shall take the necessary details from M. Barrande's "Défense des Colonies," published in 1870, one of the most valuable of the many palæontological works of this distinguished observer, and I shall confine myself chiefly to a *résumé* of the facts therein recorded and the deductions drawn therefrom.

I. SUB-DIVISIONS OF THE SILURIAN ROCKS OF BOHEMIA.

The Silurian Rocks of Bohemia are described by M. Barrande as occupying an elliptical basin, the long axis of which has a N.E., and S.W. direction, and a length of 148 kilometres. The breadth of the basin increases gradually in passing from the N.E. to the S.W., its minimum breadth being about 30 kilometres, and its maximum about 74 kilometres. The Silurians of this basin repose upon granitic and gneissic rocks, and dip inwards towards a central line. The fossiliferous beds of the entire basin occupy a far from considerable superficial area; and their extent —supposing them not to have been much denuded—would assign to the Silurian sea of Bohemia an area not exceeding 1–60 of the superficies of the Adriatic.

The Silurian rocks of the entire basin admit of separation into two primary divisions, an *Inferior* and a *Superior* division, corresponding respectively to the Lower and Upper Silurian Rocks of Sir Roderick Murchison. The Inferior Division is composed principally of schists and quartzites; or, as we should say, slates and grits or graywackes, and is wholly destitute of calcareous matter, except occasional concretions of carbonate of lime. The Superior Division is composed almost entirely of calcareous matter, with merely subordinate bands of schists and quartzites. Each division can be satisfactorily broken up into four sub-divisions (étages), grounded solely upon the characters of their contained fossils, and lettered in ascending order:—

The étages of the Inferior Division are A., B., C., D. The étages of the Superior Division are E., F., G., H. Each of the fossiliferous sub-divisions can be further broken up into minor groups or "bands," distinguished by the smaller letters of the alphabet, as shown in the annexed table.

Etages A. & B., the lowest of the Inferior Division, are composed of semi-crystalline rocks and conglomerates, and are unfossiliferous. They are termed by Barrande the "Azoic Etages," and are considered by him as forming the base of the Silurian Series. It is, however, more probable that they should be regarded as being truly of Lower Cambrian age.

Etages C. D. E. F. G. & H. are fossiliferous. Etage C. is the well-known "Primordial Zone" of Bohemia, corresponding with the Menevian beds of Britain, and characterized by primordial trilobites of the genera *Paradoxides*, *Olenus*, *Conocoryphe*, *Elliptocephalus*, &c. It should probably be regarded as Upper Cambrian.

Etage D. contains Barrande's so-called "faune second" or second fauna, and must correspond with the Llandeilo and Caradoc beds of Britain. Etages E. F. G. & H. are characterized by a single fauna termed by Barrande the "faune troisième" or third fauna; and they correspond collectively to the Upper Silurian Rocks of Britain.

The precursors ("avanteureurs") of this "third fauna" in the last portions of the period of the "second fauna" are termed by Barrande the "colonies." They are in the form of bands which are enclosed in the mass of étage D towards its higher part, and which are thus *stratigraphically* Lower Silurian, but which, nevertheless, contain a predominance of fossils characteristic of the "third-fauna," and thus come *palæontologically* to belong to the Upper Silurian series. They abound especially in the band *d* 5, occurring also in *d* 4, and about twenty of them are known in all. The subjoined table shows in a summary form the general subdivisions and lithology of the rocks of the Bohemian basin, with the principal characteristic fossils:—

TABLE OF THE SUBDIVISIONS OF THE SILURIAN ROCKS OF BOHEMIA.

Etage A.		Different crystalline rocks.	Destitute of fossils.
Etage B.			These are the "etages azoiques" of Barrande. Probably Lower Cambrian.
Etage C. "Primordial Zone."		Compact argillaceous schists, rarely metamorphic.	"Primordial fauna," comprising 27 trilobites, 5 pteropods, 2 brachiopods, 1 polyzoön (?), and 5 echinoderms.
Etage D. (containing the "second fauna.")	*d* 1.	Black, fissile, argillaceous schists, sometimes with fossiliferous siliceous nodules.	47 trilobites, 25 cephalopods, 14 pteropods, few gasteropods, brachiopods, and lamellibranchs; very few graptolites.
	d 2.	Beds of "quartzite" (*i. e.* greywacke), sometimes with thin beds of schist.	19 trilobites, 1 cephalopod, 8 pteropods; other fossils very rare.
	d 3.	Black, argillaceous, and micaceous schists.	18 trilobites, 1 cephalopod, 10 pteropods.
	d 4.	A lenticular mass of limestone forming the "Colony Zippe."	8 trilobites and 9 brachiopods.
		Impure, very micaceous schists of different tints, with beds of impure quartzites, and few calcareous concretions.	26 trilobites, 6 cephalopods, 18 pteropods; rare, gasteropods, brachiopods and bivalves; frequent, cystideans.
	d 5.	*Colonies*, composed of graptolitic schists, with calcareous spheroids, associated with beds of trap.	4 trilobites, 36 cephalopods; few brachiopods; many graptolites.
		Fissile argillaceous schists, gray, yellowish, or bluish, alternating with beds of quartzite.	54 trilobites, 12 cephalopods; few gasteropods, brachiopods, and bivalves; graptolites very rare.
Etage E.	*e* 1.	Graptolitic schists containing calcareous spheroids, and alternating with beds of trap.	15 trilobites, 149 cephalopods, 5 pteropods; few gasteropods, brachiopods and bivalves; many graptolites.
	e 2.	Compact, often fetid limestone in continuous beds, frequently blackish, but in certain localities whiteish.	81 trilobites, 665 cephalopods, 11 pteropods; very many gasteropods, brachiopods, bivalves and corals; few graptolites.
Etage F.	*f* 1.	Compact limestone, black or dark gray, not fetid.	11 trilobites, 31 cephalopods, 2 pteropods (first *Tentaculites*); few gasteropods, brachiopods and bivalves; last graptolites.
	f 2.	Compact limestone, often white or red.	Fish (first? in Bohemia); 81 trilobites, 60 cephalopods (first *Goniatites*), 15 pteropods; very many gasteropods and brachiopods; few bivalves, many corals.
Etage G.	*g* 1.	Nodular limestone, very like *g* 3, but much thicker.	4 fishes, 56 trilobites, 55 cephalopods, 10 pteropods; few gasteropods, bivalves, and brachiopods.
	g 2.	Fissile argillaceous schists, *without calcareous spheroids*, and without quartzites. A few beds of trap.	6 trilobites, 12 cephalopods, 3 pteropods (*Tentaculites* common); few bivalves and brachiopods.
	g 3.	Nodular limestone, very like *g* 1, with cherty concretions.	3 trilobites, 86 cephalopods (14 *Goniatites*), 2 pteropods; few gasteropods, bivalves and brachiopods.
Etage H.	*h* 1.	Fissile, argillaceous schists, without quartzites or calcareous concretions.	2 trilobites, 13 cephalopods (3 *Goniatites*), 3 pteropods (*Tentaculites* common); *Cardiola retrostriata*, &c.
	h 2.	Fissile argillaceous schists, alternating in thin beds with quartzites, but with no calcareous concretions.	Without fossils.
	h 3.	Fissile argillaceous schists, without calcareous concretions.	Without fossils.

II. Distribution of the Colonies.

The colonial zone occupies a great part of the superficial area and vertical thickness of the band *d* 5, forming an elliptical zone or belt concentric with the calcareous rocks of the Upper Silurian basin. From this basin the colonial zone is generally separated by schists and quartzites, which form the summit of *d* 5, and which contain no fossils of an animal nature. On the surface of this zone the colonies are distributed in concentric but discontinuous lines, with irregular intervals between. Each colony is in the form of a lenticular mass, of which the length enormously exceeds the breadth and thickness; and the phenomena of their distribution and their relations to the surrounding rocks prove plainly that they cannot be explained by invoking the agency of mechanical disturbance or faults.

Several interbedded traps are found in the colonial zone, regularly interstratified with the colonies, and similar beds are found in band *e* 1 at the base of Etage E. They all have the form of elongated lenticular masses thinning out at both extremities. As the Silurian rocks of Bohemia form a basin, the colonies are, as a matter of course, found on both sides of the central group of calcareous rocks (Upper Silurian). With the exception of the "Colony Zippe," which is found in *d* 4, all the colonies are found in the lower portion of *d* 5; and, like the rocks amongst which they are situated, they dip inwards towards the axis of the basin.

III.—Lithology of the Colonies compared with that of Bands *e* 1, *e* 2, *d* 4, & *d* 5.

A. Band, *e* 2.—This band is the second subdivision of Etage E., and is composed mainly of continuous beds of limestone, often fetid, almost black in colour, and chiefly composed of the debris of Crinoids. The beds of limestone are separated by thin courses of impure shales containing a few graptolites. Lithologically *e* 2 differs most markedly both from band *e* 1 and from the colonies; but nevertheless the palæontological relationships of the colonial zone are far stronger with *e* 2 than with *e* 1, though the mineral characters of *e* 1 are identical with those of the colonies.

B. Band e 1:—Band *e* 1 constitutes the stratigraphical base of Etage E. or of the Upper Silurian Series of Bohemia. It consists wholly of Graptolitic Schists, enclosing calcareous spheroids or "anthracolites" and having intercalated beds of trap. Its thickness is very variable, sometimes exceeding 600 metres, and it is always much thicker than band *c* 2.

Lithologically, therefore, as well as in possessing interbedded traps, *c* 1 differs greatly from *c* 2. In the same way, the palæontological differences between the two are sufficiently well marked, though they are united by many specific connexions. Each, however, has its own fauna, and the richness of the two is very unequal. Thus, *c* 1 possesses but 15 Trilobites, whilst *c* 2 has 81 species; *c* 1 has yielded no more than 149 Cephalopods, whilst *c* 2 has yielded the extraordinary number of 665 species; and similar differences are found in the Gasteropods, Bivalves, and Brachiopods. Still, the propriety of retaining *c* 1 and *c* 2 on the same stratigraphical horizon is shown by numerous palæontological relationships, amongst which may be mentioned the fact that 68 Cephalopods are common to the two divisions.

C. Band d 5:—Band *d* 5 underlies band *c* 1, and *forms the* summit of Etage D., or the highest division of the Lower Silurian Series of Bohemia. Its upper portion has a thickness of 100 metres and is composed of alternating thin beds of gray schist and quartzite (graywacke). It is remarkable in being wholly destitute of fossils of an animal nature, having yielded nothing more than a few "Fucoids". This thick deposit, therefore, corresponds with a prolonged and total intermission of the Silurian fauna of the Bohemia area.

The thickness of this unfossiliferous formation might serve as an approximate measure of the time which elapsed between the last appearance of the colonial fauna and the definitive appearance of the "third fauna" (Upper Silurian fauna). In certain localities, however, this unfossiliferous mass *appears to have undergone partial denudation, prior to the deposition of c* 1.

It may be remarked here that the above observation of M. Barrande would seem to indicate *a want of conformity* between Etage D. and Etage E., such as is found in many other countries between the Lower and Upper Silurian rocks. If this be so, the interval between the colonial fauna and the introduction of the third fauna may have been indefinitely long, and cannot even be approximately measured by the thickness of the upper part of *d* 5.

Below this unfossiliferous series, band *d* 5 is composed of masses of argillaceous schist of different tints, sometimes with subordinate beds of quartzite. In all cases, with the exception of the colony Zippe, the colonies are intercalated in this portion of *d* 5; and there are also numerous beds ("coulées") of trap at various horizons. As will be seen immediately, this portion of *d* 5 is chiefly distinguished from the beds of the colonies by the fact that the schists are almost wholly destitute of graptolites.

D. The Colonies.—The colonies, as just remarked, are situated in the schistose lower portion of *d* 5, and they are lithologically absolutely undistinguishable from band *e* 1, consisting of graptolitic schists with calcareous concretions and interbedded traps. The following distinctions, however, may be noted as compared with *e* 1:—

1. The thickness of the colonies is always much less than that of band *e* 1; and there are fewer alternations of the graptolitic schists with the traps.

2. Certain colonies are composed entirely of schists without traps.

3. In some colonies (*e. g.* Colony Haidinger and Colony Cotta) there are bands of gray schists and quartzites like those of *d* 5.

4. The calcareous concretions are generally rarer in the colonies than in the band *e* 1, and they even appear to be wanting in some colonies, especially in the deepest (*e. g.* in the Colony Haidinger.)

E. Band d, 4:—This band is composed of impure schists, which are always highly micaceous and deeply coloured, brown, gray or black. Though fissile, they are much less homogeneous and papery ("feuillétes") than those which constitute the superior band *d* 5. Sometimes there are intercalated beds of quartzite, and occasionally there are interbedded sheets of trap. There is only one colony in *d* 4, namely the Colony Zippe, situated within the ramparts of Prague. This colony differs from all the rest by its being entirely composed of a lenticular mass of limestone, about 25 centimetres thick, intercalated in the midst of regular alternations of schist and quartzite.

