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ON RECENT SPECTROSCOPIC OBSERVATIONS OF THE SUN, AND THE TOTAL ECLIPSES OF 1868 AND 1869.

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Astronomy is no longer a purely mathematical science, treating of the distances and magnitudes of the celestial bodies; nor is the telescope the only instrument by means of which the condition of these far-distant worlds can be studied. The spectroscope now enables the astronomer to determine of what the sun and many of the fixed stars are composed; whether they possess an atmosphere, and what elements exist in it; whether they are self-luminous or only reflect borrowed light; what burns in the flaming tail of the comet, and what those mysterious clouds of light—the nebulæ—are.

Until the year before last the spectroscope had revealed little else respecting the physical constitution of the sun than that it possesses a gaseous envelope or atmosphere of glowing gases and metallic vapours, in which certain known and many unknown substances existed. But a solar atmosphere had been predicated on other grounds. Looking at the sun in the full blaze of day-light, one sees a fiery orb with sharply-defined circumference; but when the sun is eclipsed, by the passage of the moon between it and the observer, the surface of the sun is seen to be broken, not like that of the moon, by rugged mountain peaks and deep valleys, but by stupendous masses of burning gas, which are whirled up by storms raging over the surface of the sun, as are the pillars of sand by the sirocco of the African desert. These flames are visible beyond the disc of the moon after it has hid the luminous body of the sun. Such mountains of glowing gas have been noted during every eclipse of which we possess a scientific record; and it was observed that they sprung from a ring of rosy-colored light which enveloped the dark orb of the moon. Outside them, and extending at places for a degree beyond the the sun, there was always observed an irregular halo of white light. For a long time, through the most perverse reasoning, these phenomena were supposed to be appendages of the moon; but the observations made during the eclipse of 1842, and the photographs made during that of 1860, left no doubt that these protuberances or prominences belong to a solar atmosphere, less luminous than the body of the sun.

It was after the eclipse of 1860 that the value of the spectroscope, in the investigation of solar physics, became evident; and, therefore, the next eclipse was looked forward to with eagerness as likely to enable the spectroscopist to determine, beyond a doubt, the nature and composition of the protuberances and the corona. Consequently, a number of expeditions left Europe to observe, at different points along its central line, the eclipse of August, 1868, which began in Africa, crossed the Red Sea to Aden, and then traversed the Indian Ocean, India and Malacca. A Prussian expedition, under Dr. Vogel, stationed itself at Aden, where totality occurred soon after daylight. M. Janssen, an eminent French astronomer, made his observations at Gondoor, in India, and M. Rayet in the Peninsula of Malacca. Several English parties were organized, foremost among which were those under Major Tennant and Lieut. Herschel, both of whom took up positions in India. Dr. Vogel and Major Tennant aimed chiefly at obtaining photographs of the eclipse. During this eclipse there were observed several large protuberances and a corona. The rosy-coloured banks of cloud from whence these protuberances sprang were brightest about the equator. One very prominent protuberance retained the same position, and underwent very little alteration in shape during the period of the eclipse. The interest of the eclipse centred in the spectroscopic observations of the protuberances. Upon the whole, the reports of the different observers accorded. They all found the protuberances to give bright lines, and, therefore, the question of their gaseous constitution was settled. There was not quite such identity in the opinion as to the number and position of the bright lines. All the observers, except Lieut. Herschel, observed two of the hydrogen lines. The blue line which he lays down corresponds, however, so nearly to the hydrogen line, F, which the others are sure they detected, that we may consider them the same. All likewise agree in having seen a line in the yellow, near the double D line of sodium; and M. Rayet noted lines indicating the presence of iron and manganese. He distinctly observed nine lines in one protuberance, and only eight in another. "Hence," he remarks, "all the protuberances do not emit identical light." The observations on the corona were more discordant. M. Rayet, with his powerful instrument, could not detect the faintest spectrum, whereas Major Tennant positively reports a continuous spectrum.

Capt. Branfell, of the same party, reports "the protuberances unpolarized, and the corona strongly polarized, everywhere in a plane passing through the centre of the sun." There is the usual disagreement with regard to the color of the protuberances, Major Tennant pronouncing them white, but all others assigning to them some shade of red.

Such are the principal results of the memorable eclipse of 1868; but they were immediately thrown into the shade, and rendered well nigh superfluous, by a discovery made almost simultaneously by M. Janssen in India, and Mr. Norman Lockyer in England, by which the spectroscopic phenomena of the protuberances may be viewed any day without the interposition of the moon.

The coincidence in time of the same discovery by two men, at the antipodes, ranks among the curiosities of science with the simultaneous discovery of Neptune by Adams and Leverrier.

More than three years ago Mr. Lockyer conceived the idea of viewing the protuberances in full sun-light by passing a spectroscope with great dispersive power around the sun's disc. His instrument being unsuitable, one of a peculiar construction was ordered in 1867, but only finished in the autumn of 1868. His anticipations were realized by his first observation. In broad daylight he was enabled to trace the position and shape of the protuberances upon the sun's disc, by means of the bright lines which their spectrum gave. A few days after the publication of these important results, and a few minutes after their communication to M. Delaunay, of the French Academy, there was received by that gentleman a letter from M. Janssen, stating that during the progress of the eclipse he had conceived the possibility of attaining the same end by the same means as Mr. Lockyer was at that very time independently working at, and that on the following day he had experimentally confirmed his idea, and drawn the altered outline of one, the same protuberance he had observed the day before during the eclipse. Since then these astronomers and other spectroscopists—notably Father Secchi, of Rome—have worked in the same field, and vastly enlarged our knowledge of solar physics. I can but briefly enumerate the conclusions arrived at. It is now determined, with tolerable certainty, that there is a very attenuated atmosphere of burning hydrogen enveloping the sun at every point, measuring, in average height, about 5,000 miles; but at certain points, and chiefly near the equator, upheaved by internal volcanic forces within the sun into masses twenty times that height, and then wafted about by solar whirlwinds. Then, from the protuberances or prominences seen during an eclipse, the expulsive force is so violent that it displaces not only the light hydrogen which forms the outermost layer of atmosphere, but also projects from a deeper stratum the heavier vapours of iron and other metals into the base of the hydrogen flames. This outer layer has been called the chromosphere, from its giving a spectrum of bright-coloured lines. Here and there, as some of the photographs taken during the three last eclipses show, and as spectroscopic observations verify, clouds of hydrogen, and even of magnesium, are carried away, burning, into space, quite detached from the visible solar atmosphere, though probably within the limits of the real atmosphere, as certain of the hydrogen lines in the spectra of the protuberance extend faintly beyond the others, and indicate the extension of the atmosphere far beyond its more perceptible bounds.

Lockyer's description of a chromosphere is quite picturesque: "In different parts the outline varies. Here, it is undulating and billowy; there, it is rugged to a degree; flames, as it were, darting out of the general surface, and forming a rugged, fleecy, interwoven outline, which, at places, is nearly even for some distances, and then, like the billowy surface, becomes excessively uneven in the neighbourhood of a prominence. Here one is reminded of the fleecy, infinitely delicate cloud-films of an English hedgerow, with luxuriant elms; there, of a densely intertwined tropical forest, the intimately interwoven branches spreading in all directions, the prominences generally expanding as they mount upwards, and changing slowly, almost imperceptibly."

Intermediate between the chromosphere, yielding its spectrum of bright lines, and the body of the sun—which gives a continuous spectrum with dark lines, Father Secchi says—may, under favourable conditions of our atmosphere, be detected a continuous spectrum. The explanation of this is not very easy, but the following is suggested: If we suppose the body of the sun to be liquid, the metals which compose it are in a state of fusion at a white heat, and, therefore, emit white light; if we suppose it gaseous, the mass of glowing vapor is too dense to be transparent, and, therefore, may act in the same manner as if it were liquid; but immediately outside this liquid, or gaseous nucleus, there is a layer of ignited gases and vapors, situated so near the thin outer limb of the orb as to be transparent, in which the vapors of so many metals are burning, that their combined bright lines will yield a continuous spectrum, or what may appear such.

Another explanation, and a more probable one, because corroborated by experiment, has been offered. A continuous spectrum, according to Frankland and Lockyer, is given by gases when undergoing condensation. Judging from what takes place in our own atmosphere, we may suppose, as Storey has pointed out, a rapid condensation of certain of its constituents upon the surface of the sun. Such a permanent gas as hydrogen would undergo no change, and, therefore, continue burning beyond the limits of the area of condensation. This area of condensation would form a cloudy envelope, radiating back most of its heat to the sun, and serving other purposes in the solar economy. Would the reversion of the bright lines take place in this area?

There is not perfect unanimity of opinion as to the condition of the body of the sun. The old idea of a solid nucleus is now generally abandoned, and the opinion that it is liquid is yielding to the views of those who conceive that at such a high temperature, as all admit, prevails, it must be gaseous. There are other reasons still for believing it to be gaseous. In this latter case there can be no well-defined atmosphere; but the term may be applied to the hydrogen or outer stratum of gas, and so much of the deeper stratum as contains the vapors necessary to give the Frauenhofer lines. The chromosphere in this view is that layer in which the reversion of the bright lines takes place, unless there be an area of condensation, as proposed above. The interior has been called the photosphere.

Whether the chromosphere, or the chromosphere and photosphere are alone gaseous, and the nucleus liquid, or whether there are not successive rings of simple or mixed gases, of decreasing density, from the centre to the circumference, will probably be determined by more extended observations on the spectra of solar spots. These spots, as you are aware, have been the subject of much controversy, and the spectroscope has not set it at rest. It is assumed by some that there is a relation between the spots, the protuberances, and the feculæ, which are generally observed in the neighbourhood of the spots. When a spot is visible on the edge of the sun's disc, a protuberance may often be detected in the neighbourhood, as, for instance, in the following observation by Mr. Lockyer:—

"On the 21st April there was a spot very near the limb which I was enabled to observe continuously for some time. At 7.30 a.m. there was a prominence visible in the field of view, in which tremendous action was evidently going on, for the C. D. and F. lines were magnificently bright in the ordinary spectrum itself; and as the spot-spectrum was also visible, it was seen that the prominence was in advance of the spot. The injection into the chromosphere surpassed everything I had seen before, for there was a magnesium cloud quite separated from the limb, and high up in the prominence itself. By 8.30 the action had quieted down, but at 9.30 another throb was observed, and the new prominence was moving away with tremendous velocity. While this was going on, the hydrogen lines suddenly became bright on the other side (the earth's side) of the spot, and widened out considerably—indeed, to such an extent that I attributed their action to a cyclone, although, as you know, this was a doubtful case. Now, what said the photographic record? The sun was photographed at 10h. 55m. a.m., and I hope you will be able to see on the screen how the sun's surface was disturbed near the spot. A subsequent photograph at 4h. 1m. p.m. on the same day shows the limb to be actually broken in that particular place; the photosphere seems to have been actually torn away behind the spot, exactly when the spectroscope had afforded me possible evidence of a cyclone."

Another instance is noted by D. Curtis in his report. He observes, of one of the most striking of the prominences in the last eclipse—the corn-ear protuberance—that while its peculiar shape has all the appearance of having been impressed upon it by a cyclone, it is in the neighbourhood of a larger sun-spot and a group of feculæ. As, however, this is the only instance in which he observed any relation between sun-spots and protuberances, he considers their vicinity to one another accidental. Lockyer, however, justly remarks that though there may be spots visible in one region without prominences, and prominences without spots, it does not follow that a spot is not accompanied by a prominence at some stage of its life, or that the spot and prominence do not originate through one and the same action.