IV. Palæontological Relations of the Colonies.

From what has preceded, it is evident that stratigraphically the colonies belong to the Lower Silurian series, and we have now to enquire what relationships can be shown to subsist between the colonial fauna and the second and third fauna respectively. The specific connexions of the colonial fauna, when examined in detail, will then be found to be most close and intimate with the first phases of the *third* fauna (Upper Silurian), so that palæontologically the colonies must be regarded as truly Upper Silurian. This result will be brought out by a comparison of the fauna of the colonies with that of the Lower and Upper Silurian periods respectively :—

A. Specific connexions between the Colonies and the Second Fauna.—As yet only two colonies are known in which there is any intermixture of the characteristic forms of the second fauna (Lower Silurian) with those of the colonial fauna, *i. e.* with those of the third fauna (Upper Silurian). Thus, out of seventeen species in the colony Zippe, there are four species representing the *second* fauna, with twelve species belonging to the *third* fauna. On the other hand, in the colony d'Archiac there are only two species of the third fauna (viz. *Cardiola interrupta* and *Graptolites priodon ?*). It is quite clear, therefore, that the colonial fauna, as a whole, has very slight connexion with the second or Lower Silurian fauna.

B. Specific connexions between the Colonies and the Third Fauna.—In showing the specific connexions between the colonies and the third or Upper Silurian fauna, it will be advisable to review briefly the different orders of fossils represented in the Silurian basin of Bohemia.

a. Fishes.—No traces of fishes have been detected in the colonies or in the whole of the Lower Silurian series, and their only indubitable remains occur in Etages F and G, which have hardly any connexion with the colonies. (Altogether five fishes have been discovered in the Upper Silurians of Bohemia, viz. *Coccosteus primus*, *C. Agassizi*. *Asterolepis Bohemicus*, *Gompholepis Panderi*, and *Ctenacanthus Bohemicus*.)

b. Crustaceans.—These are principally trilobites. The trilobites of the colonies, not taking into account the four species of the second fauna, are referable to eight species and seven genera, all belonging to the third fauna. The trilobites are, therefore, very limited in number, and their paucity agrees perfectly with the small number of these crustaceans in the first phase of the third fauna, *i. e.* in *e* 1, in which only fifteen species are known. On the other hand *d* 5 and *d* 4 have together furnished about eighty trilobites peculiar to the last phases of the second fauna. The remaining Crustaceans of the colonial fauna are *Pterygotus Bohemicus*, *Ceratiocaris inæqualis*, *Entomis migrans*, and *Apty-*

chopsis (*Peltocaris*) *primus*, all of which reappear in the third fauna. *Ceratiocaris*, however, occurs in *d* 5. *Aptychopsis* (or *Peltocaris*, Salter, as it more probably is) occurs in the Scotch Upper Llandeilos, whereas in Bohemia it is confined to the base of the Upper Silurians (*e* 1 and *e* 2) and to the colonies. A similar, if not identical form, however, has recently been discovered by Mr. Lapworth in the Scotch Silurians, high up in the series, and I have found another closely similar form in the sandstone of the Coniston series (Caradoc) of the north of England.

c. Cephalopoda.—This class of fossils, as is well known, has been an object of M. Barrande's especial study, and his results are, therefore, of the highest value and interest. The *Cephalopoda* are represented in the colonial fauna by thirty-six species, of which all except species of *Cyrtocera* are referable to the genus *Orthoceras*. The Cephalopods, therefore, abounded in the colonial fauna, and this again agrees with the state of things in the earlier portion of the third fauna. On the other hand, bands *d* 5 and *d* 4, though much thicker than the colonies, have only yielded altogether eighteen species of *Cephalopoda*, the paucity of these fossils thus contrasting strongly with the abundance of trilobites. It should also be remarked that the small representation of the genus *Cyrtoceras* in the colonies (only two species being known) contrasts very strongly with the total absence of the genus in the second fauna, and its great abundance in the earlier phases of the third fauna, twenty-six species occurring in *e* 1, and no less than 201 species in *e* 2. Lastly, of the thirty-six species of Cephalopoda in the colonies, not one is specifically identical with any form known in the second fauna. On the contrary, thirty-one species reappear on different horizons in the third fauna, the remaining five species being peculiar to the colonies.

d. Pteropoda.—Only two species of *Hyolithes* occur in the colonies, and both reappear in the first phase of the third fauna. Neither occur in *d* 5, though various other Pteropods occur in this band.

e. Gasteropoda.—Only ten species, belonging to eight genera, have hitherto been found in the colonies (almost all in the Colony d'Archiac). No species is common to the colonies and the second fauna, but the genus *Pleurotomaria* occurs in both. All the colonial species, however, reappear in the third fauna; and their rarity in the colonies agrees fully with their comparative scarcity in *e* 1.

f. Brachiopoda.—Only fifteen species of Brachiopods are known in the colonial fauna, and these occur in three colonies only. The brachiopods are, therefore, poorly represented; but the following conclusions may be drawn from such as are present: Firstly, five genera and eight species suddenly occur in the Colony Zippe, in *d* 4. which band hardly contains anything else but *Orthides*. Secondly, the colonies contain the genus *Spirifer*, which is not known at all in the second fauna of Bohemia, and is equally very rare in the Lower Silurian of other countries. The genus, however, is abundantly represented in the first phases of the third fauna. Thirdly, we meet in the colonies with *Atrypa reticularis*, which is equally unknown in the second fauna of Bohemia, and is comparatively rare in the Lower Silurian series elsewhere. On the other hand, it is a characteristic species of the Upper Silurian series from its base almost to its summit. Fourthly, of the total number of fifteen species, only one is exclusively colonial, and that doubtfully so. Fourteen species, therefore, establish the connexion with the third fauna.

g. Lamellibranchiata.—The most remarkable forms of this class in the colonies belong to the genus *Cardiola*, the most important species being *C. fibrosa*, Sow, *C. interrupta*, Sow, *C. gibbosa*, Barr., and *C. nigrans*. Barr. Not one of these species is found in any formation belonging to the second fauna, but all reappear at different horizons in the third fauna.

h. Graptolites.—These are very abundant in the colonies, and show many points of affinity with those of the third fauna, whilst "they have only few affinities with those of the contemporary phases of the second fauna." Twenty-one species of Graptolites occur altogether in the colonies, and they give rise to the following conclusions:—Firstly, not one species of the colonial fauna can be positively asserted to occur in the second fauna (Lower Silurian). Secondly, fourteen species of the twenty-one reappear in band *e* 1, and of these six pass on into *e* 2. There remains seven forms which are peculiar to the colonial zone, and these are found exclusively in the Colony Archiac.

The Graptolites, therefore, contribute largely to establish the connexion between the faunæ of the colonies and of the Upper Silurian rocks of Bohemia, no single form being certainly known to be identical in the colonies and the contemporary phases of the second fauna. It is to be noted, however, that the Graptolites of the colonies, as well as those of *e* 1 and *e* 2, show upon the whole most strongly marked affinities with those of the *Lower Silurian rocks* of Britain and America. This is especially shown by the occurrence of the genera *Diplograpsus*, *Climacograpsus*, and *Rastrites*, none of which is known to be represented in the Upper Silurian of any other country except Bohemia. Not only is this the case, but a large number of the species of Etage E are identical with those of the Caradoc beds (Coniston mudstones) of the north of England, and of similar strata in the south of Scotland. I shall, however, elsewhere endeavour to show that the Graptolites of Bohemia were introduced by emigration from the British area.

i. Crinoids.—No certain remains of Crinoids have been hitherto detected in the colonial zone, except in one doubtful instance. It should be noticed, however, that Crinoids are very rare in the second fauna, whilst there are several species of Cystideans. On the other hand, crinoidal fragments are extremely abundant in *e* 1, although the number of specific forms seems to be very small.

j. Corals.—Corals have hitherto been found in only one colony, and here there is only one indubitable species, viz., *Calamopora* (*Favosities*) *alveolaris*. As no corals of this group are known in the second fauna, and as they are common in the earlier phases of the third fauna, this establishes another link between the latter and the colonial fauna.

C. Relationships of the Colonial Fauna as a Whole.

Regarded as a whole, the following conclusions may be drawn from a study of the fossils occurring in the colonies:—

1. Altogether 110 species of fossils are known to occur in the colonies, and although this number is still incomplete, it is to be remarked that the total is little smaller than that of band *d* 5, in which the colonies are situated, and in which 130 fossil species are known in all. It is a very singular fact, therefore, that these 110 species should be "cantoned" so to speak, amongst 130 species belonging to the older second fauna.

2. The independence of the colonial fauna, in spite of its general connexion with the third fauna is shown by the existence of fourteen species exclusively confined to the colonies. This number indicates the amount of extinction which took place in the interval between the last colony and the definitive appearance of the third fauna in Bohemia. It is to be noticed, also, that it is the

numerically largest families, namely, the Cephalopods and Graptolites which have suffered most in the way of extinction.

3. The colonial fauna is related to the second fauna by no more than four species, all Trilobites, and all found in one colony.

4. On the contrary, the specific connections between the colonial fauna and the third fauna are represented by ninety-two species, or eighty-three per cent. of the total of colonial species.

5. The same relationships are shown by the general facies of the fossils, irrespective of specific identities. Thus, the last phases of the second fauna are characterised by a predominance of Trilobites and by the rarity of Cephalopods and Graptolites. On the other hand, the colonies and the first phases of the third fauna were characterised by the rarity of Trilobites and the abundance of Cephalopods and Graptolites.

6. These results lead inevitably to the conception that the species of the colonies have been introduced into Bohemia by migration from a foreign area. This conception becomes more certain by a comparison of the colonial fauna with the Silurian fauna of other countries, by which it appears that many colonial species existed in the Lower Silurian series of the British area, that is at a period earlier than the date of their appearance in Britain.

V. Palæontological Relations between the Colonial Fauna and the Silurian Fauna of Britain.

The connexions between the Silurian fauna of Britain and Bohemia are two-fold, direct and indirect. The *direct* connexions are shown by the fact that several of the colonial species of Bohemia are found existing in Britain in the "second fauna," *i. e.* in the Lower Silurian period. The *indirect* connexions consist in the fact that some of the Lower Silurian species of Britain are found in Bohemia, not in the colonies, but in the third fauna, *i. e.* in the Upper Silurian period.

The following table shows the number of species which are common to the Lower Silurian of Britain, the colonies, and the Upper Silurian of Bohemia, but which are wholly wanting in the Lower Silurian (second fauna) of Bohemia:—

Chierurus bimucronatus, Murch.
Sphaerexochus mirus, Beyr.
Atrypa reticularis, Linn.

Strophomena (Leptæna) *euglypha*, Dalm.
Cardiola interrupta, Sow.
Graptolites lobigerus, McCoy. (= G. Becki, Barr.)
———— *Nilssoni*, Barr.
———— *priodon*, Barr.
———— *Bohemicus*, Barr.
———— *colonus*, Barr.
———— *Roemeri*, Barr.
Rastrites peregrinus, Barr.

To these I may add, *Climacograpsus teretiusculus*, His., *Graptolites turriculatus*, Barr., *G. Sedgwickii*, Portl., *Diplograpsus folium*, His., and *Diplograpsus palmeus*, Barr.

Of the above eleven species enumerated by M. Barrande as common to the colonies and the Lower Silurians of Britain, six reappear in the Upper Silurian of Britain, and all are found in the third fauna (Upper Silurian) of Bohemia. M. Barrande, therefore, concludes that these species play the same part of precursors in the two countries compared; and he believes that a common centre of diffusion for these species must have existed somewhere between Britain and Bohemia. It should be remarked, however, that of the above eleven species, four of the Graptolites (viz. *G. lobigerus*, *G Nilssoni*, *G. Bohemicus*, and *Rastrites peregrinus*) are *not* known, as erroneously believed by M. Barrande, to occur in the British Upper Silurian series; nor are any of the five species added by myself to the above list. It should also be noticed that there is great doubt as to the propriety of the introduction of *Cardiola interrupta* into the above list as occurring in the Lower Silurian in Britain. On the contrary, it is becoming extremely probable that all the rocks in which this fossil occurs in Britain are truly of Upper Silurian age.

The following table shows the species of fossils which are found in the third fauna of Bohemia (Upper Silurian), but which existed at an earlier date in the Lower Silurian of Britain:—

Crustaceans.
Calymene Blumenbachii, Brongn.
Staurocephalus Murchisoni, Barr.

Cephalopods.
Orthoceras annulatum, Sow.

Brachiopods.

Atrypa marginalis, Dalm.
Cyrtia trapezoidalis, Dalm.
Leptæna sericea, Sow.
——— *transversalis*, Dalm.
Orthis elegantula, Dalm.
——— *hybrida*, Sow.
Strophomena depressa, Sow.
——— *pecten*, Linn.

Graptolites.

Graptolites convolutus, His.
——— *turriculatus*, Barr.
Diplograpsus palmeus, Barr.
Rastrites Linnæi, Barr.
Retiolites Geinitzianus, Barr.

Corals.

Favosites alveolaris, Blainv.
Halysites catenularius, Linn.
Heliolites interstinctus, Wahl.
——— *tubulatus*, Lonsdale.

Of the above twenty species thus enumerated as common to the Upper Silurians of Bohemia and the Lower Silurians of Britain, four species are found in the Llandeilo, all (with the doubtful exception of *Retiolites Geinitzianus*) are found in the Caradoc, and fifteen species occur in the Llandovery rocks of the latter country. Not one of these species, on the other hand, is found in the corresponding rocks of Bohemia, namely in the second fauna. These species, therefore, go to show that "the elements of the third fauna of Bohemia, which are represented in the colonial fauna, existed in notable numbers in a foreign country, at a time when the second fauna still predominated in the Silurian basin of Bohemia. These species thus establish an indirect connexion between the second fauna of Britain and the colonies of Bohemia.

VI. General Conclusions.

As to the general conclusions which may be deduced from the whole of the above facts, it will be sufficient to give briefly the series of propositions laid down by M. Barrande, merely remarking that these conclusions are in the main warranted by the facts, and that any subsequent modifications are not likely to affect their general tenor.

In the first place, it seems certain that during the existence of the last phases of the second fauna in Bohemia, the first phases of the third fauna had become more or less fully developed in some other country hitherto unknown.

Starting from this centre of diffusion, migrations must have taken place at different epochs into Bohemia, during the whole of the deposition of the thick band *d* 5.

On every occasion these migrations must have given rise to colonies, which are placed on the same horizon, and consist of graptolitic schists, almost always accompanied by flows of trap, and often containing calcareous concretions.

In consequence of inauspicious conditions, and from the cessation of these schistose and calcareous deposits, all the colonies must have enjoyed a relatively short existence during the period that the Bohemian area was occupied by the second fauna.

The appearance of the colonies coinciding constantly with the graptolitic deposits, we are compelled to attribute both equally to the influence of currents arising in the same quarter.

The introduction of intermittent currents into the isolated basin of Bohemia seems to have been caused by oscillations of the land, connected with the production of the traps which occur so frequently in bands *d* 5 and *e* 1.

In all cases, the colonial species appeared on different horizons without being able to establish themselves permanently in Bohemia during the last phase of the second fauna.

After the complete extinction of the second fauna, however, and after a prolonged intermission, during which the Bohemian basin appears to have been deserted, a new immigration, arising from the same foreign centre, must have invaded the Bohemian sea, and must have succeeded in permanently establishing itself there. (I may remark here that few palæontologists would admit that the presence of a considerable mass of unfossiliferous beds in the midst of a fossiliferous series, necessarily implies a period in which life did not exist, as above assumed by M. Barrande. More probably the local conditions were such as to cause a local migration of the existent fauna, or such as not to allow of their preservation in a fossil condition. There certainly do not seem to be sufficient grounds for the assumption that the whole of the second fauna of Bohemia died out during the deposition of the upper part of *d* 5, and the absence of fossils might be partially accounted for by the lithological nature of the deposits in question, which are stated by Barrande to consist chiefly of gray-wackes and grits ("quartzites"). Lastly, there are indications that *e* 1 is superimposed unconformably upon *d* 6, in which case the interval between the second and third faunas may have been an enormously long one, and some intermediate deposits may be missing.)

The above definitive introduction, constituting the first phase of the third or Upper Silurian fauna, must have taken place during the deposition of the band *e* 1, the basement band of the superior division, which agrees lithologically with the colonies in being composed of graptolitic schists with calcareous concretions, alternating with sheets of trap.

It is clear that the interpretation of the facts rests chiefly on the hypothesis of migrations. Most geologists now admit the doctrine of migrations, and Bohemia more than any country presents us with proofs of its truth.

Thus, M. Barrande has shown that the Bohemian basin of Silurian times was separated by natural barriers from the contemporaneous ocean which covered the great northern zone of Europe and America. This is shewn by the specific differences between many of the forms (such as the *Cephalopoda*) of these areas; but the occurrence of some species common to Bohemia and Northern Europe has also shown that there must have existed temporary communications between these different regions. Further, M. Barrande has shown (*Mem. sur la Reapparition du genre Arethusina*, 1868,) that although the colonies are the most striking examples of the intermittent appearance of species in Bohemia, there exists besides in the same basin a considerable number of species equally intermittent, and belonging to different classes of fossils. This was particularly shown by the occurrence of four Trilobites and one Cephalopod, which existed in *d* 1, at the commencement of the second fauna, completely disappeared during *d* 2, *d* 3, and *d* 4, and reappeared in *d* 5 at the close of the second fauna, their reappearance coinciding precisely with the introduction of the colonies into the basin.

Both these circumstances can be explained by the same hypothesis, namely by supposing a temporary communication to be formed between the Bohemian basin and other seas. This hypothesis would not only explain the reappearance of the above-mentioned species after the lapse of a vast period of time, but would also allow of the almost inevitable introduction of various other new forms into the same basin at the same time.

We have, then, on the one hand, the fact that the Silurian basin of Bohemia was isolated and separated from other regions, over which successively existed the three general faunas characteristic of the Silurian period (with the Upper Cambrian). On the other hand, divers well established facts demonstrate the co-existence of a certain number of identical species on corresponding horizons in countries geographically widely removed from one another. This co-existence can only be explained by the effect of migrations.

We may suppose, therefore, that the repeated introduction into Bohemia of species which are equally characteristic of the colonies and of the third fauna, may be explained by having recourse to the phenomenon of migrations. We may also suppose that the intermittent appearance of the colonies may be attributed to oscillations of the land during the last phases of the second fauna, the occurrence of such oscillations being testified by the frequent intercalation of traps in the beds in question (viz. in *d* 5).

Lastly, we may define the phenomena of "colonies" as consisting in "the co existence of two general faunæ, which, considered in their entirety, are nevertheless successive."

THE WHALE OF THE ST. LAWRENCE.

By Dr. J. W. Anderson, President of the Literary and Historical Society of Quebec.

In the early history of Canada, the whale and walrus fishery of the Gulf of St. Lawrence was of no inconsiderable influence, giving employment to many of the Basque and Breton fishermen, and being one of the best nurseries for French seamen In later times when the walrus had become entirely extinct, the whale fishery was prosecuted with energy by the Canadians, especially of the District of Gaspe; and *Bouchette*, writing in 1832, says: "The whale fishery is carried on with some success by a few active and enterprising inhabitants, who are almost exclusively employed in this kind of fishery. Four or five schooners, manned each with from eight to twelve able and skilful persons, are occupied in whaling during the summer months. This business yields about 18,000 gallons of oil, which is principally sent to Quebec.

The number of hands employed in reducing the blubber to oil, preparing casks, and other incidental labour, may amount to about 100."

Mr. Frank Austin, a few years ago, read a paper to the Literary and Historical Society of Quebec, on "Some of the Fishes of the St. Lawrence." In this paper, published in the "Transactions" for 1866, it is stated that it gave profitable employment to a good many schooners of from seventy to eighty tons burthen, each manned by eight men. Each schooner carried two boats, twenty feet long, narrow and sharp, with a pink stern. There were two hundred and twenty fathoms of line to each boat, and the proper supply of harpoons and lances. The species caught was that commonly called the *Humpback*, and each on an average produced three tons of oil. The mode of capture was somewhat different from that practised by the whalers who resort to Davis' Straits and Greenland, and it is said that any active man, accustomed to the management of boats, could soon become proficient. When approaching the whale in the boats, the men used *paddles* instead of oars, finding that less noise was made, and that they were thus surer of their prey. It would appear that the whale of the St. Lawrence was even more easily captured than that of Greenland, being if anything more timid and stupid when once harpooned, for sometimes within fifteen minutes after they had been struck, their huge bodies rolled like helpless logs on the water. The oil yielded in 1864 by the Gaspe fishery was of the value of $17,000. We have no means at hand to say what the returns have been since then, but we have reason to fear that like the porpoise fishery, the capture of the whale has not received that attention which it deserved, and that unless new life be imparted, it will altogether cease to be prosecuted as a regular and remunerative branch of national industry. The valuable walrus fishery was lost by ignorance, which led to the complete extinction of the animal in the St. Lawrence. The whale fishery stands a chance of abandonment from apathy.

We were struck on reading Sir Richard Bonnycastle's book, published in 1845, by remarking the number of whales which he saw on his voyage up and down the St. Lawrence, between Gaspe and Kamouraska. Certainly they do not now frequent the St. Lawrence in such abundance.

In the *Canadian Magazine*, vol. 1, page 283, will be found as follows:—"About the middle of September (1823) a large whale found its way up the St. Lawrence till nearly opposite the village of Montreal, where it continued to play itself for several days, not being able, from the shallowness of the water, to navigate its way down the river. Having attracted the notice of the inhabitants, several enterprising individuals put off in boats with some whale-fishing materials in pursuit of it; and at last after nearly a week's exertion it was harpooned by Captain Brush of the Tow steamboat. It was immediately dragged ashore, and exhibited in a booth fitted up for the purpose, for the gratification of the inhabitants. It was found to measure forty-two feet eight inches in length, six feet across the back, and seven feet deep. It has since been conveyed to Three Rivers and Quebec for the same purpose."

Early in August of this year (1871) two whales were seen sporting on the shores of the Gulf, and a Mr. Chabot, and an Englishman, who claim to have invented a gun harpoon (on Capt. Manby's principle), brought their gun to the shore and discharged the harpoon. As the whale instantly disappeared, and as the rope returned to the shore without the harpoon, they were under the impression that the whale had been struck. Some days afterwards, the government steamer 'Druid' being down the North Channel, saw something on the beach at St. Joachim, which they thought at first was a boat, but on nearer approach it was discovered to be a whale. Ropes were attached to the jaw and tail, and the huge animal was towed to the Police Wharf at Quebec, where for a few days it was visited by thousands, but becoming extremely offensive, and the weather being very hot, the Mayor very properly ordered it to be removed. It was sold by auction, and purchased by Mr. Gregory for $260, and was then towed to 'Patrick's Hole,' close to the Church of St. Laurent, where Wolfe's army first landed, and there beached and preparations made for fleching it.

I had not an opportunity of seeing it at Quebec, but through the politeness of Mr. Gregory, who gave me a passage, I had the satisfaction of seeing it at 'Patrick's Hole.' On approaching the beach we saw a number of the inhabitants around it, and on our nearer approach, our nostrils informed us that it was not the *Guard's bouquet* which made all the women have their handkerchiefs at their noses!

I was not prepared to find so huge an animal. It was supposed that the two whales had been a female and its calf, and I was informed that it was the calf that had been found. It turned out to be an aged male, apparently of the species *Balæna Mysticetus.* I measured it as carefully as I could, and satisfied myself that it was *sixty-five* feet in length. The back was black, the belly furrowed, presenting exactly the appearance of a clinker-built boat, and each furrow alternately black and dingy white. The baleens of one side had been lost by being caught on the rocks while it was being hauled ashore, but the other though it had been removed from the jaw, was quite perfect, till the visitors began to appropriate its plates. With the permission of Mr. Gregory I secured a few plates. I never had an opportunity of seeing so large a whale before, though I saw the skeleton of the whale stranded on the beach of Portobello, near Edinburgh, in 1829, and purchased by Dr. Knox. I concluded after a careful examination that it answered fully the description given by De Kay, as follows:

Nat. Ord. Cetacea; Genus Balæna; Species, Balæna mysticetus. Right or common whale. Characteristics, black, occasionally varied with white or yellow Gape of the mouth, arched, with about 600 laminæ of whalebone. Length, forty to sixty feet.

Description: body thickest in the middle, a little behind the fore paws; somewhat furrowed, tapering towards the tail. Head large, somewhat triangular. Opening of the mouth large, with a few scattering hairs on the end of the jaws. Eyes very small, and placed near the corners of the mouth. External jaw exceedingly minute. Spiracles two, oblong, adjacent, slightly largish in front. Palate and sides of upper jaw with two rows of whalebone from ten to thirteen feet long, and generally curved longitudinally, and giving an arched form to the roof of the mouth. Each series consists of three hundred or more laminae of whalebone, the interior edges of which are covered with a hair-like fringe. Swimming paws rounded, somewhat pointed, 7—9 feet long with a width of 4—5 feet, and situated about two feet behind the angle of the mouth. Tail very broad, notched in the centre, curved on the edges, and pointed at the tips. Colour: blackish throughout, occasionally with a small space under the body, and a larger space on the lower jaw, whitish grey or flesh colour. Very old individuals become varied with white, black, or piebald. Weight from 60 to 100 tons. It is presumed to have a gestation of nine months, produces one at a birth, which it suckles for about a year. It exhibits great maternal fondness.

and although at other times remarkably timid. manifests great boldness and even ferocity in defending its young. It is gregarious, and was fo.merly found in every part of the ocean, but has been driven by the fishermen from the coasts of Europe and America. It was early followed by the Americans to the South Pacific. and its capture is now prosecuted in India and Africa.