Prof. Young, of Hanover, N.H., who is making daily observations on the spots and protuberances, does not admit so intimate a relation between them. From his observations he considers it evident that the spots and prominences obey nearly the same laws in respect to their distribution on the solar surface; but the prominences, which are far more numerous than the spots, approach nearer to the poles, and are more frequently found on the equator. He has never yet been able to watch a spot in its passage round the limb, so as to observe its effect on the chromosphere; but his present impression is that certain depressions. observed from time to time in the chromosphere, are due to spots directly under them. In only one case has he found a prominence very near a spot, and then only a small one. Whether the prominences are connected with the feculæ, he thinks, is a different question, and more likely to receive an affirmative answer.

Dr. Curtis remarks that his photographs show abundance of feculæ, and prove that there must have been an almost continuous line of thin objects along the portion of the circumference of a great circle of a solar sphere occupied by the protuberances.

What appears in the telescope as ripples on the surface of the sun—the feculæ—generally occur near a spot, and reveal their presence to the spectroscope by a decided reduction in the intensity of the dark hydrogen lines, and sometimes their conversion into bright lines, even upon the surface of the sun.

The spectroscopic phenomena of the spot itself are very curious. Of course, deductions have been drawn from them; but it would be premature to put implicit reliance on them until more extended experiments on gases at different temperatures, and under varying pressure, have enabled the conditions existing on the surface of the sun to be imitated and watched in the laboratory. Mr. Lockyer detects the presence of a spot by a general darkening of the spectrum and the widening of certain of the Frauenhofer lines—phenomena which he attributes to a local increase in the general and selective absorption of the chromosphere. The Frauenhofer lines put on a sudden blackness and width in the case of a spot with steep sides, but expand gradually in a shelving one. This thickening of the absorption lines Lockyer and Frankland have proved, by experiments, to be due to varying pressure; and this variation in pressure they attribute to convection currents in the chromosphere: "Suppose a hydrogen flame to be suddenly projected from the sun in the direction of the earth, the waves of light will be shortened, and the hydrogen lines of the spectrum be shifted nearer the violet. If the flame travels from the earth the waves will be lengthened, and the lines shifted nearer to the red end of the spectrum. The line F undergoes strong contortions when seen near the centre of the sun's disc. It is seen, in fact, stopping short in one of the small spots, swelling out prior to disappearance, invisible in a fecula between two small spots, changed into a bright line, and widened out two or three times in the very small spots, becoming bright near a spot, and expanding over it on both sides, and so on. The Frauenhofer lines may thus be looked upon as so many milestones, telling the rapidity of the approach and downrush. Thanks to Angstrom's map of the wave length of the different parts of the spectrum, it is known that the shifting of the F line the ten-millionth part of a millemeter nearer the violet, means a velocity of uprush to the eye of 38 miles per second. The observed alterations of wave-length is such that twenty miles a second is very common."

From this, I presume, we are to gather that Lockyer considers that the same cyclone which whirls the chromosphere up into space projects the heavier vapors of the photosphere into the chromosphere, and thereby leaves a cavity in the photosphere itself. This is filled by a downrush of the chromosphere, which is, consequently, there much thicker than in the surrounding region, and, therefore, more absorbent.

Father Secchi's observations agree, in the main, with the above. He remarks that when the slit of the spectroscope is carried across a solar spot, the relative intensity, as well as the length of the spectral lines, changes. The spectrum is never really interrupted; it is merely darkened through the narrowing of the bright interspaces by reason of the bulging of the dark rays and the formation of a number of cloudy lines. Many of these cloudy lines correspond with those observed in the spectrum of the sun, when on the horizon; and certain lines in the red orange space are identical with those produced by a cirrus cloud crossing the field of view, and, therefore, indicate the existence of watery vapor. A careful comparison of their spectra has led Father Secchi to the conclusion, that, as the spectra of the red orange stars and the spectra of the solar spots are identical, the sun, stripped of its chromosphere, would resemble Alpha in Orion, or Omicron in the Whale; as it is, it is a variable star. The layer of absorbing vapor, which, by its varying thickness and density, produces this variation, is denser on the spots. The questions then arise: is it piled up at such points above the average level of the chromosphere?—or, does it fill cavities in the photosphere? The Rev. Father inclines to the latter opinion. He finds, moreover, that in the spectrum of the spot, the iron and calcium lines are more strongly marked than the magnesium and sodium; hence, he concludes that the former metals, existing at the bottom of the cavity, mark the dark nucleus of the spot: the latter are within the region of the penumbra. Remark that this opinion differs materially from the old view, which supposed the dark nucleus to be the dark body of the sun—the penumbra to be the sides of the cavity. It approaches nearly the old notion that the spots are caused by a downrush of a cool, absorbing atmosphere upon the visible body of the sun,—only, according to recent observations, the downrush fills cavities in the gaseous body of the sun. This gaseous body, under such pressure as exists there, emits white light, which is more largely absorbed in the spot than elsewhere, because there the absorbing medium—viz., the vapors and gases which fill the cavity—forms a deeper and denser layer than elsewhere.

As I said before, the subject requires further elucidation; and in its further investigation, Capt. Ashe's theory of falling asteroids being elements in the disturbance which takes place in the region of a spot, is certainly worthy of consideration; for, although the theory requires remodelling to suit new facts, some of the data on which it rests cannot be overlooked.

The old cavity theory, which he long ago showed the absurdity of, has been abandoned by all, and the new cavity theory, which is being put in its place, by no means explains all the facts of the case. At the same time, it is not easy to reconcile Capt. Ashe's hypothesis with the laws of physics and chemistry. Were the spots caused by melting asteroids floating on the chromosphere, these incandescent masses of metal would give continuous spectra, whereas the spots give the very reverse; but one cannot conceive how a mass of heavy metal could float for days and months upon an ocean of light hydrogen, while undergoing fusion and then volatilization; nor in a sea of burning hydrogen would there probably be formed the dross which the Captain supposes the penumbra of the spot to be. For all that, the correspondence between the zone to which spots are confined and that within which asteroids would fall upon the sun's surface, and the fact that there is a maximum and minimum period in the occurrence of sun-spots, give strong probability to the supposition that there is a relation between sun-spots and intra-mercurial asteroids.

Lockyer and Janssen's discovery has greatly detracted from the interest which attends a total eclipse, as the most remarkable phenomena of the eclipse—the chromosphere and its protuberances—may be observed at any time. This may be the reason why no European party crossed the Atlantic to witness the eclipse of the 7th of August last. A further reason, doubtless, was, that it was known it would be so carefully observed by American astronomers as to make any assistance from them almost superfluous. It is, nevertheless, to be regretted that some European astronomers, who witnessed the eclipses of 1842, 1860, and 1868, did not bring their experience to the observation of the last. The scientific results, however, of the eclipse have been by no means insignificant. All the parties of observation have not yet published their reports; but from such as have appeared, the following summary is gathered:

The eclipse was total at sunrise in Siberia; it crossed the north Pacific a little south of Behring Straits, and thence pursued a south-east course across the continent, terminating at sun-set off the coast of North Carolina. It was observed by two United States Government parties in the Pacific, whose reports have not yet been published; by Mr. Gilman, of New York, at Sioux city, on the Missouri; by Capt. Ashe, at Jefferson City, Iowa; at Des Moines, about fifty miles south-east of Jefferson, by Dr. Curtis, of the U.S. Army Medical Museum, and a party from the U.S. Naval Observatory; as well as by Prof. Rogers, and some of the officers of the U.S. Coast Survey; by three divisions of a party under charge of Dr. Morton, of Philadelphia, stationed —one at Burlington, another at Otumwa, and the third at Mount Pleasant, Iowa. Prof. Alexander and others took up a position at Springfield, Illinois; and the Harvard University sent their observers to Selbyville, Kentucky. Many other colleges and scientific bodies sent their representatives to these or other stations along the line of totality.

The general phenomena of the eclipse did not differ from what had been observed on previous occasions. The darkness was not so great that print of moderate size could not be read during totality; and it was not till totality had almost occurred that the decrease in light became to the eye very manifest. Prof. Eastman found the light during totality to be about equal to that after sunset. The moon moved majestically and calmly across the surface of the sun, till it had almost extinguished it: when, quickly, as if by an effort, it totally eclipsed it. The shadow of the moon, as it rushed through the air, and enveloped the earth in sudden darkness, struck observers with more awe than perhaps any other of the many almost perternatural appearances of the eclipse—an awe that was dissipated only by the equally sudden return of light, as the sun blazed forth from behind the jet-black orb of the moon. The planets Mercury, Venus, and Saturn, and one or two stars of the first magnitude, burst forth at the commencement of totality, and were visible for a few seconds afterwards. The sky is described (for, having been shut up in my photographic room, I saw nothing, and speak, therefore, from hearsay) as presenting a very unusual appearance. Immediately outside the sun, beyond the corona, it was of an inky black; yet, even here there were no stars visible, only the planets; while further towards the zenith, and beyond it, to the east, the color changed to an indigo blue; and all around the horizon, but particularly to the west, it was of a bright orange. At the moment of totality, there shone forth a halo of light from all sides of the dark moon; but so much more strongly from the equator than the poles, that it more resembled a nimbus, lozenge-shaped, with rays of unequal length, than a regular crown of light. Some of the rays were over 1° in length. Within the corona there appeared, on the eastern limb of the sun, or rather moon, a rugged line of rosy red light, rising in several places into larger masses. As the moon advanced and covered the eastern limb and this range, as it were, of burning mountains, it uncovered a similar range, with its high peaks, on the western limb, and brought into better view a like phenomenon on its lower limb. This band of red light, with its remarkable excrescences, is probably the chromosphere and its protuberances.

Thermometrical observations were made by Prof. Pickering, with the following results: "Shortly before the eclipse the thermometer rose, attaining its maximum at the instant of contact, so that when three digits of 14 per cent. of the sun's disc was obscured, the temperature was about the same as before the eclipse. Again, the thermometer began to rise after the eclipse was over. These anomalies, Prof. Pickering thinks, are explained by the photographs taken at the same time. The increased brightness which they show along the *moon's limb, proves*, he supposes, that the latter augmented the active power of those parts of the sun's disc nearest to it, and thus renders the increase of heat very probable. This is, at least, another contribution to the many explanations of this knotty point.

The photographers' delineations of the eclipse are many, and very beautiful. Photographs were taken during totality by Dr. Curtis, at DesMoines; by Mr. Willard, at Burlington; by Messrs. Brown and Baker, at Ottumwa; by Messrs. James Clifford, Curbutt, and other gentlemen, at Mount Pleasant; by Mr. *Black*, of Boston, at Springfield, Ill.; by Mr. Whipple, at Selbyville, Kentucky; and by ourselves, at *Jefferson. Prof. Davidson took* photographic apparatus to Alaska; but we have not heard what use he made of it. Several other observers, whose telescopes were not provided with clock-work, took pictures during partial obscuration only.

At DesMoines 120 pictures were taken during the partial, and 2 during the total eclipse. They are all faultless. The pictures, before and after totality, were taken at regular intervals, and carefully timed, so as to assist in the correction of nautical tables. The two pictures of totality are probably the grandest photographs of an eclipse ever taken. They are 5½ inches in diameter, and were exposed 120 and 40 *seconds respectively. Owing to* this lengthy exposure the first picture exhibits the chromosphere all round, and shows, combined in one picture, passing phases which were not visible at any one moment. Scientifically, this is a disadvantage. It shows the most exquisite detail in the structure of the chromosphere, especially in a group of fantastic forms in the eastern limb, which, throwing out long tongues of light, have the appearance of delicate flickering flames, in many cases disconnected from the surface of the sun. In the second picture the chromosphere is visible only on the western limb, and is less brilliant than that on the eastern.

By the three parties under Prof. Morton thirteen pictures in all were taken during totality, with exposures varying from 5 to 16 seconds, all more or less successful. All display the chromosphere and protuberances, and one of them, taken the instant before totality, shows the limb of the sun cut into bright dots by the mountainous edge of the moon, settling, Professor Morton thinks, conclusively, the question of the origin of Bailey's beads. The exposure in all cases was too short to secure the corona; but this was most admirably done by Mr. Whipple at Selbyville, who exposed a plate in the principal focus for 40 seconds. Even in this picture the chromosphere may be detected as a very bright ring within the crown of light, but all detail is smothered; for, so actinic is the light issuing from the chromosphere, that probably no picture was exposed briefly enough to catch all the detail in its structure and that of the protuberances, which the photographic plate is capable of delineating. If any attempts are made to photograph the eclipse which will occur in China this year, the aim should be by very short exposure—say one second in the principal focus—to secure the utmost possible definition in the chromosphere. As these protuberances are ever in motion, reliable deductions as to their structure can be drawn only from pictures taken with a very short exposure. From the rapidity which my plates—exposed only ten seconds—developed, I am satisfied a well-defined image of a protuberance can be taken in one or two seconds. So short an exposure would only give the larger masses of the chromosphere, whose light, from the great accumulation of light-giving material burning in them, is very strong; but it should suffice for giving the most minute detail in these masses—detail which is obliterated or blurred in pictures with a longer exposure.

During totality we took four pictures, of one inch diameter, in the principal focus of the large telescope of the Quebec Observatory, which Capt. Ashe had the courage to take with him, and the skill to pack, mount, and re-pack without accident. Our instrument was a nine-foot equatorial, made by Alvan Clarke, of Cambridge, Mass. Our pictures received an exposure of ten seconds each, and were taken at equal distances of time from the beginning to the end of the totality. They exhibit the protuberances and parts of the chromosphere well, but do not show a trace of the corona.

It is not easy to distinguish the protuberances in all cases from the chromosphere whence they spring. Our photographs, and a drawing made by Mr. Vail, of Philadelphia, who rendered us the greatest assistance in our preparations, and carefully noted the passing phenomena of the eclipse through a Dolland 40-inch telescope, agree in laying down five protuberances. Mr. Falconer, of London, who likewise joined our party, distinguished only five protuberances. Professor Morton, on the other hand, finds nine in his pictures. Some that he and we consider as such only differ by being isolated from the neighbouring banks of light. Flames are strongly marked in pictures taken to the east of us, of which the rudiments only are visible in ours; and the large protuberance on the lower limb, which, in our pictures, grows from a bright dot in picture I. to a high flame in picture III., burns down in picture IV. to one-half its former height, and commences to assume the flattened form which it has in all the pictures taken to the east of us. This remarkable protuberance was seen by Capt. Ashe, and the other members of our party, to blaze up rapidly after the exposure of the second picture; then the top of the flame was wafted away to the east, as if by a strong current in the upper atmosphere of the sun, and the body of the flame gradually burned down, assuming the forms it bears in pictures III. and IV.

Mr. Vail described the protuberances, and especially the large one, as follows:—

"But the most remarkable appearance of all, and that which attracted the attention of every one who witnessed the eclipse, whether seen with the naked eye or with the telescope, were the red protuberances that shot up immediately on the disappearance of the sun from various places on the edge of the moon. Their position your photographs will fix better than I can describe. The largest was on the lower edge of the moon, and was, by my estimate, when highest, not less than two minutes in altitude from the edge of the moon, or about 55,000 miles.

"Its color was a bright *pinkish red*; its outlines were perfectly well defined, and were not curves, but rather irregularly broken straight lines; and, throughout, it seemed marked by similar lines.

"It reminded me of the appearance one sometimes sees on the face of a cliff where the rock is broken by horizontal and vertical lines. The same, or nearly the same appearance would be presented if one were to view columnar basaltic rocks from a point where the rocks in the rear would rise above those in front. I would, therefore, suggest whether these lines may not have a similar origin, and each be the outline of a vast column of luminous matter thrown up above the atmosphere of the sun."

Capt. Ashe has made accurate drawings of the structure of the protuberances from our magnified photographs. No semblance of a spiral structure, such as was thought to be discernible in the Indian pictures, exists; but dark lines cut the flame longitudinally and transversely, giving it the appearance—as described by Mr. Vail—of being built of huge blocks, laid in irregular rows. The same structure may be recognized in the lower protuberance on the western limb. The outline of these flames, as delineated in the photographs, is not sharp, especially on their western side, where a hazy band, like a shadow, is very manifest. The bright band of light, broken into flickering flames, which surrounds the eastern limb, exactly corresponds to Lockyer's description of the chromosphere. It presents, however, a different structure on the western limb, where it forms two concentric bands of light, extending round the sun, from the large protuberance on the lower limb, for about 90°. Between the bright bands is a dark space. Within the rings are enclosed three protuberances. The axes of all these protuberances are parallel to one another, and the chromosphere is crossed by numberless lines parallel with one another and the protuberances, and not radiating from the sun's centre, but at right angles to its axis. It would be presumptuous to offer any explanation of these appearances before comparing our pictures with others, as even photographs are liable to so many sources of error.

But justice has not been done our pictures in England, whither they were sent last autumn to the care of M. De La Rue. He faintly praised pictures I. and II., but unhesitatingly pronounced pictures III. and IV. to be worthless, as the telescope must have moved or followed irregularly. He questions the fact of the large protuberance having been seen to shoot up and then burn down, and disregards the minute structure of the protuberances and the chromosphere, considering them photographic blemishes. Mr. Airy concurs in the opinion, which is strengthened, in his mind, by the difference between our pictures III. and IV. and the pictures taken by the American parties to the east of us. This last reason is palpably fallacious. Had any other party photographed the sun at the same moment as ourselves, and our pictures differed, one or other would have been faulty; but the eclipsed sun was neither observed nor photographed by others during the period of totality at Jefferson. Mr. Gilman observed it at Sioux City before totality occurred, and Dr. Curtis photographed it at Des Moines after totality at Jefferson. I saw nothing of the total eclipse, but I heard, in my dark room, the strong expressions of wonder uttered by all at the striking changes in form the protuberance was undergoing, and the very vehement language Capt. Ashe was using toward me on account of the delay in passing him plates when he wanted to catch the strange phase of the dissolving view, as the top of the protuberance was being blown away to the east. There are probably periods of greater or less activity in the life of the prominences, and, considering that but a few prominences are visible for a few hours during a total eclipse, what wonder that a prominence in activity should rarely be seen? Our pictures so closely correspond with the descriptions of the various appearances given independently by intelligent observers on the spot, especially in the structure of the great protuberance, as to afford *prima facie* evidence of their correctness; but Capt. Ashe, in his report to Government, gives geometrical proof to the same effect, by showing that the rings of the chromosphere (if such it be) in picture IV. are perfectly concentric, and that if the independent protuberances which the English astronomers pretended are duplicates of one and the same, be duplicates, the telescope must have moved in *opposite* directions.

The chromosphere appears to be heaped up most densely about the equator, though the largest protuberances in each of the late eclipses was isolated and at a distance from the equator.

All the prominences in our own and others' pictures seem to eat into the moon; and the same appearance is presented by the more elevated portions of the chromosphere. Captain Ashe conjectures that this is due to reflections from the moon's surface. This is clearly proved, he thinks, by the following facts, viz.: that the limb of the moon is distinctly seen as a dividing line between the protuberance and its reflection, and that the inner is a similar and inverted image of the outer figure. The same explanation of this puzzling phenomenon has been given independently by Dr. Gould. But Dr. Curtis believes this appearance to be due to excessive deposition of silver in the photographic plate from vicinity to the bright protuberance. His experiments in proof of this would be conclusive had not the appearance been noticed by the most uninitiated observer when watching the eclipse. A carpenter asked Capt. Ashe what the notches (not a bad expression) in the moon were.

SPECTROSCOPIC OBSERVATIONS.

Spectroscopic observations were made by Professor Young, who was stationed at Burlington, Iowa. He observed nine bright lines, the number noted by M. Rayet at the previous eclipse, though they do not correspond in position. Two, if not three, of the lines are indisputably those of hydrogen, and several others nearly correspond with iron lines. In the following table I give a list of the lines observed, and Professor Young's remarks. The middle column I am responsible for.

Lines Observed by Prof. Young.	Coincidences and Nearest Correspondence.	Remarks.
C.	A hydrogen line	Dazzling in brightness.
1017.5	Near double D—Sodium	Bright, but not equal to C.
1250.2	1250.4.—Iron	Very faint; position only estimated, and extending apparently beyond the protuberance, and thought to be a coronal line.
1350.2	1351.1.—Iron	Like the preceding.
1474	1473.9.—Iron	A little below E; conspicuous, but not half as bright as 1017.5. Like the two preceding, supposed to extend into the corona.
F.	Hydrogen	Next to C in brightness.
2602.2	2601.7.—Iron	A little fainter than 1474; position determined by micrometrical reference to the next.
2796	Hydrogen?	A little below H δ; in brightness, between 1017.5 and 1474.
H δ	Hydrogen	Somewhat brighter than 1474.
B.		Supposed to have been overlooked.

Prof. Harkness, at Des Moines, had taken every precaution to ensure accuracy in the record of his observations. He noted six lines in the protuberances, and one of the same lines in the corona. As might be expected, while he found the different protuberances to possess essentially the same constitution, he detected more lines in one than in another, and found different metals to occur at different altitudes in the prominences. This is not difficult of explar .tion ; for, supposing the protuberance to be caused by violent convulsions, which displace the gaseous envelope of the sun, while the lighter hydrogen which composes the outermost layer will occupy the top of the flame, the heavier metallic vapors will be lifted out of their appropriate strata, and be detected about the base of the protuberance. Suppose, further, that a protuberance on the eastern limb of the sun is examined at the instant of totality, the heavier vapors of the base and the lighter gases of the summit will both be uncovered, and give their respective spectra ; whereas, if a protuberance on the opposite limb be observed, as it is being uncovered, only the summit will be visible, and the hydrogen spectrum alone be obtained, till just before totality finishes, when the base of the protuberance comes into view.

The following Table summarises the result :—

1	2	3^1	3^2	4	Corona.	Mean.	Kirchoff Scale.	Wave length.	Wave length of chemical elements.
46.0	37.0	36.5	36.0	33.0	...	36.3	693	656.9	656.8 Hydrogen—C.
50.0	50.5	....	50.0	50.0	....	50 1	1007	589.4	587.9 (Sodium—D.) unknown.
67.5	67 0	67.0	66.5	67.5	66 5	67 0	1497	530.0	530.7 Iron.
....	....	....	70.5	.....	....	70 5	1611	520.1	518.7 Magnesium.
85.0	...	....	84.0	84.5	....	84.5	2069	487.5	486.5 Hydrogen—F.
....	....	....	114.0	114.5	....	114.2	2770	435.9	435.1 Hydrogen—Hy.

Columns 1, 2, 4 give the lines detected in three different protuberances; columns 3^1 and 3^2 those detected in a fourth protuberance during the observations taken at an interval of some seconds.