From the structure of its jaws and the smallness of its throat, it can only feed on the smaller oceanic animals. such as medusæ or sea jellies, shrimps. crabs. and some minute mollusca. Hence it differs most materially from the genus *cachelot* or *sperm whale*, which has got a *wide gullet*, and is capable of swallowing fishes of very considerable size. It feeds abundantly on the mackerel, and a portion of a shark has even been found in its stomach. At first thought it appears very wonderful that so immense an animal as the common whale should have to depend for its subsistence on minute animals, but the wonder ceases when we examine the waters to which they resort, sometimes in very large herds. De Kay says that he has seen off the coast of Brazil hundreds of miles where the mollusca are so numerous as to discolour the water, giving the appearance of wheat scattered over a reddish sandbank; and Scoresby has estimated that in some parts of the Arctic seas twenty-three quadrillions of such animalculæ are distributed over a surface of two square miles. There is very great difference in the accounts given of the size of the two whales which I have mentioned. Some writers give the length of the sperm whale at from 70 to 80 feet. and of the common whale at from 80 to 100 feet. It is quite possible that such may have been occasionally found, but they are to be viewed as exceptional. for Capt. Scoresby. the very highest authority. and who had personally engaged in the capture of 322 whales. says that not one of them exceeded 60 feet.

I may mention how apt people are to be deceived as to the size of objects. and that no reliance can be placed on anything but actual measurement. A gentleman of Quebec, noted for his general intelligence and the interest he takes in all these subjects, met me in the library of the Literary and Historical Society, on his return from Cacouna. He said: "So you have had a great visitor at Quebec during my absence, but not so great as one that visited the St. Lawrence nearly fifty years ago, and was captured at Montreal. I have seen that the whale brought here last week was *only* 65 feet long; I should say that the other was at least a third larger." He was both surprised and amused when I read to him the account from the *Canadian Magazine* which I have already given. The obvious difference between the sperm whale and the common is, that the *sperm* has a dorsal fin, and when the water is smooth the projection or hump is seen two or three feet above the surface. Its throat is also large, so that it would have no difficulty in swallowing a man. The *Mysticetus* or *common* whale, on the other hand, has neither dorsal fin or hump, and its gullet, as has been already said, is exceedingly small, not more than 1½ inches in diameter.

According to my admeasurement, corroborated by Mr. Gregory, as the whale lay on the beach at 'Patrick's Hole,' he was *sixty-five* feet long, the fluke of his tail twelve feet, his jaw fifteen feet. From the condition he was in, I could not measure his breadth. When the skeleton was subsequently brought to the Police Wharf I had an opportunity of verifying, at any rate to my own satisfaction, the correctness of my first measure. The jaw bone, as it lay on the wharf stripped of all covering, measured exactly *fourteen feet six inches.* I felt justified from this fact in considering that my other measurements had been equally correct. Taking his length, then, at sixty-five feet, he was twenty-three feet longer than the one killed at Montreal in 1823, and five feet larger than the extreme length given by De Kay to the *Mysticetus.* A whale of such a size under ordinary circumstances should have yielded about sixty barrels of oil; this one only gave *six*, which is endeavoured to be accounted for by the supposition that he was aged, diseased, and worn out. May it not have been possible that having strayed from his feeding grounds, and having wandered up the St. Lawrence, where I believe he would have to depend for his subsistence on shrimps and medusae alone, he may have died from simple inanition. At any rate there was no mark of violence on his body, and Mr. Chabot's brother, who was sent to claim the whale as killed by his harpoon, failed to trace any wound or to find the harpoon, as he had expected. The skeleton has been well cleaned, and is very nearly complete, though the thin bones of the skull have been considerably fractured. It is still in the possession of Mr. Gregory, who has been more desirous of promoting science than enriching himself by the preservation of this splendid skeleton. We trust that some of our scientific bodies may make an effort to secure it, so that it may not be permitted to be sent out of the Province.

NOTES ON THE PRIMORDIAL ROCKS IN THE VICINITY OF TROY, N. Y.

By S. W. Ford.

(*From the American Journal of Science and Arts, Vol. II., July, 1871.*)

In view of the prevailing uncertainty respecting the age of the rocks of that portion of the Taconic series of Professc. Emmons lying east of the Hudson river, I was led several years ago to undertake the investigation of some of these rocks in my own neighbourhood, though I had but few hopes of learning anything essentially new about them. It soon became apparent that much valuable information might be obtained from them; and from certain facts which early came under my observation I was induced to continue their study. I propose here to notice briefly some of the more noteworthy results thus far obtained.

The rocks immediately east of the Hudson at Troy are fine, black, glazed shales, with occasional sandy layers, and have usually been regarded as belonging to the Hudson River formation. They have been greatly crushed, but their general dip is evidently eastward, and at a high angle. They extend eastward about half a mile, and form a hill of considerable magnitude within the city limits. Following the course of this hill northward, we find them frequently well exposed in railway cuttings, and before reaching Lansingburgh, which is three miles distant, in a bold elevation several hundred feet in height.

The only fossils which these shales have afforded, are the obscure form described under the name of *Discophyllum peltatum* (Pal. N. Y., vol. i, 277, plate lxxv fig. 3), and two or three species of graptolites, the latter having been but recently obtained. The graptolites resemble closely certain well-known Hudson river forms, but whether certainly identical I am at present unable to state. If truly Hudson river shales, then the absence of any other fossils in these rocks, except those above mentioned, appears not a little remarkable.

Upon the east, after an interval of concealment varying somewhat in different localities, these shales are followed by the widely different rocks of the "Taconic" series, likewise dipping eastward, and apparently at about the same angle. The best exposures of these rocks in this vicinity occur opposite the central portion of the city, where they are brought to view in a number of abrupt, quickly concealed ridges. These ridges trend northerly and southerly, and appear to be all constructed upon the same pattern, having on the west a steep, on the east a more gradual slope. Only the western faces are naturally exposed. This uniformity of structure is very striking, and there are reasons for believing that it has resulted largely from successive short, sharp folds in the strata, of which we have a fine example in the rocks east of Lansingburgh; but as nearly the whole district is covered with a thick sheet of drift, and the rocks bear evidence of extensive faulting, much further study will be necessary before it will be fully understood.

These ridges generally consist for the most part of coarse red and yellow weathering slates and shales, with occasional thin-bedded sandstones; but the most of them are supposed, and four of them are known, to hold subordinate limestone deposits. Of these deposits the two westernmost individually consist of a few courses of thick-bedded limestone, and of irregular, sometimes lenticular, sparry and frequently pebbly masses, varying from one to several hundred pounds in weight, imbedded in a coarse, dirty-looking arenaceous matrix: while the others form tolerably compact, even-bedded limestones, with an abundance of scattered black nodules, from twenty-five to thirty feet in thickness.

So far as investigated, these limestones have been found to be highly fossiliferous, though the fossils are usually in a very fragmentary condition. From two of them—one of the conglomerates and one of the even-bedded masses—the writer has made frequent collections during the last three years. With a single exception the same species occur in both. Up to the present time they have yielded eighteen species, which are distributed as follows:

Protozoa (*Archeocyathus*)	1	species.
Brachiopoda	7	"
Lamellibranchiata	1	"
Gasteropoda	1	"
Pteropoda (*Hyolithes*)	2	"
Annelida (*Salterella*)	1	"
Crustacea	5	"
Total,	18	"

Of these, six—*Obolella* (*Avicula ?*) *desquamata* (Hall), *O.* (*Orbicula ?*) *crassa* (H.), *O.* (*Orbicula*) *cælata* (H.), *Metoptoma rugosa* (H.), *Theca triangularis* (H.), and *Agnostus lobatus* (H.)—were figured and described in the first volume of the Palæontology of New York in 1847, from this locality; and two—*Conocephalites* (*Atops*) *trilineatus* (Emm.) and *Olenellus* (*Elliptocephalus*) *asaphoides* (E.),* from Greenwich, Washington county. All the rest are new or undescribed. †

Desiring further information in regard to certain of these new species, I several months since wrote Mr. E. Billings, Palæontologist of the Geological Survey of Canada, at the same time giving him a list of the species in my possession from this quarter. In reply Mr. B. informed me that he was just engaged upon a collection of new fossils from the Lower Potsdam formation below Quebec, which he strongly suspected to be identical with my own: and on comparison it was found that fifteen out of the eighteen species from Troy were held by us in common, and shown to be perfectly identical. Such an unlooked-for result of course surprised us greatly. That the Lower Potsdam formation below Quebec, and the western portion of the Taconic series near Troy are of the same age, there seems now but little room for doubt.

Two very characteristic fossils of this formation are the opercula of two species of *Hyolithes*, upon which I communicated a

* These two species, to which great interest has long attached, were, until quite recently, supposed to be confined to an exposure of the "Black Slate" of Dr. Emmons, about two miles north of Bald Mountain, N.Y., where they were first discovered by Dr. Asa Fitch of Salem, N. Y., so long ago as the year 1844. Owing to the imperfection of the specimens furnished by that locality, however, their true relations have long been considered doubtful among geologists. But the state of preservation in which they are now found in limestone leaves no longer a doubt as to their true affinities. Good specimens of these species are comparatively rare in the limestones at Troy, though fragments of large individuals of the *Olenellus asaphoides* are very common. I am indebted to Mr. Billings for having pointed out to me the specific identity of the Troy specimens with the *Atops* and *Elliptocephalus*—an acknowledgment which was unintentionally omitted in this paper as originally published. As it is, however, about to be republished in the "*Naturalist and Geologist*," I gladly embrace this opportunity to set the matter right.

† Unless one of them should prove identical with the species of *Cypricardia* figured by Emmons (American Geology, p. 113, plate 1, fig. 1.)

note in the preceding number of this Journal. One of them was there described as a "minute, circular species, with four pairs of lateral muscular impressions and two smaller dorsal, all radiating from a point near one side;" the other as "larger, and like a *Discina* on the outside." The former occurs quite abundantly in the Troy limestones, and is a very beautiful little object. It varies in size from a mere point to a diameter of three lines. Perfect specimens have a rich, polished appearance. The other occurs more rarely. As might naturally be expected, these rocks contain immense numbers of *Hyolithes*. Indeed, large portions of the limestone are often almost wholly composed of them.

Without doubt this formation in New York will yet afford many new species.* The even-bedded limestone east of Troy, to which especial attention has been given, as well as portions of the conglomerates, are literally loaded with fossils, and promise richly to repay investigation for a long time to come. Their associated slates, shales and sandstones have as yet afforded no fossils. Near Lansingburgh, however, where what is at present regarded as a lower member of the formation, consisting of heavy and thin-bedded gray sandstones with interstratified black slates, is exposed, a few obscure Fucoids have been found, but these rocks have been but imperfectly investigated. Neither the thickness nor precise eastern limit of this formation has yet been ascertained.

Troy, N. Y., May 24, 1871.

* These rocks have hitherto been referred, though with some doubt, to the Calciferous portion of the Quebec Group; but all modern investigations in our older strata have steadily pointed to their higher antiquity; and it is simply justice to state that, by several geologists besides those who have adopted Prof. Emmons' views of their age, this has long been suspected.

ON SOME NEW SPECIES OF PALÆOZOIC FOSSILS.

By E. Billings, F.G.S.

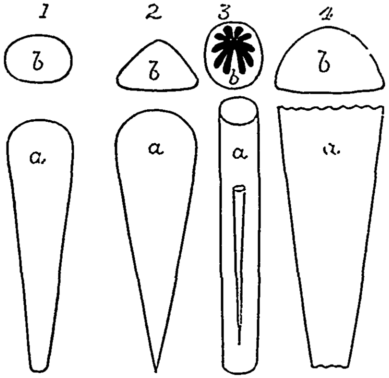

Fig. 1. *Hyolithes communis.* 2. *H. Americanus.* 3. *H. ? micans.* 4. *H. princeps.* In these diagrams *a* represents the rate of tapering of the shell on the ventral side; *b*, the transverse section (except in 3 *b*, which is the inner surface of an operculum enlarged two diameters). The small figure in 3 *a* represents the apical portion of a specimen. N.B.—All these species vary slightly in the rate of tapering.

Genus Hyolithes, *Eichwald.*

In the following description of new species of *Hyolithes*, I shall call the side of the fossil which is most flattened, or from which there is a projection in front of the aperture, "the ventral side." Directly opposite is the "dorsum." The lateral walls, whether consisting of two sloping planes, as in fig. 2, or rounded as in the other figures, I shall designate simply "the sides." The "width" of the aperture is the greatest distance between the two most projecting points of the sides. This is sometimes close to the ventral side as in fig. 2. The "depth" is the distance between the median line of the ventral side and the dorsum, and is at right angles to the width. That part of the ventral side which projects beyond the aperture is the "lower lip." The "ventral limb" of the operculum is that side which is in contact with the lower lip, when the operculum is in place, in the aperture. The "dorsal limb" is the opposite side of the operculum, in contact with the dorsum. In some of the opercula there is a point around which the surface markings are arranged concentrically; this is the "*nucleus*."

The following species occur in the pebbles and boulders of a conglomerate which constitutes an important formation on the south shore of the St. Lawrence below Quebec. The age of the rock in which these pebbles are found, is not yet certainly determined, but it is, at all events, near that of the Potsdam.

H. COMMUNIS.—This species attains a length of about eighteen lines, although the majority of the specimens are from ten to fifteen lines in length. The ventral side is flat (or only slightly convex) for about two-thirds the width, and then rounded up to the sides. The latter are uniformly convex. The dorsum, although depressed convex, is never distinctly flattened, as is the ventral side. The lower lip projects forward for a distance equal to about one-fourth or one-third the depth of the shell. In a specimen whose width is three lines the depth is two lines and a-half.

The operculum is nearly circular, gently but irregularly convex, externally and concave within. The ventral limb is seen on the outside as an obscurely triangular, slightly elevated space, the apex of the triangle being situated nearly in the centre of the operculum. The base of the triangle forms the ventral margin. This limb occupies about one-third of the whole superficies of the external surface. The remainder, constituting the dorsal limb, is nearly flat, slightly elevated from the margin towards the centre. On each side of the apex of the ventral limb there is a slight depression, running from the nucleus out to the edge. On the inside there is an obscure ridge, corresponding to each one of the external depressions. It is most prominent where it reaches the edge. These two ridges meet at the centre, and divide the whole of the inner surface of the operculum into two nearly equal portions.

The surface of the operculum is concentrically striated. The shell itself in some of the specimens is covered with fine longitudinal *striæ*, from five to ten in the width of a line. The shell varies in thickness in different individuals. In some it is thin and composed of a single layer, but in others it is much thickened by concentric laminæ, and thus approaches the structure of a *Salterella*. There are also fine engirdling striæ, and sometimes obscure sub-imbricating rings of growth.

This species has been found at Bic and St. Simon.

Fig. 1, *b*, representing the transverse section, is not so distinctly flattened on the ventral side as it is in most specimens.

Collected by T. C. Weston.

H. AMERICANUS.—Length from twelve to eighteen lines, tapering at the rate of about four lines to the inch. Section triangular, the three sides flat, slightly convex or slightly concave, the dorsal and lateral edges either quite sharp or acutely rounded. Lower lip rounded, projecting about two lines in full-grown individuals. Surface finely striated. the striæ curving forwards on the ventral sides, and passing upwards on the sides at nearly a right angle, curve slightly backwards on the dorsum. In a specimen eighteen lines in length, the width of the aperture is about six lines and the depth about four, the proportions being slightly variable.

The operculum has a very well-defined conical ventral limb, the apex of which is situated above the centre, or nearer the dorsal than the ventral side. The dorsal limb forms a flat margin, and is so situated that when the operculum is in place, the plane of this flat border must be nearly at right angles to the longitudinal axis of the shell. In an operculum six lines wide, the height of the lower limb to the apex of the cone, is two and a-half lines, and the width of the flat border, which constitutes the dorsal limb, about one line.

This species occurs at Bic and St. Simon; also at Troy, N.Y., where it has been found abundantly by Mr. S. W. Ford of that city. It is *Theca triangularis* of Hall, Pal. N.Y., vol. I., p. 213, 1847. As that name was preoccupied by a species previously described by Col. Portlock, Geol. Rep. on Londonderry, p. 375, pl. 28 A, fig. 3*a*, 3*b*, 3*c*, 1843, it must be changed. It is a very abundant species, and varies a good deal.

The Canadian specimens were collected by T. C. Weston.

H. MICANS.—This is a long slender cylindrical species, with a nearly circular section. The rate of tapering is so small, that it amounts to scarcely half a line in length of eighteen lines, where the width of the tube is from one to two lines. The largest specimen collected is two and a-half lines wide at the larger extremity, and if perfect would be four or five inches in length.

The operculum does not show distinctly a division into a dorsal and ventral limb. It is of an ovate form, depth somewhat greater than the width, the nucleus about one-third the depth from the dorsal margin. Externally it is gently concave in the ventral two-thirds of the surface; a space around the nucleus is convex, and finely striated concentrically. On the inner surface there is a small pit at the dorsal third of the depth, indicating the position of the nucleus. From this point radiate ten elongate ovate scars, arranged in the form of a star, the rays towards the ventral side being the longest. None of these scars quite reach the margin.

The shell and operculum are thin and of a finely lamellar structure, smooth and shining.

Occurs at Bic and St. Simon; also at Troy, N.Y.

Collectors, T. C. Weston and S. W. Ford.

Sometimes numerous small specimens from half a line to three lines in length are found with the operculum on the same slab.

This shell appears to me at present to constitute a new genus, differing from the majority of the species of *Hyolithes* in its circular section, the operculum not divided into dorsal and ventral lines, and in the remarkable system of muscular impressions on the interior. Barrande has figured an operculum of the same type, differing from this in having only three instead of five pairs of impressions. They are, however, arranged on the same plan in both the Canadian and Bohemian species.* It is possible that our species may be a *Salterella*.

H. PRINCEPS.—Shell large, sometimes attaining a length of three or four inches, tapering at the rate of about three lines to the inch. In perfectly symmetrical specimens, the transverse section is nearly a semicircle, the ventral side being almost flat, usually with a slight convexity, and the sides and the dorsum uniformly rounded. In many of the individuals, however, one side is more abruptly rounded than the other, in consequence of which the median line of the dorsum is not directly over that of the ventral side, and the specimen seems distorted. This is not the result of pressure, but is the original form of the shell. Sometimes, also, there is a rounded groove along the median line of the dorsum. The latter is somewhat more narrowly rounded than the sides. Lower lip uniformly convex, and projecting about three lines in a large specimen. Surface with fine striæ and small sub-imbricating ridges of growth. These curve forwards on the ventral side. In passing upwards on the sides, they

* Système Silurian, &c., vol. III., pl. 9, fig 16 H, and fig. 17.

at first slope backwards from the ventral edge, and then turn upwards and pass over the dorsum at a right angle to the length.

When the width of the aperture is seven lines, the depth is about five. The operculum has not been identified.

Collected by T. C. Weston at Bic and St. Simon.

Genus OBOLELLA, *Billings*.

5 6 7

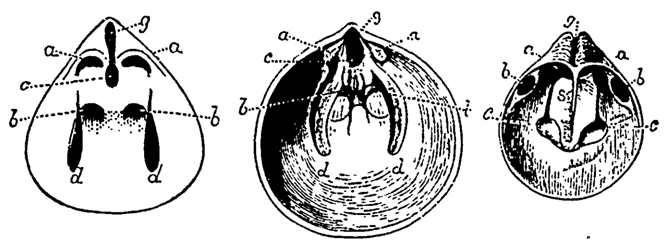

FIG. 5. Interior of the ventral valve of *O. gemma*, enlarged about five diameters. *aa*, the two small scars at the hinge; *bb*, the two central scars; *c*, the small pit near the hinge; *dd*, the two principal muscular scars; *g*, the groove in the area.

6. Interior of the ventral valve of *O. desquamata*, Hall,* enlarged $2\frac{1}{2}$ diameters.

7. Interior of the ventral valve of *Obolus Apollinis*, Eichwald, copied from Davidson's "Introduction to the study of the fossil Brachiopoda."

GENERIC CHARACTERS.—Shell unarticulated, ovate or sub-orbicular, lenticular, smooth, concentrically or radiately striated, sometimes reticulated by both radiate and concentric striæ. Ventral valve with a solid beak and a small more or less distinctly grooved area. In the interior of the ventral valve there are two elongated sub-linear or petaloid muscular impressions, which extend from near the hinge line forward, sometimes to points in front of the mid-length of the shell. These are either straight or curved, parallel with each other or diverging towards the front. Between these, about the middle of the shell, is a pair of small impressions, and close to the hinge line a third pair, likewise small, and often indistinct. There is also, at least in some species, a small pit near the hinge line, into which the groove of the area seems to terminate. In the dorsal valve there are six impressions

* Engraved from a figure kindly drawn for me by Thos. Davidson, Esq., F.R.S., of Brighton, England. The specimen is from the original locality of the species, Troy, N.Y. Collected by T. C. Weston

corresponding to those of the ventral valve, and sometimes an obscure rounded ridge along the median line.

If we compare the interior of the ventral valve of an *Obolella* with that of *Obolus Apollinis*, we see that there are six muscular impressions in each, but not arranged in the same manner. The two small scars *aa* at the hinge line are most probably the same in both genera. The two lateral scars *bb* of *Obolus* have no homologue in *Obolella*, unless they be represented by the two large ones *dd*. Should this be the case, however, the great difference in their position, would no doubt be of generic value. I think it more probable that the large scars *dd* of *Obolella* reprepresent the central pair *cc* of *Obolus*. Again, Eichwald says that in the interior of the ventral valve of *O. Apollonis* there is a longitudinal septum (shown in the above fig. 7 at *s*), which separates the two adductors *cc*, and extends to the cardinal groove (I suppose he means the groove *g* on the area).* No such septum occurs in any species of *Obolella*. I have not seen any description of the dorsal valve of the *O. Appollinis* sufficiently perfect to afford a means of comparison with that of *Obolella*, but the differences in the ventral valve alone are so great that the two genera can scarcely be identical. They are, however, closely related, and occur in nearly the same geological horizon.

In the rocks below Quebec and at the Straits of Belle Isle, we find the following species of *Obolella* :—

1. *O. desquamata*, Hall, = *Avicula ? desquamata*, Pal. N.Y., vol. 1, p. 292, pl. 80, fig. 2. Occurs at Troy, N. Y.

2. *O. crassa*, Hall = *Orbicula ? crassa*, op. cit. p. 290, pl. 79, fig. 8. Occurs at Troy.

3. *O. cœlata*, Hall, = *Orbicula cœlata*, op. cit. p. 290, pl. 79, fig. 9. Occurs at Troy.

4. *O. gemma*, n. sp.

5. *O. circe*, n. sp.

6. *O. chromatica*, Billings, has been found as yet only at the Straits of Belle Isle.

The following are new species:

O. GEMMA.—Shell very small, about two or three lines in length, ovate, both valves moderately convex and nearly smooth.

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* Speaking of the adductors, he says: "Une crête longitudinal occupe le milieu des dernières impressions et arrive jusqu'au sillon cardinal." (Lethea Rossica, vol. 1, p. 925.)

Ventral valve ovate, the anterior margin broadly rounded, with sometimes a portion in the middle nearly straight; greatest width at about one-third the length from the front, thence tapering with gently convex or nearly straight sides to the beak, which is acutely rounded. The area is about one-fifth or one-sixth the whole length of the shell, with a comparatively deep groove, which extends to the apex of the beak. *The dorsal valve is nearly circular*, obscurely angular at the beak, and rather more broadly rounded at the front margin than at the sides.

In the interior of the ventral valve there are two small muscular impressions of a lunate form, close to the cardinal margin, one on each side of the median line. A second pair consists of two elongate sub-linear scars, which extend from the posterior third of the length of the shell to points situated at about one-fourth the length from the front margin. These scars are nearly straight, parallel or slightly diverging forwards, and divide the shell longitudinally into three nearly equal portions. Between them, about the middle of the shell, are two other small obscurely defined impressions. There is also a small pit close to the hinge line and in the median line of the shell. In the interior of the dorsal valve there is an obscure rounded ridge which runs from the beak along the median line almost to the front margin. Close to the hinge line there is a pair of small scars, one on each side of the ridge. The other impressions in this valve have not been made out.

The surface of both valves is in general nearly smooth, but when well preserved shows some obscure concentric striæ.

This species is closely allied to *O. chromatica*, the species on which the genus was founded, only differing from it, so far as the external characters are concerned, in being much smaller, and the beak of the ventral valve more extended.

Occurs at Bic and St. Simon. Collected by T. C. Weston.

O. Circe.—Ovate, front and sides uniformly rounded, posterior extremity more narrowly rounded than the front, length and width about equal, greatest width at the mid-length, rather strongly and uniformly convex, surface nearly smooth, but with fine concentric striæ. Length seven lines, width a little less. The rostral portion of the shell is much thickened for about one-fifth the length, and in this part there is a deep and wide groove. In front of the thickened portion the muscular impressions are indistinctly seen, but appear to be formed on the same plan as those of the ventral valve of the genus.

The above description is drawn up on one exterior, and several interiors of the same valve, apparently the ventral valve. The exterior is very like that of *O. desquamata*, and is of the same size, but the interior shows it to be an entirely distinct species.

Length of the largest specimen seen, seven lines; width about the same, or slightly less.

Occurs at Trois Pistoles. Collected by T. C. Weston.

PLATYCERAS PRIMÆVUM.—Shell minute, consisting of about two whorls, which as seen from above are ventricose, but most narrowly rounded at the suture; the inner whorl scarcely elevated above the outer. The under side is not seen in the specimen. Diameter, measured from the outer lip across to the opposite side, one line; width of last whorl at the aperture, about one-third of a line.

Collected at Bic by T. C. Weston.

(Proposed new genus of Brachiopoda.)

Genus MONOMERELLA, N. G.

GENERIC CHARACTERS.—Shell unarticulated, ovate or orbicular; ventral valve with a large area and with muscular impressions like those of *Trimerella*. Dorsal valve with muscular impressions in the central and posterior portion of the shell, nearly like those of *Obolus*. In the ventral valve there is only a single septum, which extends from the cardinal line a greater or less distance forwards. There are two cavities in the shell beneath the area. In the dorsal valve there are no cavities in the shell. The main difference between this genus and *Trimerella* are, thus, as follows:—

Trimerella.—Cavities in both valves.

Monomerella.—Cavities in the ventral valve but none in the dorsal.

The above description is intended to be merely introductory. As Mr. Davidson will soon fully describe and illustrate the genus from both Canadian and Swedish specimens, no more need be said about it here.