There still remain, therefore, to be detected in the protuberances many lines whose position in the chromosphere Mr. Lockyer has determined, though the only metal, whose presence in the chromosphere Mr. Lockyer is certain of, which has not yet been found during an eclipse observation, is "Barium."

THE CORONA.

The corona, such as it appeared to an observer, as previously stated, has been brought out in only one photograph, which was taken by Mr. Whipple. It is a very remarkable picture. In it the corona resembles what it appeared to the naked eye, an irregular, somewhat oval-shaped halo of light, lowest at the poles, but at the equator one-fourth of the sun's diameter in height; diminishing in intensity from within outwards. The rays, which to the eye seemed distinct and in constant motion, like cilia, form in the photograph, of necessity, from the length of exposure, an unbroken sheet of light. Prof. Hume describes the structure of the corona as "fibrous, slightly crooked, or twisted, somewhat like a cirrous cloud, and of silvery whiteness." The dim haze seen round the moon in other photographs is probably also produced by the corona, as the chromosphere would give a better defined outline.

We saw that the Indian observers disagreed as to the spectroscopic character of its light, M. Rayet finding no spectrum, and Major Tennant a continuous one. Prof. Young thinks it gave a faint, continuous spectrum, and that three of the lines, viz.: 1250, 1350 and 1470, which he found in the protuberance spectrum, extend into the corona, and that these three are the lines which Prof. Winlock detected in the spectrum of the aurora borealis. Prof. Young is, however, not confident of the accuracy of his observation, and thinks it possible that the three lines in question may extend only beyond the more visible parts of the protuberance into that hazy region which the photographs dimly reveal, as if it were a shadow thrown by the flame. These three lines are not exactly coincident with any known lines, though they vary very little from three iron lines.

Prof. Harkness is not doubtful of the accuracy of his observation. He found the corona to yield a faint continuous spectrum, with one bright line, whose position is given in the table above. He remarks:—"The brightness of the continuous portion was about equal to—perhaps slightly less than—that of the spectrum which I get from the moon in the same instrument; and I am perfectly convinced that there was no absorption lines. I looked particularly for them, and the light was sufficiently intense, and the slit sufficiently narrow, for me to have seen them if they had been present. The bright line was tolerably conspicuous, but it did not stand out so glaringly as the bright line in the prominences. So far as a single observation can be depended upon, it seems to me that this one tends to prove that the corona is a highly-rarified, self-luminous atmosphere surrounding the sun, and that it is composed principally of iron in the state of incandescent vapor. Probably the selective absorption of the continuous portion of the spectrum is not sufficiently strong to do more than slightly dim, without actually reversing, the bright lines of the chromosphere. But with the bright line at 67.0 divisions of my scale the case is different. If I have rightly identified its wave-length, *it does reverse the solar spectrum*, for the rays whose wave-lengths are 530.7 and 528.8 are respectively identical with the dark lines at 1487.7 and 1508.6 of Kirchoff's maps.

What is the corona, and of what does it consist? If Prof. Young is correct, do the three bright lines which he observed, belong to some unknown element—a gas lighter than hydrogen, and which, like the hypothetical ether, fills space? We can hardly suppose such intense action as exists on the surface of the sun to be unaccompanied by electricity, which, in the auroral light of our own heavens and the corona of the sun, may render this hypothetical gas luminous. Storey, years ago, discussed the likelihood of such an extra-atmospheric medium. If Prof. Young's observations are corroborated by those of others, there may be found some probable proof for such a supposition.

Are the corona and the zodiacal light identical? Major, in his essay, "The Dynamics of the Heavens," offers an explanation of the zodiacal light, as follows:—

"As cosmical masses stream from all sides in immense numbers towards the sun, it follows that they must become more and more crowded as they approach thereto. The conjecture at once suggests itself, that the zodiacal light, the nebulous light of vast dimensions which surrounds the sun, owes its origin to such closely-packed asteroids. However it may be, this much is certain, the phenomenon is caused by matter which moves according to the same laws as the planets, round the sun; and it consequently follows that the whole mass which originates the zodiacal light is continually approaching the sun and falling into it. This light does not surround the sun uniformly on all sides—that is to say, it has not the form of a sphere, but that of a thin convex lens, the greater diameter of which is in the plane of the solar equator; and, consequently, it has, to an observer on our globe, a pyramidal form. Such lenticular distribution of the masses in the universe is repeated in a remarkable manner in the distribution of the planets and the fixed stars." * May, then, the zodiacal and coronal light be one and the same? Supposing the above hypothesis to be correct, would not the asteroids, falling in

* Page 272 of Youman's "Collection of Essays on the Correlation and Conservation of Forces."

a shower towards the sun by their attrition produce a sheet of light resembling the corona? Moreover, as the meteors which fall upon our earth are composed almost entirely of iron, we may suppose those reaching the sun to contain that metal as a predominant element. Although the spectroscopic observations of the corona differ—Professor Young having detected several bright lines, and Professor Harkness only one—by both the presence of iron is rendered highly probable.

POLARISCOPIC OBSERVATIONS.

Prof. Pickering entirely disagrees with the observers of the Indian eclipse as to the polariscopic condition of the coronal light. He says:—"The form of polariscope used was that adopted by Arago in his experiments on sky polarization. It consists of a tube about twenty inches long and two inches in diameter, one end of which is closed by a double-image prism of Iceland spar, and the other by a plate of quartz. Looking through the former, we see two images of the latter, which, when the light is polarized, assume complementary tints. If, now, the corona was polarized in planes passing through the centre of the sun, (as is generally admitted,) when viewed through the polariscope, in one image the upper and lower parts should have appeared blue, and those on the right and left yellow, while in the second image these colours would be reversed.—the yellow being alone below, and the blue on the sides. In reality the two images were precisely alike, and both pure white; but one was on a blue, and the other on a yellow back-ground. From this we infer that the corona was unpolarized, or, at least, that the polarization was too slight to be perceptible." Prof. Pickering adds, that "although this does not prove that it shines by its own light, since polarization is produced only by specula, and not by diffused reflection, yet these observations, and those by the spectroscope, seem to render it probable. This view is also strengthened by the fact, that as the most distant portions are but about 100 parts the distance of the earth, they receive about 10,000 times as much heat per square foot. The coloured background mentioned above shows that the sky, close to the corona, is strongly polarized; and, since the tint is uniform on all sides of the sun, the plane of polarization is independent of the position of the latter—that is, the same on the sides that it is above and below it. The most probable explanation of this most unexpected result is, that the earth beyond the limits of the shadow being strongly illuminated, acts as an independent source of light, and this being reflected by the air, becomes polarized in planes perpendicular to the horizon." These results are so diametrically opposed to those previously obtained, that their accuracy is sure to be called in question.

The discrepancies in opinion of the different observers of the corona, in the late eclipses, are in striking contrast to the accordance of their observations of the protuberances. To the corona attention must chiefly be directed in future, the main points as to the constitution of the protuberances *having been determined*. No means of examining it, except during an eclipse, have yet been proposed; so that unless some method of doing so is devised in the interim, we must wait for the intervention of the moon before we can be sure what that beautiful crown of light is—whether it is composed merely of the rays which issue from behind the moon as we see them radiate from behind a cloud when it obscures the sun; or whether they emanate from some metal known or unknown, forming an extremely attenuated atmosphere beyond the hydrogen envelope; or whether they are identical with the auroral or the zodiacal light, whatever they may be.

CANADIAN DIATOMACEÆ.

By William Osler,

[Of the Toronto School of Medicine.]

Among the many beautiful objects which the microscope has revealed to us, none, perhaps, are such general favourites, (especially with the younger microscopists,) as the Diatomaceæ. Their almost universal distribution — the number of species — and above all, the singular beauty and regularity of their markings — have all tended to make them objects of special interest and study. In the following paper I propose to give, briefly, the principal points connected with their life, history, and structure, together with a list of those species I have met with in Canada.

Standing, as they do, upon the very border-land between the animal and vegetable kingdoms, it is not to be wondered at that the earlier observers, unable to free their minds from the idea of motion being a special characteristic of animal life, claimed for them a place with the former; stricter investigations, aided with better instruments, have proved most conclusively that their real position is among the Protophytæ.

A Diatom consists, essentially, of a single cell, and only differs from the other unicellular plants in the ultimate structure of its cell wall, which is impregnated with silex—this impregnation always following a definite and distinct pattern in each organism, and forming a most valuable means of determining the species.— I need hardly observe that this secretion of silex is by no means peculiar to the Diatomaceæ; parallel instances are found in the Equisteæ, and many other plants. On examining a living frustule the cell-contents are clearly seen, consisting of a bright central nucleus (not always visible,) and a yellowish brown-coloured substance called Endochrome, dispersed throughout the frustule; this is sometimes seen to exhibit the phenomenon of cyclosis, moving freely from one portion of the cell to the other. In addition, several oil-globules are usually present. These, at certain seasons, become very abundant; so much so, as almost to take the place of the Endochrome. At the apices and sides of the frustule a clear or slightly granular substance exists, which, as we shall see, Prof. Schultze believes to be the chief agent in producing the movements of this family. A curious motion of granules is to be observed in some diatoms, which is very similar to, and probably owes it origin to the same cause as the "swarming of the Desmids."

The siliceous envelope is composed of two valves of the most perfect symmetry, which are at first in close proximity to one another, and enclose between them the cell-contents; but as the process of self division goes on, the valves separate from each other, and a hoop or connecting membrane is formed, usually containing less silex, and not often presenting the beautiful markings so well seen on the valves. The connecting membrane generally separates from the valve on the application of strong heat, or on boiling the frustules with nitric acid.

When the connecting membrane is turned towards the observer, it is said to be the "front view;" when the valves are turned, the "side view." It is on the valves principally that the markings so characteristic of the Diatomaceæ, and about which so much discussion has taken place, occur. Until recently, great uncertainty prevailed as to the true nature of these markings, especially in the genus Pleurosigma,—some maintaining that they were depressions, others regarding them as elevations. The Rev. Mr. Reade has at last, I believe, settled this vexed question by means of a very simple little piece of apparatus, which he calls a "Diatom prism." With this he clearly demonstrates that the dots into which the striæ are resolvable in the Pleurosigma and allied genera are elevations, and he aptly compares them to a "field of haycocks," or a "plate of marbles." Through the kindness of Prof. Bovell, I have been enabled to use the prism, and certainly the *appearances produced strongly favour this view.* The large cellular markings of some of the marine genera, Isthmia for example, are undoubtedly depressions, while in the beautiful genus Pinnularia, the striæ are continuous, and have been called by Mr. Thwaites, "costæ."

Minute apertures exist along the line of suture, and at the apices, through which the cell is nourished; these, in some genera, communicate with the interior by means of channels (canaliculi) hollowed out between the valve and primordial utricle. Nodules of silex are present at the centre and extremities of the valves, in many species. These, by Ehrenberg and others, were supposed to be apertures; but they probably only serve to give additional strength and firmness to the valves.

Increase in the Diatomaceæ takes place in several ways, namely —by division — by conjugation — and, most likely, by the formation of gonidia. The first of these methods is, as Mr. Thwaites observes, rather an act of generation than of reproduction. It is thus described by Messrs. *Griffith and Henfrey* — "The primordial utricle, enclosing the contents, divides into two portions, which separate from one another in a plane parallel with the sides of the undivided frustule; the two halves of the parent cell gradually separate from one another, remaining connected by the simultaneous gradual widening of the hoop. In the space thus afforded the two segments of contents secrete each a new layer of membrane (ultimately silicified) over the surfaces where they are in contact, which layers of membrane constitute the two new half frustules, back to back, corresponding to and conjoining with the two half frustules of the parent, to form new individuals." In the free species, when the self-division is completed, the hoop drops off — and it is not until that occurs, that the two new half frustules become perfectly silicified; but in the filamentous species the hoop is persistent, and forms the connecting band between the frustules. The true act of reproduction is, comparatively speaking, rare among the Diatomaceæ, and probably only occurs when conditions become unfavourable to the process of self-division.—In this act two frustules approach one another — their concave surfaces being in apposition; from each of these surfaces two conical projections of the Endochrome are seen — these coalescing become developed into sporangial frustules, which are considerably larger than the parent ones, but exhibit similar markings. Varieties of this mode occur in several genera; in some (Himantidium) the product of the united Endochrome is a single sporangial frustule, while in others (Cocconeis, etc.) the Endochrome of a single frustule escaping, may develop into a sporangium. During the act both old and developing frustules are enclosed in a thick layer of mucous. The subsequent history of the sporangia is as yet very imperfectly understood; but it is probable that their contents break up into gonidia, and these becoming encysted, develop into several individuals — though some believe that the sporangia undergo self-division, to a limited extent, before breaking up into the gonidia.

The movements of the living frustule are of a most peculiar kind, and are generally described as a "series of successive jerks in a straight line, and a return, after a slight pause, upon the same path." To explain this motion various hypotheses have been advanced, from time to time. Some observers supposed that cilia were the active agents in producing it, and even went so far as to publish woodcuts of the Diatoms, with the cilia at either end. These have been proved, by Mr. Wenham, to have been "optical delusions." It is true, however, that hair like processes, uniformly arranged, and bearing a striking resemblance to cilia, are very often seen attached to Diatoms — (this seems especially the case in Nitzshia sigmoidæa, though it not uncommonly happens that the Diatoms of a whole gathering have them) — but these are never seen in motion, and appear to impede rather than assist the movements. They are, in all probability, of fungoid origin. Nageli's hypothesis, namely — that the movements are produced by endosmotic and exosmotic currents, is one which has met with considerable favour. It was advocated by the late Prof. Smith, and still is, I believe, by Dr. Carpenter. Prof. Max Schultze, of Bonn, has recently advanced a view, which certainly appears reasonable, if borne out by facts. It is this: He supposes that the clear, or slightly granular protoplasmic fluid, which extends underneath the valves, along the raphe to the apices, and in which a movement is sometimes seen, is in connection, by means of excessively minute pores in the raphe, with a similar, clear external layer; and in this way the movements of the protoplasm are communicated through the pores to the external layer, enabling the frustule, when in contact with smooth surfaces, to glide along, with undulating motion, not unlike a snail.

Below is given a list of one hundred and ten species, comprised in thirty-one genera. Many more, no doubt, will be found, as the number of practical microscopists increase in the country.

In conclusion, I beg to acknowledge the many obligations I am under to Prof. Bovell, of Trinity College, and the Rev. W. A. Johnson, of Weston, Ont.; from both these gentlemen I have received much valuable assistance, especially in the use of books and microscopical apparatus.

EPITHEMIA, KUTZ.

E. turgida, Sm.—Common. Grenadier Pond; Sandy Cove.
E. granulata, Kutz.—Rare. Grenadier Pond.
E. zebra, Kutz.—Rare. Desjardin Canal.
E. gibba, Kutz.—Common. Humber Ponds.
E. ventricosa, Kutz.—Not uncommon. Kempenfelt Bay.
E. argus, Sm.—Rare. Desjardin Marsh; Burlington Bay.
E. ocellata, Kutz.—Rare. Grenadier Pond.
E. sorex, Kutz.—Rare. Ditch at Ancaster; Don River.
E. proboscidea, Kutz.—Numerous. Stream near London.

EUNOTIA, EHR.

E. arcus, Sm.—Numerous. Cedar Swamp, Weston; Humber Bay.
E. tetrodon, Ehr.—Rare. Desjardin Canal.

CYMBELLA, AG.

C. Ehrenbergii, Kutz.—Not uncommon. Grenadier Pond; Desjardin Canal; Don River.
C. maculata, Kutz.—Rare. Stream at Niagara Falls.
C. Scotica, Sm.—Rare. Grenadier Pond.

AMPHORA, EHR.

A. ovalis, Kutz.—Common. Grenadier Pond; Sandy Cove; Lake Simcoe.

A. minutissima, Sm.—Rare. Sunken boat at mouth of River Humber.

COCCONEIS, EHR.

C. Thwaitesii, Sm.—Common. Grenadier Pond.

C. pediculus, Ehr.—Very common. Constantly attached to Cladophora glomerata in the fall. Wharves at Toronto.

C. Placentula, Ehr.—Rare. Wharf at Orillia.

CYCLOTELLA, KUTZ.

C. Kutzingiana, Thw.—Frequent. Stream at London; Desjardin Canal; Grenadier Pond.

C. operculata, Kutz.—Rare. Sandy Cove; Lake Simcoe.

C. rotula, Kutz.—Rare. Pond Mills; London.

SURIRELLA, TURP.

S. splendida, Kutz.—Common. Pond near Clifton House, Niagara Falls, (numerous); Grenadier Pond; London.

S. nobilis, Sm.—Rare. Sandy Cove; Lake Simcoe.

S. minuta, De Breb.—Rare. University Pond, Toronto; Stream near Weston, (Rev. W. A. Johnson.)

S. biseriata, De Breb.—Rare. Burlington Bay.

S. craticula, Ehr.—Very rare. Sandy Cove; Lake Simcoe.

S. linearis, Sm.—Not uncommon; Grenadier Pond.

TRYBLIONELLA, SM.

T. angustata, Sm.—Rare. Marsh at Dundas.

CYMATOPLEURA, SM.

C. solea, Sm.—Common. Don River; Grenadier Pond.

C. elliptica, Sm.—Uncommon. Mouth of the Humber.

C. apiculata, Sm.—Common, with *C. solea*.

NITZSCHIA, HASS.

N. sigmoidea, Sm.—Not uncommon. Humber Ponds; Burlington Bay.

N. Brebissoni, Sm.—Rare. Barrie; Don River.

N. amphioxys, Sm.—Not uncommon; Island Ponds, Toronto.

N. acicularis, Sm.—Rare. Niagara Falls.

N. tenuis, Sm.—Rare. Wharf at Orillia.

N. minutissima, Sm.—Common. Mono Mills; Island Ponds, Toronto.

AMPHIPLEURA, KUTZ.

A. pellucida, Kutz.—Rare. Grenadier Pond.

NAVICULA, BORY.

N. cuspidata, Kutz.—Common. Sandy Cove; Niagara Falls.

N. lanceolata, Kutz.—Common. Desjardin Canal; Humber Ponds; Don Marsh.

N. ovalis, Sm.—Rare. River Thames, London.

N. amphirhynchus, Ehr.—Rare. Desjardin Canal.

N. rhomboides, Ehr.—Common. Burlington Beach.

N. affinis, Ehr.—Common. Sandy Cove; Grenadier Pond.

N. tumida, Sm.—Rare. Toronto Bay.

N. crassinervia, Ehr.—Rare. Sandy Cove; Pond at Ancaster.

N. sphærophora, Kutz.—Rare. Niagara Falls.

N. ambigua, Ehr.—Not uncommon. Don River; Kempenfelt Bay; Welland Canal.

N. amphisbæna, Bory.—Common. Niagara River, above the Falls.

N. producta, Sm.—Rare. Pond at Dundas.

PINNULARIA, EHR.

P. major, Sm.—Common. Sandy Cove; Humber Ponds.

P. gibba, Ehr.—Common. Clifton; Mono Mills; Don River.

P. stauroneiformis, Sm.—Rare. Grenadier Pond.

P. nobilis, Ehr.—Not uncommon. Grenadier Pond; Desjardin Canal.

P. acuta, Sm.—Rare. Stream at London.

P. viridis, Sm.—Common. Humber Ponds; Burlington Bay.

P. mesolepta, Ehr.—Rare. Grenadier Pond.

P. acuminata, Sm.—Rare. Sunken boat at mouth of Humber.

P. oblonga, Sm.—Common. Grenadier Pond; Oakville.

P. acrosphæria, Sm.—Common. Humber Ponds; Thames, London.

STAURONEIS, EHR.

S. Phœnicenteron, Ehr.—Not uncommon. Grenadier Pond.

S. acuta, Sm.—Rare. Sandy Cove; River Don.

S. dilatata, Sm.—Rare. Burlington Bay.

S. gracilis, Ehr.—Common. Island Ponds, Toronto; Humber Ponds.

S. punctata, Kutz.—Rare. River Don.

S. linearis, Ehr.—Very rare. Pond near Niagara Falls.

S. anceps, Ehs.—Common. Desjardin Canal; Kempenfelt Bay.

PLUROSIGMA, SM.

P. attenuatum, Sm.—Not uncommon. Outlet of Grenadier Pond; Don Marsh; Burlington Beach.

P. Spencerii, Sm.—Rare. Mr. Saunders' farm, London; Desjardin Canal.

SYNEDRA, EHR.

S. lunaris, Ehr.—Rare. Humber Bay; Stream at Barrie.

S. minutissima, Kutz.—Common. River Thames, London.

S. radians, Sm.—Very common. Streams at Dundas, Weston, Paris, London, etc.

S. capitata, Ehr.—Common. Sandy Cove; Grenadier Pond.

S. ulna, Ehr.—Not uncommon. Niagara Falls; Humber Bay.

S. longissima, Sm.—Rare. Sunken boat, Humber River.

S. fasciculata, Kutz.—Common. Stream at London.

COCCONEMA, EHR.

C. lanceolatum, Ehr.—Common. Grenadier Pond; Desjardin Canal.

C. parvum, Sm.—Rare. Pond at Ancaster.

C. cistula, Ehr.—Not uncommon. Sandy Cove; Humber Bay.

GOMPHONEMA, AG.

G. geminatum, Ag.—Common. On *Cladophora glomerata*, in swiftly running streams, and on wharves.

G. olivaceum, Ehr.—Common. Trinity College stream, and streams at Weston.

G. acuminatum, Ehr.—Not uncommon. Grenadier Pond.

G. cristatum, Ralfs.—Rare. Mouth of the Humber.

G. dichotomum, Kutz.—Common. Wharves, Toronto; Grenadier Pond; St. Lawrence, at Prescott, (Rev. W. A. Johnson.)

G. curvatum.—Not uncommon. Grenadier Pond; Desjardin Canal.

MERIDION, AG.

M. circulare, Ag.—Common. Cedar swamp, Weston; streams at Weston, Dundas, and Toronto.

M. constrictum, Ralfs.—Rare. Island Pond, Toronto.

HIMANTIDIUM, EHR.

H. arcus, Sm.—Not uncommon. Burlington Bay, Humber Ponds.

H. pectinale, Kutz.—Common. Grenadier Pond; stream at Paris.

H. majus, Sm.—Rare. Kempenfelt Bay.

ODONTIDIUM, KUTZ.

O. mutabile, Sm.—Common. Sandy Cove; Lake Simcoe; stream at London.

O. Tabellaria, Sm.—Rare. Mouth of Desjardin Canal.

O. parasiticum, Sm.—Rare. Sandy Cove; Lake Simcoe.

O. Harrisonii, Sm.—Frequent. Kempenfelt Bay; stream at Dundas.

O. anomalum, Sm.—Not uncommon. Don Marsh; Grenadier Pond.

FRAGILARIA, LYNG.