This genus was discovered in the spring of 1871, at Hespelar, Ontario, in the Guelph limestone, by T. C. Weston. Before venturing to describe it, I sent a specimen to Mr. Davidson. and on returning it he stated that he considered it to be a new genus, "very closely allied to *Trimerella*." Lately I received a letter from him in which he states that he has obtained the same genus from Wisby, Island of Gothland, and he requested me to name it, as he was about to publish the Swedish species.

We have two distinct species, both occurring in the Guelph limestone. This formation I consider to be about the age of the Aymestry limestone of the English geologists. I shall characterize our species briefly as follows. Full descriptions and figures will be given hereafter.

M. PRISCA.—Ventral valve ovate, greatest width at about the anterior third of the length, thence tapering with gently convex sides to the narrowly rounded beak; front margin broadly rounded; septum about one third the length of the shell. Dorsal valve about one fourth shorter than the ventral, and more broadly rounded at the anterior extremity. On a side view the outline of the ventral valve would be, so far as we can judge from a cast of the interior, somewhat straight, or only gently arched from the beak to the front margin. The dorsal valve, on the other hand, is rather strongly convex, most prominent in the anterior half. It is evident that the general cavity of the shell of the dorsal valve extends a short distance under the area.

Length of ventral valve, eighteen lines; greatest width, thirteen or fourteen lines; length of dorsal valve about fourteen lines. There are some fragments in the collection which indicate a larger size.

Occurs in the Guelph limestone at Hespelar, Ontario. Collected by T. C. Weston.

M. ORBICULARIS.—Broadly ovate, nearly circular, lenticular, both valves moderately convex; septum about one-third the length. The casts seem to show that a thin plate extends forwards a short distance from the cardinal edge, supported by the septum. The length and width appear to be about twelve or fifteen lines.

Occurs with *M. prisca*. T. C. Weston, collector.

Both *Trimerella* and *Monomerella* are sub-genera of *Obolus*.

There is, besides the above, a third group which differs from the other two in having no cavitias in either valve. It includes the species I have called *Obolus Canadensis* and *O. Galtensis*. For this group I would propose the name OBOLELLINA. It differs from *Obolus Apollinis* in the form of the area of the ventral valve, and in having a small pair of muscular impressions in the dorsal valve, in front of the large central pair. In all three of these sub-genera, there are species which have the large muscular impressions of the ventral valve obliquely striated or grooved. This seems to show that the muscles were not single but composed of several bands. The three genera pass gradually into each other, and yet I think some sort of a subdivision is required. It seems almost absurd to place such shells as *T. grandis* and *O. Canadensis* in the same generic group.

NATURAL HISTORY SOCIETY.

FIELD DAY AT MONTARVILLE.

The fourth of these social gatherings took place on Saturday, June 3rd, the place selected being Montarville, or as it is commonly called, Boucherville Mountain. The weather being propitious, about one hundred persons assembled at the Bonaventure Street Station, at 9 a.m., from whence they were conveyed by a special train to Boucherville Station, which was reached about 10.15. From this point vehicles of various descriptions conveyed the excursionists to the grove near the lake on the grounds of Madame Bruneau, the lady of the manor. When all were assembled together, the President, Principal Dawson, stated that parties would be formed to examine, respectively, the geological features, the zoology, and the botany of the mountain. Principal Dawson, Dr. T. Sterry Hunt, and Mr. A. R. C. Selwyn, undertook the direction of the geological party; Mr. Whiteaves was deputed to lead the zoological expedition; but as no botanist was forthcoming to explain the points of interest in the various plants that might be met with, Mr. S. J. Lyman volunteered to act as guide to those who wished to ascend the mountain. Each party took a different direction, with the understanding that all were to meet again at the lake at 2 p.m. The results obtained by the geologists will be found described in Dr. Hunt's and Principal Dawson's remarks farther on. It may be mentioned, however, that on the way Principal Dawson picked up two pieces of rock of Hudson River group age, one containing a portion of a crinoidal column, the other specimens of *Orthis testudinaria* and *Leptæna sericea*. The followers of Mr. Lyman failed to reach the summit of the hill opposite the lake, and on their return many could sympathise with the plaint of Beattie's Minstrel,

"Ah who can tell *how hard it is to climb!*"

The zoologists formed a small but compact body, and looked as if they meant business. A large number of chipmunks were seen during the day, and several of their curious underground burrows were met with. The birds noticed were the black-billed cuckoo, *Coccygus erythrophthalmus;* the gold-winged woodpecker, *Colaptes auratus;* the ruby-throated humming-bird, *Trochilus colubris;* the tyrant flycatcher, *Tyrannus Carolinensis;* the golden-crowned thrush, *Seiurus aurocapillus;* the yellow-rumped and the black-throated green warblers, *Dendroica coronata* and *virens;* the red-eyed and the warbling vireo, *Vireo olivaceus* and *gilvus;* the cat-bird, *Mimus Carolinensis;* the swamp sparrow, *Melospiza palustris;* and the blue jay, *Cyanura cristata*. We are indebted to Mr. Passmore for this list of birds observed. No reptiles of special interest were observed; in the lake, specimens of the American perch, the sun-fish, cat-fish, roach-dace, and striped minnow, were taken. Among the butterflies captured were *Papilio Turnus* and *asterias*, *Colias Chrysostheme*, a *Lycæna*, *Vanessa Antiopa*, a skipper, probably *Hesperia hobomuck*, a *Hipparchia*, and the now formidable cabbage butterfly, *Pieris rapæ*, a species closely allied to those "large white butterflies" spoken of by Mrs. Browning in Aurora Leigh,

"Which look as if the May flower had caught life,
And palpitated forth upon the wind."

The following is a list of the beetles found during the day:—

Cicindela patruelis, Dejean.	*Dicerca divaricata*, Say.
Pterostichus mutus, Say.	*Melanotus laticollis*.
Chlænius sericeus, Forster.	*Dendroides concolor*.

Lachnosterna fusca, Frolich.

Seven species of land shells were collected, the rarest of which was *Helix multidentata*, Binney. It will be observed that no specimens of much rarity in any branch of Natural History were collected, the most common plant noticed during the day was the yellow lady's slipper.

About two p.m. the scattered parties re-assembled in the grove near Madame Bruneau's residence; and an hour was allowed for rest and refreshment. The various collections of plants were then examined, and the following prizes were awarded:—

For the best *named* collection in botany or zoology. No competitor.

For the largest number of species of flowering plants, unnamed. 1. Master Rankin Dawson, 21 species. 2. Miss Lovell, 13 species.

Mr. WHITEAVES gave a short verbal account of the objects of interest met with in the department of zoology, after which

The President of the Society, Principal DAWSON, F.R.S., came forward, and after a few remarks introduced Dr. T. STERRY HUNT, who proceeded to give a brief notice of the Mountain of Montarville and its geological history. This mountain, he said, stands in the north-east part of the Seigniory of Montarville, and being near the Seigniory and Parish of Boucherville is sometimes known as Boucherville Mountain. The family Bruneau, the present lords of the manor, to whose kind courtesy the Natural History Society was indebted for the privilege of holding its meeting on the domain, have however caused the Parish Church near by to be dedicated to St. Bruno, and hence the mountain or rather the group of hills around was now frequently spoken of as the Mountain of St. Bruno. In proceeding to speak of its geological history, Dr. Hunt remarked that Montarville has so much in common with the adjacent mountain of Belœil, which the Natural History Society had visited two years since, that much of what he then said would be equally applicable to the present occasion. He next proceeded to describe the two great classes of rocks into which most of the solid portion of the earth's crust may be divided, viz: stratified and erupted rocks; the formed being chiefly layers of sand, clay and carbonate of lime deposited as sediments from water, and subsequently hardened into rocks, somewhat as mortar and cement harden. These sediments, many thousand feet in thickness, accumulated during ages in the subsiding bottom of the ocean, and enclose the fossil remains of the various species of animals and plants which then lived. The erupted or non-stratified rocks are found breaking through the stratified rocks of various periods from the oldest to the most recent. They are composed of crystalline minerals, chiefly different species of feld-spar, mica, hornblende, pyroxene or augite, olivine and quartz. The nature of these various minerals, and of the different rocks which are made of mixtures of two or more of them was then explained, showing the difference between granite, trachyte, syenite, dolerite, diorite, and basalt, all of which are erupted rocks. Many of these from their peculiar jointed structure, occasionally show at their outcrops a step-like arrangement, which has procured for them the common name of trap, from a Swedish word signifying a stair. It is applied indiscriminately to almost all ancient erupted rocks, and has therefore little scientific value. Such rocks are closely related to the lavas of modern volcanos, which when solidified under pressure resemble trachyte, dolerite, basalt, etc. As the source of lavas is many thousand feet beneath the surface, the lower parts of the lava columns must always be thus solidified. Dr. Hunt then proceeded to explain that Montarville was the site of an ancient and extinct volcano belonging to palæozoic times, and that the crystalline rocks there seen were the basal portion of the former eruption of lava. The whole valley around, being the northward extension of the valley of Lake Champlain to the St. Lawrence, had in palæozoic times been filled with soft stratified rocks to a height much above the present summits of Mount Royal and Belœil, and presented a plateau, above which probably active volcanos marked the sites of the mountain just named, and of Rougemont, Yamaska, Monnoir, and Montarville. In some cases, however, there is reason to suspect that there may be masses of erupted rock which never came to the surface, and hence did not appear as active volcanos in subsequent ages. The eroding action of the elements, air and water, cut away the soft sedimentary rocks. and swept away the volcanic peaks, leaving little more than the hard cores of crystalline rock below, which were better able to resist the eroding agencies. He called attention to the fact that the stratified sediments near their contact with the erupted rocks had been much hardened, and still remained in place, preserving, however, their fine grain, and showing fossil shells within a few inches of the line of contact with the crystalline dolerite, near the spot where the company stood. The slow disintegrating action of the air, water and frost was shown in the crumbling of this crystalline rock beneath their feet, a process to which the oxydation of iron pyrites which had given rise to white crusts of soluble sulphates of iron and magnesia, contributed. The supposed source of erupted rocks was briefly alluded to as probably the fusion of deeply-buried stratified rocks, and the fact was noticed that not only different volcanos in the same region, but the same volcanos at different periods, discharge lava of very unlike characters. This fact was then compared with the different characters of the various mountains of erupted rock around us. Thus Belœil was in great part, at least, a micaceous diorite; Monnoir a diorite of another type; Yamaska presents two kinds of erupted rock, unlike either of these. Montarville, though in a great part a dolerite consisting of a coarse grained mixture of black pyroxene with white feldspar, shows in the hill rising from the lake just behind the manor-house, a rock of very different type, consisting of a coarsely crystalline mixture of dark green pyroxene with a considerable amount of amber-brown olivine or chrysolite, which in other parts of the mass is associated with a white feldspar and with black pyroxene. The various rocks of these different mountains have been described in detail by the speaker in "The Geology of Canada," He concluded by saying that the stratified rocks around the mountain have a history not less beautiful and curious than that of erupted rocks, and would now be described by one far more competent to the task than himself—Principal Dawson.

Dr. Hunt concluded his remarks amid much applause.

Principal Dawson then said that ancient though the volcanos referred to by the last speaker were, there were still more ancient facts represented by some of the specimens which had been collected. The fossil shells and crinoids represented by specimens which he exhibited, showed the evidences of an ancient Lower Silurian sea, which once overspread all the plain of Canada, and in which flourished multitudes of curious creatures now extinct. He particularly referred to the Crinoids or stone lilies, some curious specimens of which had been collected. He then thanked the company for their presence, referred to the fact that the excursion had been honored by the presence of the Director of the Geological Survey, and by many of the *elite* of the citizens of Montreal, and to the kindness of the lady of the manor, who had so liberally given them the use of her grounds; and cordially invited all who might have been interested in the day's works to connect themselves with the Society. The President was warmly applauded.

A little after 4 o'clock the conveyances were again in requisition, and the party returned to Boucherville Station, and arrived at Montreal about 7 p.m.

J. F. W.

GEOLOGY AND MINERALOGY.

ON THE CANADIAN TRILOBITE WITH LEGS.—The following is an extract from the Report of the Committee of the British Association on the Structure and Classification of the Fossil Crustacea, at the Edinburgh meeting, August, 1871. The committee consists of Henry Woodward, F.G.S., F.Z.S., Dr. Duncan, F.R.S., and R. Etheridge, F.R.S. The report was drawn up by Mr. Woodward.

"Since noticing the occurrence of an Isopod (*Palæga Carteri*), from the Kentish, Cambridge, and Bedford Chalk, Dr. Ferd. Roemer, of Breslau, has forwarded me the cast of a specimen of the same Crustacean from the Chalk of Upper Silesia. This, together with the example from the Miocene of Turin, gives a very wide geographical as well as chronological range to this genus.