F. capucina, Desm.—Common. Streams at Dundas, Toronto, London, and Oakville.

F. virescens, Ralfs.—Not uncommon. Desjardin Canal.

ACHNANTHES, BORY.

A. exilis, Kutz.—Not uncommon. Stream at Hamilton; Humber Ponds.

DIATOMA, DEC.

D. vulgare, Bory.—Very common. Grenadier Pond and elsewhere.

D. elongatum, Ag.—Common. Desjardin Canal; stream at Orillia.

TABELLARIA, EHR.

T. flocculosa, Kutz.—Frequent. Humber Ponds; Burlington Bay; Cedar Swamp, Weston.

T. fenestrata, Kutz.—Common. River Thames, London.

MELOSIRA, AG.

M. varians, Ag.—Common. Stream near Dundas; wharves at Toronto.

ORTHOSIRA, THWAITES.

O. orichalcea, Sm.—Rare. Sandy Cove; Lake Simcoe.

O. spinosa, Sm.—Rare. Buoy in Burlington Bay.

ENCYONEMA, KUTZ.

E. prostratum, Ralfs.—Common. Wharves at Toronto; water trough near Dundas.

COLLETONEMA, BRIB.

C. vulgare, Thw.—Rare. Mill-stream, Dundas.

C. neglectum, Thw.—Not uncommon. River Don; Toronto Island; Kempenfelt Bay.

NOTES ON THE BIRDS OF NEWFOUNDLAND.

By Henry Reeks, F.L.S., &c.

(*Continued from page 47.*)

Picidæ. The Woodpeckers.

Hairy Woodpecker, or *Sapsucker* (Picus villosus, *Linn.*)—Tolerably common, and does not migrate. Newfoundland specimens appear to agree with Professor Baird's variety—*medius*.

Downy Woodpecker, or *Sapsucker* (P. pubescens, *Linn.*)—Very common, and, like the preceding species, is non-migratory.

Black-backed Three-toed Woodpecker (Picoides arcticus, *Swains.*)—This fine species is tolerably common in Newfoundland throughout the year; and, often when the snow is drifting through these dreary forests, no other sign of animal life is noticeable than the "Woodpecker tapping" in search of the larvæ of several fine species of Sirex which abound there.

Banded Three-toed Woodpecker (Picoides hirsutus, *Vieill.*)—Scarcely so common as the preceding species, but, like that, is a resident throughout the year. I shot several males, but had a difficulty in getting a female, though I succeeded at last in killing one specimen. It is a rather darker bird than the male, and is without the yellow patch on the crown, having that part spotted with white. The transverse bands on the back are similar to those on the male.

Black Woodcock, or *Logcock* (Hylotomus pileatus, *Linn.*)—This is the "great black Woodpecker" of the Newfoundland settlers, and appears to be rather rare, as I did not meet with it during my stay there. It is probably a summer migrant.

Flicker (Colaptes auratus, *Linn.*)—This species is a summer visitor to Newfoundland, where it is called the "English Woodpecker," and is tolerably common. It has a peculiar note, which bears a fancied resemblance to that of the green Woodpecker (*Picus viridis*;) hence the name bestowed on it by the settlers.

Three other species of Woodpecker probably occur in Newfoundland, but I did not meet with them, viz., *Sphyrapicus varius*, Linn.; *Centurus Carolinus*, Linn.; and *Melanerpes erythrocephalus*, Linn.

CYPSELIDÆ. The Swifts.

American Chimney Swallow (Chætura pelasgia, *Linn.*)—apparently rare, at least at Cow Head. I only examined one specimen, shot in June, 1868. It is, of course, a summer migrant.

American Night Hawk (Chordeiles popetue, *Vieill.*)—Well known to the settlers as the "Night Hawk," but I did not meet with a specimen. It is a summer migrant.

ALCEDINIDÆ. The Kingfishers.

Belted Kingfisher (Ceryle alcyon, *Linn.*)—Tolerably common during the summer months, and, like the British species of Kingfisher, builds in banks, often at a considerable depth, and lays five or six white eggs. I have always found the belted Kingfisher a very shy bird, and difficult to get a shot at.

TYRANNIDÆ. The Tyrant Flycatchers.

King Bird, or *Bee Martin* (Tyrannus Carolinensis, *Linn.*)—Visits Newfoundland for nidification, and is tolerably abundant. I have shot them after the first fall of snow in the autumn.

Pewee (Sayornis fuscus, *Gmelin.*)—A summer migrant, but not common.

Wood Pewee (Contopus virens, *Linn.*)—A summer migrant, arriving in May. Not common.

Least Flycatcher (Empidonax minimus, *Baird.*)—A single specimen, obtained in the month of June, 1868. It is a summer migrant.

Green-crested Flycatcher (Empidonax Acadicus, *Gmelin.*)—Not very common. Frequents woods in the neighbourhood of houses, and is a summer migrant.

Yellow-bellied Flycatcher (Empidonax flaviventris, *Baird.*)—Apparently a common summer migrant, arriving in May.

TURDIDÆ. The Thrushes.

Hermit Thrush (T. Pallasi, *Cabanis.*)—A common summer visitor, and tolerably good songster. Arrives about the middle of May.

Wilson's Thrush (T. fuscescens, *Stephens.*)—A summer migrant, but not so common as the preceding species. One specimen, obtained in May, 1868.

Olive-backed Thrush (T. Swainsoni, *Cab.*)—A summer migrant, but scarcely so common as *T. Pallasi.*

Migratory Thrush, or *American Robin* (T. migratorius, *Linn.*)—A summer migrant, and by far the commonest of all the Turdidæ. Arrives in April, and soon commences building. I have taken the eggs early in May. This bird is called the "Robin" by the English settlers, evidently from its redbreast and familiarity; it is, however, about the size of the Fieldfare (*T. pilaris,*) and much resembles that bird in habits. The eggs are not quite so large, and of an unspotted blue. A pair of these birds occupied the same nest at Cow Head for six consecutive years. Considering the vast number of "Robins" which annually breed in Newfoundland, this habit may account for the scarcity of old nests, so apparent in passing through the thick fir woods.

Blue Bird (Sialia sialis, *Linn.*)—A summer migrant, and said, by the settlers, to be occasionally common. I did not, however, meet with it.

Ruby-crowned Wren (Regulus calendula, *Linn.*)—Not uncommon. Arrives in Newfoundland in May.

[*Hydrobata Mexicana,* Bonap.—Has this species really occurred in Nova Scotia? *Vide* Downs on the "Land Birds of Nova Scotia."]

SYLVICOLIDÆ. The Warblers.

American Tit Lark (Anthus Ludovicianus, *Gmelin.*)—I do not think this bird breeds in Newfoundland, as I have only seen it in August, or during the autumnal migration.

Black and White Creeper (Mniotilta varia, *Linn.*)—Apparently a common summer migrant.

Maryland Yellowthroat (Geothlypis trichas, *Linn.*)—A summer migrant. Common.

Nashville Warbler (Helminthophaga ruficapilla, *Wilson.*)—A summer migrant, but apparently rare. One specimen, obtained in June, 1868.

Oven Bird, or *Golden-crowned Thrush* (Sciurus Aurocapillus, *Linn.*)—A summer migrant, but not common.

Black-throated Green Warbler (Dendroica virens, *Gmelin.*)—A summer migrant, and tolerably common, arriving towards the latter end of May.

Yellow-rumped Warbler (D. coronata *Linn.*)—A common summer migrant, arriving early in May.

Bay-breasted Warbler (D. castanea, *Wilson.*)—Tolerably common. Arrives in Newfoundland early in June.

Chestnut-sided Warbler (D. Pennsylvanica, *Linn.*)—Tolerably common throughout the summer.

Black-poll Warbler (D. striata, *Forster.*)—Apparently not uncommon in summer.

Yellow Warbler (D. æstiva, *Gmelin.*)—A common summer migrant, and called, by the settlers, "Yellow-hammer." It makes a pretty little nest in low bushes, somewhat resembling that of our English Goldfinch.

Yellow Red-poll Warbler (D. palmarum, *Gmelin.*)—One of the arliest spring migrants, and tolerably common.

Black and Yellow Warbler (D. maculosa, *Gmelin.*)—Arrives in May, and is tolerably common.

Green Black-cap Flycatcher (Myiodioctes pusillus, *Wilson.*)—A summer migrant. Arrives in June, but is not very common.

Canada Flycatcher (M. Canadensis, *Linn.*)—Arrives in June, but not common.

American Redstart (Setophaga ruticilla, *Linn.*)—A summer migrant, but rare in the north of Newfoundland. It is called "Goldfinch" by the English settlers. Arrives about the middle of May.

HIRUNDINIDÆ. The Swallows.

Barn Swallow (Hirundo horreorum, *Barton.*)—A rare summer migrant at Cow Head.

Cliff Swallow (H. lunifrons, *Say.*)—An equally rare summer migrant with the preceding species.

White-bellied Swallow (H. bicolor, *Vieill.*)—A summer migrant, and very common at Cow Head; in fact, the only species of swallow to be seen there throughout the summer.

Bank Swallow, or *Sand Martin* (Cotyle riparia, *Linn.*)—Very rare at Cow Head, but said to be very common about the Bay of St. George, and further south.

Purple Martin (Progne purpurea, *Linn.*)—This beautiful species appears rare in Newfoundland; at least I only obtained one specimen, shot at Daniels' Harbour in June, 1868. The settlers did not seem to be acquainted with the bird, or know anything of its breeding habits.

[*Note.*—Of the Bombycillidæ, Ampelis cedrorum, *Baird*, be looked for in Newfoundland.]

LANIIDÆ. The Shrikes.

Great Northern Shrike, or *American Butcher Bird* (Collyrio borealis, *Vieill.*)—Visits Newfoundland in its periodical migrations, but appears rare. Perhaps a few remain to breed on the island, although I have no evidence at present to prove it.

Yellow-throated Flycatcher (Vireo flavifrons, *Vieill.*)—A summer migrant, and appeared tolerably common in 1868 arriving in June at Cow Head.

LIOTRICHIDÆ.

Winter Wren (Troglodytes hyemalis, *Vieill.*)—Common, and resident throughout the year.

CERTHIIDÆ.

American Creeper (Certhia Americana, *Bonap.*)—Apparently a summer migrant, but not very common. I am inclined to think this bird may not migrate, although I did not observe it in the depth of winter.

Red-bellied Nuthatch (Sitta Canadensis, *Linn.*)—Perhaps a resident on the island. The only one obtained was in April, 1868. It is certainly a rare bird at Cow Head.

PARIDÆ.

Black-cap Titmouse (Paris atricapillus, *Linn.*)—Common, and resident throughout the year. Breeds in holes in trees; sometimes adopts deserted holes made by *Picus pubescens*.

Hudsonian Tit. (P. Hudsonicus, *Forster.*)—Common, and non-migratory. Breeds in holes in trees, and associates with the preceding species in winter, at which season the juvenile Newfoundlanders frequently amuse themselves by calling these little birds around them and knocking them off the boughs with a stick, or even the ramrods of their guns. My specimens were obtained for me in this manner.

FRINGILLIDÆ.

American Pine Grosbeak (Pinicola Canadensis, *Briss.*)—Common throughout the year, but apparently more abundant in winter, when they get together in small flocks of about two broods. They feed on the *buds only* of Pinus, Abies, Larix, &c., and are very tame, being often killed with sticks. Provincial name, "Mope."