A still more remarkable extension of the Isopoda in time is caused by the discovery of the form which I have named *Præarcturus* in the Devonian of Herefordshire, apparently the remains of a gigantic Isopod resembling the modern *Arcturus Baffinsii.*

I have also described from the Lower Ludlow a form which I have referred with some doubt to the Amphipoda, under the generic name of *Necrogammarus.*

Representatives both of the Isopoda and Amphipoda will doubtless be found in numbers in our Palæozoic rocks, seeing that Macrouran Decapods are found as far back as the Coal-measures,* and Brachyurous forms in the Oolites.†

Indeed the suggestion made by Mr. Billings as to the Trilobita being furnished with legs (see Quart. Journ. Geol Soc., vol. xxvi., pl. 21, fig. 1), if established upon further evidence, so as to be applied to the whole class, would carry the Isopodous type back in time to our earliest Cambrian rocks.

I propose to carry out an investigation of this group for the purpose of confirming Mr. Billings's and my own observations, by the examination of a longer series of specimens than have hitherto

* *Anthrapalæmon Grossartii*, Salter, Coal-measures, Glasgow.

† *Palæinachus longipes*, H. Woodw., Forest Marble, Wilts.

been dealt with. In the meantime the authenticity of the conclusions arrived at by Mr. Billings having been called in question by Drs. Dana, Verrill, and Smith (see the American Journ. of Science for May last, p. 320; Annals and Mag. Nat. Hist. for May, p. 366). I have carefully considered their objections, and have replied to the same in the GEOLOGICAL MAGAZINE for July last, p. 289, Pl. VIII.; and I may be permitted here to briefly state the arguments *pro* and *con*, seeing they are of the greatest importance in settling the systematic position of the Trilobita among the Crustacea.

Until the discovery of the remains of ambulatory appendages by Mr. Billings in an *Asaphus* from the Trenton Limestone (in 1870), the only appendage heretofore detected associated with any Trilobite was the hypostome or lip-plate.

From its close agreement with the lip-plate in the recent *Apus*, nearly all naturalists who have paid attention to the Trilobita in the past thirty years have concluded that they possessed only soft membranaceous gill-feet, similar to those of *Branchipus*, *Apus*, and other Phyllopods.

The type-number of segments in Crustacea is 20 or 21. In all the higher forms, as in the Decapoda, Stomapoda, Isopoda, etc., several of these segments are coalesced either in the head, thorax, or abdomen, so that we never meet with a Crustacean having 21 distinctly marked segments until we arrive at the Branchiopoda and Phyllopoda, many of which have their full number of separate segments.

In the Trilobita, a very variable number of body-rings is met with, from 6 even to 26 (in *Harpes ungula*, Sternb.), so that on that account alone the Trilobita must be considered as a much lower type than the Isopoda, in which the body-segments are usually seven in number. There seems, however, no good reason against the conclusion that the Trilobita were an earlier and more generalized type of Crustacea from which the latter and more specialized Isopoda have arisen.

The large compound sessile eyes, and the hard, shelly, many-segmented body, with its compound caudal and head shield, differ from any known Phyllopod, but offer many points of analogy with the modern Isopods, and one would be led to presuppose the Trilobites possessed of organs of locomotion of a stronger texture than mere branchial frills.

The objection raised by Drs. Dana and Verrill to the special case of appendages in the *Asaphus* assumed by Mr. Billings to possess ambulatory legs, is, that the said appendages were merely the semicalcified arches in the integument of the sternum to which the true appendages were attached.

A comparison, which these gentlemen have themselves suggested, between the abdomen of a Macrouran Decapod and the Trilobite in question, is the best refutation of their own argument. The sternal arches in question are firmly united to each tergal piece at the margin, not along the median ventral line. If, then, the supposed legs of the Trilobite correspond to these semicalcified arches in the Macrouran Decapod, they might be expected to lie irregularly along the median line, but to unite with the tergal pieces at the lateral border of each somite. In the fossil we find just the contrary is the case; for the organs in question occupy a definite position on either side of a median line along the ventral surface, but diverge widely from their corresponding tergal pieces at each lateral border, being directed forward and outward in a very similar position to that in which we should expect legs (*not sternal arches*) to lie beneath the body rings of a fossil crustacean. The presence, however, of semicalcified sternal arches presupposes the possession of stronger organs than mere foliaceous gill-feet; whilst the broad shield-shaped caudal plate suggests most strongly the position of the branchiæ. In the case of the Trenton *Asaphus* I shall be satisfied if it appears, from the arguments I have put forward, that they are *most probably* legs—feeling assured that more evidence ought to be demanded, before deciding on the systematic position of so large a group as the Trilobita from only two specimens.*

With regard to the embryology and development of the modern King-Crab (*Limulus polyphemus*), we must await the conclusions of Dr. Anton Dohrn before deciding as to the affinities presented by its larval stages to certain of the Trilobita, such relations being only in *general external form*. Dr. Packard (Reports of the American Association for the Advancement of Science, August, 1870) remarks, "The whole embryo bears a very near resemblance to certain genera of Trilobites, as *Trinucleus*, *Asaphus*, and others;" and he adds, "previous to hatching it strikingly resembles *Trinucleus* and other Trilobites, suggesting that the two groups should, on embryonic and structural grounds, be included in the same order, especially now that Mr. E. Billings

* One in Canada, and one in the British Museum, both of the same species.

has demonstrated that *Asaphus* possessed eight pairs of five-jointed legs of uniform size."

Such statements are apt to mislead, unless we carefully compare the characters of each group. And first let me express a caution against the too hasty construction of a classification based upon *larval* characters.

Larval characters are useful guide-posts in defining great groups, and also in indicating affinities between great groups; but the more we become acquainted with larval forms the greater will be our tendency (if we attempt to base our classification on their study) to merge groups together which we had before held to be distinct.

To take a familiar instance: if we compare the larval stages of the common Shore-Crab (*Carcinus mænas*) with *Pterygotus*, we should be obliged (according to the arguments of Dr. Packard) to place them near to or in the same group.

The eyes in both are sessile, the functions of locomotion, prehension and mastication are all performed by one set of appendages, which are attached to the mouth; the abdominal segments in both are natatory, but destitute of any appendages.

Such characters, however, are common to the larvæ of many Crustaceans widely separated when adult, the fact being that in the larval stage we find in this group, what has been so often observed by naturalists in other groups of the animal kingdom, namely, a shadowing forth in the larval stages of the road along which its ancestors travelled ere they arrived from the remote past at the living present.

If we place the characters of *Limulus* and *Pterygotus*, side by side, and also those of Trilobita and Isopoda, we shall find they may be, in the present state of our knowledge, so retained in classification.

I.

Pterygotus (Fossil, extinct)	*Limulus* (Fossil and living).
1. Eyes sessile, compound.	1. Eyes sessile, compound.
2. Ocelli distinctly seen	2. Ocelli distinctly seen.
3. All the limbs serving as mouth-organs	3. All the limbs serving as mouth-organs.
4. *Anterior* thoracic segments bearing branchiæ or reproductive organs.	4. *All* the thoracic segments bearing the branchiæ or reproductive organs.
5. Other segments destitute of any appendages.	5. Other segments destitute of any appendages.
6. Thoracic segments *unanchylosed.*	6. Thoracic segments *anchylosed.*
7. Abdominal segments *free and well developed.*	7. Abdominal segments *anchylosed and rudimentary.*
8. Metastoma, *large.*	8. Metastoma, *rudimentary.*

II.

Trilobita (Fossil, extinct).	*Isopoda* (Fossil, and living).
1. Eyes sessile, compound.	1. Eyes sessile, compound.
2. No ocelli visible.	2. No ocelli visible.
3. (Appendages partly oral, partly ambulatory, arranged in pairs).	3. Appendages partly oral partly ambulatory, arranged in pairs.
4. Thoracic segments *variable in number, from 6 even to 26*, free and movable (animal sometimes rolling in a ball).	4. Thoracic segments *usually seven*, free and movable (animal sometimes rolling in a ball).
5. Abdominal somites coalesced forming broad caudal shield (bearing the branchiæ beneath).	5. Abdominal somites coalesced, forming broad caudal shield, bearing the branchiæ beneath.
6. Lip-plate, *well developed.*	6. Lip-plate, *small.*

Should our further researches confirm Mr. Billings's discovery fully, we may propose for the second pair of these groups a common designation (as in the case of the Merostomata); meantime, the above may serve as representing the present state of our knowledge.

BOTANY AND ZOOLOGY.

Popular Names of Plants.—Botanists generally ignore the use of any other than scientific names for plants, because it leads to a great deal of confusion in their nomenclature, the same name being frequently applied to two or more plants of entirely different species, and sometimes of widely separated genera; and in other cases the same plant will receive a dozen or more names, varying in different countries, and even in various sections of the same country, among people speaking the same language. For precise nomenclature, therefore, the names given by acknowledged authorities in the botanical world have to be accepted by amateurs and professional men. Nevertheless, the popular names of plants are not merely empirical, but are founded, as the scientific names are founded, upon some peculiar feature or use of the plant.

Of late years these popular names have become the object of very interesting research, as throwing much light upon ethnological history, the antiquity of various nations, and the migrations of the larger tribes of men. We can not, of course, go into a lengthy account of these matters, or give the derivation of all the popular names in use—it would require a large volume to do this; but we will give a few examples of the results of the researches made as to the names of some common trees and plants. With the exception of the hazel-nut, and some other wild berries, the Apple appears to be the only fruit known to our European ancestors, as it is the only name not derived from the Latin or French. In the Zend, or old Persian language, and in the Sanscrit, the name for water is *ap*, and for fruit *p'hala*; hence ethnologists think that the name is compounded of these two words, meaning "water fruit," or "juice fruit." This corresponds with the Latin name *pomum*, derived from *po*, to drink, which is a somewhat curious coincidence. In Welsh it was formerly called *apalis*, now *apfel*; in high-German, *aphol*; in German, *apfel*; in Anglo-Saxon, *apl*, or, *appel*; in old Danish, *epli*; in modern Danish, *æble*; in Swedish, *aple*; and in Lithuanian, *obolys*, or *obelis*. This close similarity in the name as used by these various nations, renders it highly probable that they all come from the same root or stock, and that such root or stock originally inhabited the western spur of the Himalayan Mountains or northern Persia.

Again, the name of Beech-tree, given to the *Fagus sylvatica*, is another curious proof of our descent from Asiatic nations. In Sanscrit the word *bôkô* signifies a letter, and the word *bôkôs* writings. In Swedish the name of the Beech-tree is *bok*; in Danish, *bög*; in Dutch, *beuk*; in German, *buch*; in modern high-German, *buoche*; in old high-German, *puocha*; and in Anglo-Saxon, *boc*, *bece*, and *beoce*—names applied indifferently to this tree and to a book, because the ancient books of these different nations were written in their Runic characters upon tablets or leaves made from the bark of this tree. Ethnologists, therefore, consider this as another proof of our descent from the nations of Upper Asia, the more so as the use by the Greeks of the word *biblos*, as signifying a book, is derived from the name of an Egyptian plant that was used in making the material upon which they wrote, showing that our ancestors received their ancient alphabetic signs from India by the way of the north, and not by a southern route.

As a curious example of the way in which the names of plants become transmitted in passing from one language to another, we instance one of the names of the Carnation, or *Dianthus caryophyllus*. Chaucer, in his *Canterbury Tales*, speaks of "A primerole, a piggesnie." This last word, the glossaries state, means "pig's-eye," the first one meaning the primrose. Now "piggesnie" really means Whitsuntide Pink, and comes from the German words *Pingsten*, or *Pfingst*, derived from a Greek word for fiftieth, meaning the fiftieth day after Easter, and *eye* from the French *œillet*, a Pink. The word *Pingsten*, therefore, has reference to the time of its blooming, and *eye* to the circular markings in the flower, and thus *Pinksteneye* has passed into *Piggesnie*.

The *Viola tricolor*, or Pansy, is an instance of numerous and various names being applied to the same plant. The above name comes from the French word *pensée*. Because it has three colors in the same flower it is called "Three faces under a hood," and also "Herb Trinity;" and from its coloring, "Flame Flower." It is also called "Heart's-ease," but this name properly belongs to the Wallflower, which was formerly called *giroflée*, or Clove Flower, because cloves were in former times considered good for diseases of the heart. Of amatory names, the Pansy has probably more than any other plant; we name a few of them: "Kiss Me ere I Rise," "Kiss Me at the Garden Gate," "Jump up and Kiss Me," "Cuddle Me to You," "Tittle my Fancy," "Pink of my John," "Love in Idle," or "in Vain," "Love in Idleness," and many others.

The old herbalists were great believers in the doctrine of signatures; by which they meant that some particular character or habit of the plant indicated its medical use. Thus the spotted leaves of the Pulmonaria indicated that it was a remedy for pulmonary complaints; the tubers of the roots of Scrophularia, being hard and knotty, must be good for glandular affections, and because the Saxifrage grows in the clefts of the rocks it must be good for stone in the bladder. They even ascribed different qualities to various parts of the same plants. An old author says: "The seed of garlic is black; it darkens the eyes with blackness and obscurity. This is to be understood of healthy eyes. But those which are dull through vicious humidity, from these garlic drives it away. The skin of garlic is red; it expels blood. It has a hollow stem, and therefore helps affections of the windpipe."

Some common names are the embodiment of some poetic thought of our forefathers, as the Daisy, Belle's-perennis, which comes from the Anglo-Saxon *dæges-eage*, or the old English Daieseye-ghe, meaning the eye of day, because its flowers are only open in the day time; though some derive the name from *dais*, a canopy, from the shape of the flower, as in the line,

"The *daisie* did unbraid her *crownall small*"—

crownall meaning coronal, the upper part of a canopy.

Other names derive their origin from the uses to which the plant is put, as the Dogwood; which is not named after the animal, but because the wood was formerly used for making skewers, the proper name being *dawkwood*, or skewer-wood, this name coming from the Anglo-Saxon *dale* or *dole;* German, *dolch;* Spanish, *duga;* French, *dague;* and old English, *dagge*.

A curious instance of confusion and transposition of names is to be found in the Forget-me-not, as this name has only been given to the pretty blue Myosotis within the past forty or fifty years. For more than two hundred years the name had been given by the English to the *Ajuga chamæpitys*, or Ground-pine, on account of the unpleasant taste it leaves in the mouth. Some of the German botanists and herbalists gave the name to a plant known botanically as *Teucrium Botrys*. In Denmark and some parts of Germany the name was applied to the Speedwell or *Veronica chamædrys*, and by others to *Gnaphalium leontopodium*. The name appears properly to belong to the Veronica, having reference to the way in which the flowers fall off and are blown away as soon as it is gathered; hence the valediction "Speedwell," "Farewell," "Good-by," "Forget-me-not," etc., as applied to this plant. The later application was brought about by the legend in a story of modern date in which a drowning lover snatches it from the river bank, and as he sinks throws it ashore, as a token of remembrance.

J. H. in "Hearth and Home."

MISCELLANEOUS.

OBITUARY.—SIR RODERICK IMPEY MURCHISON, BART., K.C.B., LL.D., D.C.L., M.A., F.R.S., F.G.S., &C., &C., &C.

The death of Sir Roderick Murchison, although at the ripe age of 80 years, is a loss which Geologists and Geographers are alike called upon to mourn. In relation to both these sciences, he has for many years justly occupied the most prominent positions. But, apart from his high social and scientific standing, he was a man full of genial and kindly feeling, who could be readily approached; and those who knew him most intimately acknowledge that he was never known to fail his friends in the hour of need, but was ready to aid them with his advice, his influence, and his purse, as many a young scientific man amongst us can testify.

Born at Tarradale, in Ross-shire, he received his early education as a boy at the Grammar School at Durham.

But the associations of his Highland home—his ancient Scottish pedigree, numbering in the long roll many a staunch supporter of the Stuarts, who had freely laid down their lives for their Sovereign—combined with the stirring events which marked the period of his own youth, no doubt powerfully influenced young Murchison in selecting a profession, until in imagination he too, like Roderick Vich Alpine, heard the mountains say—

"To you as to your sires of yore,
Belong the target and claymore!"

Having made up his mind to follow the military profession, he was sent by his father, Mr. Kenneth Murchison, to the Royal Military College, Great Marlow, after which, having pursued his studies for a few months at the University of Edinburgh, he obtained a commission in the army in 1807, and joining his regiment the following year, served in the 36th Foot with the army in Spain and Portugal under Lord Wellington, afterwards on the Staff of his uncle, General Sir Alexander Mackenzie, and lastly as Captain in the 6th Dragoons. He took an active part in several of the most important battles in the war, and earned the reputation of being a brave and able officer. He carried the colours of his regiment at the Battle of Vimiera, and afterwards accompanied the army in its advance to Madrid and its junction with the force under Sir John Moore, and shared in the dangers and retreat at Corunna. At the end of the war in 1815, he married Charlotte, only daughter of the late General Francis Hugonin. It was Sir Roderick's own conviction that to his wife's influence was mainly to be attributed the choice he made in following scientific pursuits with her, and giving up, as he did, the ordinary amusements of a retired cavalry officer.* She was his friend, *companion, and fellow-labourer in geology, aiding him* in his observations, and making for him those remarkable geolo-

* See notice of Lady Murchison, Geol. Mag., 1869, Vol. VI., p. 227, by Prof. Geikie, F.R.S., President Edinburgh Geological Society.

gical sketches of landscape that illustrate his works. He is also said to have early become acquainted with Sir Humphry Davy, who suggested to him that he should attend the lectures of the Royal Institution. This advice he followed, and he also studied with Mr. Richard Phillips, F.R.S.

In 1825 he was elected a Fellow of the Geological Society of London, and in the same year he read his first paper on "The Geological Formation of the North-west extremity of Sussex, and the adjoining parts of Hants and Surrey," before that Society.†

In 1826 he recorded the results of his investigations in the Oolitic series of Sutherland, Ross, and the Hebrides, and in the same year he was elected to the Fellowship of the Royal Society; the following year he again visited the Highlands in company with Professor Sedgwick and succeeded in showing that the primary Sandstone of McCulloch was really the true Old Red Sandstone or Devonian.

In 1828 he resolved to extend his researches abroad, and to study the extinct volcanos of Auvergne and the geology of the Tyrol. He was accompanied on this occasion by Mr. (now Sir Charles) Lyell.

Following Dr. Buckland's advice, Murchison next devoted himself to a careful examination of the geology of Hereford, Shropshire, and the Welsh Borders, the ancient country of the *Silures*, and it was upon this investigation that his great Silurian system was afterwards founded.

These researches he afterwards followed up by others in Pembrokeshire, to the west of Milford Haven; and his conclusions as to the stratigraphical relation between the Devonian and the underlying Silurian systems was made public at the meeting of the British Association for the Advancement of Science in 1831, but his great work did not appear until 1839.

Further geographical investigations in Devon and Cornwall followed, in which Professor Sedgwick took part, and in 1835 and 1839, two journeys were performed by Sedgwick and Murchison to the Rhenish Provinces; on the latter occasion M. de Verneuil also accompanied them. The result of these researches,

† This paper is of great historical interest, being accompanied by a letter from the illustrious Baron Cuvier, in which he gives a detailed description of the Reptilian remains forwarded to him by Mr. Murchison for examination. The specimens which are figured and described in this paper are now preserved in the British Museum.

and comparison of the English Devonians with those of Rhenish Prussia, was published in 1839, and a final classification adopted.

In 1840, accompanied by De Verneuil, Murchison visited Russia, at that period very little known geologically.

They examined the banks of the rivers Volkoff and Siass, and the shores of Lake Onega, thence to Archangel and the borders of the White Sea, and followed the river Dwina in the government of Vologda. They traversed the Volga and returned by Moscow to St. Petersburg, examining the Valdai Hills, Lake Ilmen, and the banks of the rivers which they passed. They then returned to England, but having been invited by the late Emperor Nicholas to superintend a Geological Survey of Russia, the two geologists returned to St. Petersburg in the spring of 1841, and being joined by Count Keyserling and Lieutenant Kokscharow, they proceeded to explore the Ural Mountains, the Southern Provinces of the Empire and the Coal Districts between the Dneiper and the Don. In 1842 Murchison travelled alone through several parts of Germany, Poland, and the Carpathian Mountains, the better to understand the relations of the great formations to each other over wide areas. In 1844 he explored the Palæozoic rocks of Sweden and Norway. In 1845–6 he completed his great joint work on "The Geology of Russia and the Ural Mountains," in two quarto volumes of 700 and 600 pages, copiously illustrated with maps, sections, and plates of fossils. Not long after the publication of this work, Mr. Murchison was knighted by her Majesty, the Emperor having previously conferred several Russian orders on him, including that of St. Stanislaus. In 1849 he received the Copley medal from the Royal Society, in recognition of his having established the Silurian system in geology.

His researches (extending over six visits) in the Alps, Apennines, and Carpathian mountains, established the fact of a graduated transition from Secondary to Tertiary rocks, and clearly separates the great Nummulitic formation from the Cretaceous formations with which it was confounded.

Ranking next in importance to his definition of the Silurian System was his differentiation of the Permians. Having satisfied himself that the Lower Red Sandstone, and the Magnesian Limestone and Marl Slates constituted one natural group only, which, from their organic contents, must be entirely separated from the overlying formations, he proposed, in 1841, that the group should receive the name of the "Permian" system, from Perm, a Russian Government, where these strata are more extensively developed than elsewhere, occupying an area twice the size of France, and containing an abundant and varied suite of fossils. The name Permian is now generally adopted.

In 1854 Sir Roderick published the first edition of his best-known work, "Siluria," which had, in 1867, reached its fourth edition, and contains 566 pages 8vo. of closely printed matter, 41 plates and explanations.

In 1855 he produced a memoir in conjunction with Prof. Morris on the German Palæozoic rocks, and shows that there is no break between the Permian system and the Triassic series.

By the death of Sir H. T. de la Beche, Sir Roderick, in 1855, succeeded to the post of Director General of the Geological Survey and the Museum of Practical Geology in Jermyn Street, which have owed their efficiency for the past fifteen years very largely to his energy and constant attention.

Sir Roderick Murchison will long be remembered both in the world of science and of commerce in connexion with the discovery of gold in Australia. Long years before the actual discovery of gold in Australia was made known, he inferred the presence of auriferous deposits in the Australian mountain-ranges from the analogy which existed between their rock formations and those of the Ural mountains, with the physical characters of which he had made himself familiar. He endeavoured most earnestly at the time to awaken the attention of the Home Government to the great importance of the subject to our colonies in the Southern hemisphere, but with little success.

During his scientific career he has been identified most intimately with the Geological Society. He acted as Secretary for five years, was elected President in 1831-2, and again in 1842-3.

He aided Sir David Brewster, in 1830, to establish the British Association, of which for several years he acted as General Secretary. He was President at the Meeting for 1846, at Southampton.

In 1844 he was elected President of the Royal Geographical Society, and again in 1845, in 1852, and in 1856; indeed, he has held the Presidential chair of that Society almost down to the present time; having been succeeded only a few months ago by Sir Henry Rawlinson.

His energetic efforts in advocating the search after Sir John

Franklin; his success in raising a monument to Lieutenant Bellot, of the French Navy; his advocacy of the explorers of Central Africa, Burton, Speke, Grant, Baker, and especially his friend Livingstone, are among the proofs of his earnest self-devotion to the cause of Geographical research.

Amongst the many workers in the fields of science how few there are whose actual published labours extend over half a century; yet almost the last Blue Book which has appeared, namely, "the Report of the Commissioners appointed to inquire into the several matters relating to Coal in the United Kingdom," (Vol. I. General Report and Twenty-two Sub-reports, folio, 1871), bears Sir Roderick's name second on the Commission.

The Council of the Geological Society awarded him the Wollaston Gold Medal, in 1864, in recognition of his contributions to geology as an inductive science. The Universities of Oxford, Cambridge, and Dublin *have also bestowed on him their Honorary* Degree.

He held for many years the post of a Trustee to the British Museum, with great advantage to the Natural History Departments in that Institution, which he specially promoted.

Sir Roderick was created, in 1863, a Knight Commandant of the Order of the Bath (civil division), and in the following year he received the prize named after Baron Cuvier from the French Institute. In 1859 the Royal Society of Scotland presented him with their first Brisbane gold medal, for his scientific classification of the Highland rocks, and for the establishment of the remarkable fact that the Gneiss of the north-west coasts is the oldest rock in the British Islands. He was created a baronet in January, 1866.

One of his latest acts consisted in offering the munificent sum of £6,000 to found a Chair of Geology and Mineralogy in the University of Edinburgh, on condition that the Government would supplement the proceeds by an annual grant of £200. This was duly acceded to, and the chair so endowed, is now held by Professor Geikie, F.R.S., etc.

The death of Lady Murchison in 1869 was most keenly felt by Sir Roderick, indeed it may be said to have given him a shock from which he never wholly recovered. He was first attacked by paralysis in December, 1870, but gradually rallied until two months since, when he had a second stroke, but the symptoms had lately abated. A slight attack of bronchitis, caused by a cold caught in riding out on the 19th ulto., ended his valuable and well-spent life on Sunday evening, Oct. 22, at 8.30 p.m.

His scientific career, now brought to a close, represents the period of the dawn and development of Geology as a science in this country. He commenced work at the moment when William Smith issued the first Geologically-coloured map of England, and he has lived on to see half the world surveyed geologically, and has himself mapped a vast extent of territory in Europe for his Silurian kingdom.

In conclusion (to quote the words of the *Daily News*), "the honors he won are a great testimony to the scientific enlightenment of the age. We have crowned Science Queen, and all her servants form her court, and wear the titles she bestows. And, truly, a scientific man earns his honours more nobly, and wears them more honourably than those who win them in political intrigue or on the field of battle. Sir Roderick Murchison, dying at eighty, covered with titles of literary and scientific honour, and satisfied with social position and renown, is a prophet of the coming time. He may not be looked back on as a great scientific genius; but he is one of the pioneers of that new order of renown which is won by fruitful service rather than by destructive deeds."

—*From the* GEOLOGICAL MAGAZINE *for November*, 1871.

(Proposed new genus of Pteropoda.)

Genus HYOLITHELLUS, N. G.

Since the sheet containing the description of *Hyolithes micans* was printed off, I have arrived at the conclusion that a new genus for its reception should be instituted. I propose to call it *Hyolithellus*. It differs from *Hyolithes*, in its long slender form and in the peculiar structure of its operculum.

E. BILLINGS.

Published December, 1871.