Yellow Bird, or *Thistle Bird* (Chrysomitris tristis, *Linn.*)—A common summer migrant.

Pine Finch (C. pinus, *Wilson.*)—A summer migrant, but apparently not so common as the preceding species.

From my short residence in Newfoundland the observations on the distribution of some of the smaller species belonging to the *Fringillidæ*, *Sylvicolidæ*, &c., may not be of much value—*e. g.*, it is very probable that some birds, especially of these families, which are not uncommon, and even generally distributed over the island, may have altogether escaped my notice, while, on the other hand, some rare, or otherwise not regular migrants, may have fallen to my gun on more than one occasion during the summers of 1867 and 1868. In such cases I have naturally stated the birds to be frequent, or common, as the evidence may tend to show.

American Crossbill (Curvirostra Americana, *Wilson.*)—Common throughout the year, and an early breeder. Feeds on the seeds of *Coniferæ*, and is called by the settlers the "large spruce bird," to distinguish it from the following species.

White-winged Crossbill (C. leucoptera, *Gmelin.*)—These pretty little birds are common throughout the year, but more abundant during winter, when they congregate in small flocks of from five to twenty individuals, feeding principally on the cones of the White Spruce (*Abies alba.*) When feeding these birds are usually very tame, and easily approached. I kept an old "Joe Manton," loaded with small shot, in the house, for the purpose of shooting Crossbills and other small birds, and remember, on one occasion, snapping three percussion caps at a small flock of *C leucoptera*, within fifteen yards of me, without causing them sufficient alarm to take wing. They have a very pleasing note, much resembling the song of the canary. The provincial name is "Spruce Bird."

Mealy Redpole (Ægiothus linaria, *Linn.*)—Very common, and does not migrate. Breeds early, and generally in alder bushes; hence its provincial name of "Alder Bird." Feeds on the buds of *Coniferæ*, &c., when the ground is covered with snow.

Snow Bunting (Plectrophanes nivalis, *Linn.*)—Very common in its periodical migrations, but, I scarcely think, breeds on the island, although I saw a good many there in June last (1868.) Provincial name, "Snow Bird."

I did not meet with *P. lapponicus*, Linn., but it is probably seen in some parts of the island.

Savannah Sparrow (Passerculus Savanna, *Wilson.*—Abundant throughout the summer. Frequents grassy places, building its nest on the ground. Provincial name, "Grass Bird."

White-crowned Sparrow (Zonotrichia leucophrys, *Forster.*)—A common summer migrant, arriving in May.

White-throated Sparrow (Z. albicollis, *Gmelin.*)—A summer migrant, and equally common with the preceding species. Arrive in May, usually towards the latter end of the month.

Snow Bird (Junco hyemalis, *Linn.*)—A summer migrant, arriving about the last of May, and tolerably common throughout the summer.

Chipping Sparrow (Spizella socialis, *Wilson.*)—A common summer migrant.

Fox-coloured Sparrow (Passerella iliaca, *Merrem.*)—This fine species of Sparrow is a summer migrant, and very common. It is called the "Hedge Sparrow" by the settlers, and is very troublesome in gardens, scratching up fine seeds. Breeds sometimes on the ground, at others in low bushes.

ICTERIDÆ.

Rusty Blackbird (Scolecophagus ferrugineus, *Gmelin.*)—A regular and common summer migrant, remaining generally until after the first fall of snow.

Crow Blackbird (Quiscalus versicolor, *Linn.*)—A summer migrant, but rare; at least I only saw one specimen at Parson's Pond, about twelve miles north-east of Cow Head.

CORVIDÆ.

American Raven (Corvus carnivorus, *Bartram.*)—Common throughout the year. I think Wilson and Audubon were right in not separating this bird from the European *C. Corax.* I cannot see the least difference—at least, not more than would be found in examining a quantity of either species, if they are distinct. The more slender bill is more individual than typical of the American bird. The eggs certainly cannot be separated, but this is also the case with several of the *Corvidæ*, which are otherwise well marked and well-known species.

American Crow (C. Americanus, *Audubon.*)—A common summer migrant to Newfoundland, arriving in April. Frequents the sea coast, breeds in trees, and lays four or five eggs much resembling those of *C. frugilegus.* It is called the "Otter Crow" by the settlers.

Pica Hudsonica, *Sabine*—May reasonably be expected to occur in Newfoundland, but I am inclined to think it does so only as a straggler.

Blue Jay (Cyanura cristata, *Linn.*)—A summer migrant, but not common. Breeds in Newfoundland, and is called the "Silken Jay" by the settlers.

Canada Jay (Perisoreus Canadensis, *Linn.*)—Common, and remains throughout the year. In some of its habits, and especially its familiarity, this bird much reminds the English sportsman of Robin Redbreast at home. When camping in the woods, miles back in the country, the Canada Jay, or, as it is often called, "Whiskey Jack," was ever my constant, and, frequently, only feathered companion. Like others of its tribe it appears very partial to raw meat for food, although, when in the vicinity of houses, it becomes almost omnivorous, eating bread, fish, potatoes &c., with an evident relish. It is said to collect and store away large quantities of cranberries for winter use. I have never met with any of these "stores," but have often noticed the Jays picking the berries, especially in the spring of the year, where the snow has disappeared in patches in the open marshes. In a state of nature I think the Canada Jay is even tamer than the Robin. I remember on one occasion, particularly when deer-hunting in the country, I had the hearts of three caribou hanging to the "tilt," or camp, within four feet of my head, and, although unable to leave the "tilt" for the whole day, from bad weather, the Jays managed to eat all the fat from the hearts, notwithstanding I continually drove them away, but, like vultures and carrion crows, with every re-appearance there seemed a re-inforcement, until at last, to save my venison, I had to amuse myself by firing balls at them from my rifle as they sat on and picked a fine fat quarter of caribou only a few yards distant from the camp. My specimens were obtained by tying a piece of meat to the pan of a rat-gin and retiring a few yards from the trap: they were invariably caught by the bill. The settlers, strange to say, cannot succeed in keeping this bird alive in confinement.

I did not meet with any of the *Columbidæ* in Newfoundland. *Ectopistes migratoria*, Linn., may prove an occasional straggler there.

(To be continued.)

ON THE ORIGIN AND CLASSIFICATION OF ORIGINAL OR CRYSTALLINE ROCKS.

BY THOMAS MACFARLANE.

(Continued from March Number.)

III.—TEXTURE OF ORIGINAL ROCKS.

In adverting to the origin of rocks, those which have been called original were described as analogous in nature to furnace scoriæ. This may seem a forced comparison, and it may be supposed that crystalline rocks are not likely to be influenced by heat; but the truth is that nearly every one of them have been shewn, experimentally, by Hall, Bischof, Delesse, and Sorby, to be fusible, and to be reduced by a high temperature to the same condition as furnace scoriæ. But while the latter generally exhibit, on cooling, a homogeneous mass, original or compound crystalline rocks are most frequently seen to be composed of various and different minerals. While the furnace slags, in rapid cooling, had no time during which their chemical constituents could arrange themselves into different compounds, the greater number of original rocks, having solidified in enormous masses, and, doubtless, during long periods of time, their constituents had opportunity for arranging themselves in such a manner as their chemical affinities suggested. The minerals, which were the result of this re-arrangement of the chemical elements, are not, however, always readily recognized in rocks. The latter have in some rare cases solidified so hurriedly that they present merely the appearance of natural glass. Others have had time to lay aside the vitreous character and assume a stony appearance, but they appear so homogeneous and fine-grained that their compound nature would scarcely be suspected. This is, for instance, the case with basalt, which, on this account, was at one time regarded as a simple mineral. On grinding it to powder and washing it, however, Cordier found it to consist of several minerals with distinct physical characters. A good many other rocks are seen, on examination, to be distinctly compound, but their constituent minerals are developed in such minute grains that their determination becomes a matter of very great difficulty. It is only in the coarser and large grained rocks that the constituent minerals can be readily recognized by the student, and their physical and chemical properties easily tested.

These variations in the size of the constituent minerals are accompanied by differences in their form and position, and, both together, give rise to what is called the texture of crystalline rocks,—difference in which may easily and at once be detected by the student. Coarse and fine grained, schistose and slaty, vitreous, porous, and other such names, are used for characterizing peculiarities of texture, which are not at all to be regarded as merely trifling accidents in the history of rocks, but which really possess a deeper meaning than we are inclined at first to imagine. Although neither the furnace nor the volcano can give us any conception of the magnitude of the scale upon which the earlier original, or, as they have been named, the plutonic rocks, were erupted, still, they furnish us with hints which we cannot afford to neglect. To the metallurgist, it is an every day occurrence to observe that the same scoriæ yields either a vitreous slag or a stony mass, accordingly as it has been quickly or slowly cooled. Slag cakes, a few inches in diameter, are found to be impalpable or glassy on the outside, while on breaking them, the interior is found to be porcelain-like or crystalline. Bischof made some interesting experiments on this matter at the iron-works of Mägdesprung in the Hartz. He allowed common iron furnace slag to run into cold water, where it disengaged sulphuretted hydrogen, and yielded a white, easily friable pumice stone. He next allowed the slag to solidify upon cold, somewhat moist, sand. This gave a harder pumice, still retaining some of the original color of the slag. In the next experiment the slag was allowed to cool on a completely dry bottom of sand, and the result was a brownish-green transparent glass. Under a protecting cover of dry sand, the solidified slag was found to contain crystalline quadratic prisms in considerable numbers, and between them lay spherical concretions, consisting of regular radiating fibres, extending from the middle point in every direction. In the last experiment the slag was exposed to slow cooling in a basin lined with a warm mixture of charcoal powder and clay. When broken, after cooling, it did not exhibit a trace of vitreous substance nor any quadratic prisms, but a fine radiated texture had spread itself equally throughout the whole mass. The experiments of Sir James Hall have often been mentioned in connection with this subject. Nearly seventy years ago he applied experiment, for the first time, to the elucidation of geological phenomena. It occurred to him to melt a small piece of basalt, and the result was a dark vitreous substance. But on fusing a much larger quantity, and allowing it to cool slowly, he obtained a crystalline mass. Since that time geologists gradually became accustomed to look upon the original rocks of a glossy appearance, which occur in nature, as the products of rapid, and those of a granular texture as the products of slow, cooling. Nor are there wanting instances to show that other physical causes have influenced the structure of such artificial silicates as slags. At the Eglinton iron-works in Scotland, and those of Bethlehem, Pennsylvania, the writer observed that there is frequently developed in the slags, as they flow from the furnace, streaked bands of different colors, not at all unlike those developed in many slate rocks. Then again, when the workmen, at the establishment first named, tap off the iron and cool the small amount of scoriæ which follows after it with a plentiful supply of water, the slag froths up and solidifies to a porous cellular substance, the exact parallel of which is to be found in the pumice stone of volcanoes. In observing the slags of copper furnaces, nothing is more common than to see those which are allowed to flow over damp ground rise up into porous scoria, while those which run over wet portions of the smelting-house floor, boil up into loose pieces, or throw themselves about in the form of little volcanic bombs and lapilli. Similar phenomena are observed in the lava streams of active and extinct volcanoes. Those of Alta Vista, in Teneriffe, consist, on the surface, of glittering, transparent bottle-glass-like obsidian, which, towards the interior, changes into a less glittering pitchstone-like mass, which is so filled with crystals as to resemble a crystalline rock. These instances have been given in order to show that, in studying the varying textures of original rocks, it is well to bear in mind that such textures are, *in all likelihood*, the result of the influence of the physical conditions under which their respective rocks solidified, and of the temperature and plasticity of the mass from which they were produced.

The following modifications in the texture of original rocks may here be distinguished:—

1st. The constituent minerals are of a comparatively large size, ranging from several inches to one eighth of an inch in diameter, generally large enough to be easily tested as to hardness, cleavage, and other physical characters. The mode of their arrangement is altogether irregular, and, although the individual minerals may sometimes have a greater length than thickness, no parallelism of their larger axes can be noticed. Granite, syenite, and diorite are examples of this order of texture, which may be called the *course and small grained.*

2nd. The constituent minerals are of a size varying from the smallest individuals to those of an inch in diameter. One or more of them have their longest axes arranged in the same direction and parallel with each other, there being thus developed a fibrous or laminated texture. This may be called the *schistose* order, to which gneiss and hornblende schist belong.

3rd. The constituent minerals are finer grained than in the preceding order, and more difficult of determination. A similar parallel structure, however, is visible, which occasions an easie fracture of the rock along a particular plane, or what is called a slaty cleavage. Common roofing slate may be regarded as the type of this *slaty* order of texture.

4th. The next order of texture to be distinguished is the *porphyritic*. Large individuals, or crystals of one or several minerals, are enclosed in a fine-grained or impalpable matrix. Augitic, syenitic and felsitic porphyry are examples of this order of texture, the rocks of which are distinguished from each other as well by variations in the nature of their matrices as in the compositions of the crystals developed in it.

5th. The next order may be called the *variolitic*, and regarded as incipient porphyritic texture. In a fine-grained matrix, small rounded concretions are developed, without, however, being sharply separated from it. These concretions sometimes possess a fibrous structure in the interior, the fibres radiating from the centre, and their existence is frequently betrayed by the weathering of the rock.

6th. The minerals are here of a much smaller size than in the coarse-grained order, so as to be in most cases difficult of determination. This texture is the same as that often possessed by the matrices of porphyries, and, being destitute of parallel structure, bears the same relation to the coarsely schistose texture. Trap and felsite belong to this order, which may be called the *fine-grained.*

7th. In a small or fine-grained matrix, rounded cavities have been formed, and afterwards partly or wholly filled up with various minerals. On account of the resemblance between the long drawn and flattened shape of these mineral aggregations and almonds, this texture has been called the *amygdaloidal.* Trappean amygdaloid and the spilite of French lithologists may be cited as examples.

8th. The next order of texture includes certain fine-grained and globular rocks, characterized by their containing very appreciable quantities of water. The globular texture resembles the variolitic, but the concretions, instead of possessing a radiated structure, are composed of concentric layers. Pearlstone is the type of this species of rock, which is intimately connected, geologically, with pitchstone and other impalpable rocks belonging to this order. Phonolite and basalt are examples of the fine-grained members of the order, which, as above-mentioned, are distinguished from the fine-grained order already mentioned by their containing a considerable percentage of water. It may, therefore, be called the *fine-grained and hydrated.*

9th. This order may be denominated the *trachytic,* and, although its rocks have frequently a porphyritic development, they are distinguished from those of that class, in having a rough porous, sometimes even cellular, matrix, and felspar crystals developed in it of a vitreous appearance and full of small fissures. The same rough uneven surface and fracture is developed in those trachytic rocks which contain no largely developed crystals, and even in many of a much more basic composition than what are usually termed trachytes. Rhyolite, andesite and dolerite are examples of this order.

10th. In this order of texture the porous appearance above referred to is developed to such a degree that a scoriaceous or cavernous structure results. This structure is peculiar to volcanic rocks, which also afford examples of purely vitreous texture, in which no "grain" nor any mineralogical constituents are observable, but an impalpable glassy appearance predominates. This order may be called the *lava texture*, and lava pumice-stone, and obsidian, mentioned as examples of it.

It is not to be supposed that these varieties of texture are at all sharply separated from each other. On the contrary, rocks the most varied in their structure are found to be connected with each other by insensible gradations. Thus, vitreous rocks are gradually found to assume an impalpable and then stony character. Then again, they frequently become porous and cellular, and graduate into scoriaceous lavas. Rocks of the latter order have very often well-defined minerals developed in them, and when also the cellular texture becomes more subdued, trachytic rocks result. These, when they gradually become more compact or their felspars gradually lose their vitreous and fissured appearance, become indistinguishable from felsites and porphyries. Further, when the matrices of the last-mentioned rocks gradually become coarser grained and their crystals reduced in size, they pass into thoroughly granular rocks. When, on the contrary, the well-developed crystals of porphyries gradually disappear, fine-grained rocks are the product. Nothing is more common than to find the latter gradually assuming a slaty structure or gradually becoming coarser in the grain, and so giving rise to schistose or granular rocks. And nothing is more common than to find the constituents of granular rocks, little by little, arranging themselves in a given direction, and so producing coarsely schistose structure.

But with all the frequency of gradation between original rocks of various textures, it is to be remarked that those which differ widely from each other in structure, do not exhibit sudden transitions the one into the other. Cavernous and coarsely granular rocks are never found to constitute part of one and the same mass, or to pass into each other, without gradually assuming the character of intermediate impalpable and fine-grained rocks. Nor is it ever the case that coarsely schistose rocks become trachytes all at once. A certain consistency or method is recognisable in all these transitions, and it is only those orders which are more nearly related to each other as regards texture, or are more intimately associated, geologically, that graduate into each other in the manner above described. In the description of the various species of texture given above, those have been placed nearest to each other which are most prone to pass into each other by modifications of texture.

To account satisfactorily for these variations of texture among original rocks is no easy matter; but if the facts already given, as regards the solidification of artificial silicates, have any value as applied to lithogy, they would lead us to suppose that the coarsely schistose rocks solidified very slowly during the lapse of great intervals of time and under the influence of widely extended movements of the crystalline, but still fluid mass; that the coarsely granular rocks solidified very slowly, but in comparative rest; that porphyritic and small-grained rocks cooled more quickly than coarse granites, although crystallisation evidently took place while they were in a plastic condition; that fine-grained schistose rocks solidified while in motion, but are the products of comparatively rapid cooling; that porous trachytes cooled rapidly, but in comparative rest; that very cavernous rocks came into contact with water during cooling, and we may suppose that, where that element was present in great quantity, many original rocks underwent disintegration while their solidification was in process, giving rise to the tufaceous series of derived rocks. Many of those generalisations are supported by observations recently made on the microscopic structure of rocks to which, however, it is impossible here to refer.

(To be continued.)

AQUARIA STUDIES.

(Part II.)

By A. S. Ritchie.

In the last number of this journal a description was attempted of some of the different representatives of animal life contained in our aquarium, of what may be termed its visible beauties, that is, such creatures as may be seen with unassisted vision. The present sketch is connected still further with its denizens, as beautiful in their structure, and, notwithstanding their minuteness, no less wonderful in their design.

The unassisted eye can only look at relatively few of the creator's works: it cannot enter the inner shrine of nature's temple, or take cognizance of the myriad manifestations of the power and wisdom which enables these animated atoms to live, move, and have their being, and to enjoy themselves as well as the more complex productions of the Infinite.

The microscope, however, gives us an insight into worlds heretofore hidden from view, and shows us creatures more strange than "fancy ere had feigned or fear conceived." We may see in "the small dimensions of a point" a world peopled with creatures, to which, as we believe, there is no limit. More powerful glasses are only wanted to lead us farther into the labyrinth of the creative wonders of the Almighty.

Comparatively few enquire into this world of hidden wonders in order to become acquainted with its inmates, still, a few philosophical spirits are yet to be found, who, like Sir Thomas The Good,

> "Would pore by the hour
> O'er a weed or a flower,
> Or the slugs that come crawling out after a shower."

At the outset of the present sketch we would premise that the glass side of our aquarium which is placed next to the wall, is never cleaned, and, in consequence of this, it is soon covered over with a growth of what botanists call *Confervæ.* The *Confervæ* are among the lowest forms of *Algæ*, a group which contains a great number of very minute microscopic plants, which have been, of late years, specially studied by microscopists. Among the lower forms of these Protophytes are the *Diatomaceæ*, *Desmidiæ* and *Volvocinæ*, plants of very simple organization, only lately removed from the animal kingdom. Other orders are the *Palmellaceæ*, likewise plants of humble type; *Ulvaceæ*, plants of a rather more complex character; *Oscillatoriaceæ*, remarkable for a peculiar kind of motion; *Nostochaceæ*, *Ulvaceæ*, *Siphonaceæ*, and *Confervaceæ.*

First, let us scrape some of the growth off the glass at the back of the tank, then place it in the live box with a drop of water over it, and, having adjusted our microscope, what do we see?

First of all notice the vegetation contained in this drop of water. That long pointed ribbon, having the green colouring matter twisting and curling through the centre, is one of the *Confervæ*, a species of *Spirogyra*, and close beside it there is another jointed species having the chlorophyll or colouring matter in patches:

this is a variety of *Stigeoclonium*. These are purely vegetable, and are the resort of many little creatures which revel and hide themselves among their tiny clusters of bands.

The first intruder in the field of the microscope we would call attention to is that shapeless mass near the centre. It looks like a small piece of clear jelly with little black dots or granules within. But see, it has changed its shape: it is, as it were, running out ; a finger-like process is flowing out here and there; the granules also are moving. Again we look; it has now assumed a shape something like an outline of a map of Italy. While you are looking it has again changed. You ask, what is that? That is one of the simplest forms of animal life; it is called the *Amœba* or *Proteus*.

In the *Amœba* we see an animal that breathes without lungs or gills, digests without a stomach, moves without limbs, and contracts without muscles. Like other animals, of simple type, which live for the most part in the deep sea, and which from the possession of root-like feet, are called *Rhizopods*, its body is composed of a jelly-like substance called sarcode. Some of these creatures have siliceous and some calcareous shells, while others have none at all. You will ask how does the *Amœba* live, and how does it feed? We shall endeavor to shew. Although without a nervous system, it is nevertheless very sensitive, as will be seen.

That other creature near it is a *Rotifer* or wheel-bearer. If you watch you will now see how and upon what the *Amœba* feeds. As its body flows and contracts, it is nearing the *Rotifer* which is attached by its foot to the glass, unconscious of his fate. Presently the little mass of jelly flows and touches him, but too late for the *Rotifer* to make his escape; as if stimulated by the contact, the *Amœba* has fairly covered him, and through its transparent body the *Rotifer's* struggles for life are perceptible. All is over with it now, the laws of absorption have so decreed it, and soon nothing will be left of it but its silicious covering.

This is the way the *Amœba* feeds, by absorbing the juices of its victim.

This creature is reproduced by fission, that is, by splitting or dividing itself into pieces, each of which pieces becomes a perfect animal.

The wheel animalcule (*Rotifer vulgaris*) will be our next subject for examination. He is many degrees higher in the scale than the *Amœba*; his body is constructed in some degree on the principle of the tube of a telescope; he can also draw himself into a ball at pleasure; he has a mouth and jaws, which are constantly at work; his eyes are distinctly visible. When fishing he attaches himself by a foot or tail-like process either to the glass or to the stems of aquatic plants and stretches himself out, when the entrance to his mouth opens and the cilia, or hair-like appendages with which his mouth is furnished, commence moving or rushing, thus causing a current or small whirl-pool in the water, by means of which monads and other animacules are drawn in, and amongst others, our friend the *Amœba* falls in, so that the victor of yesterday is the victim of to-day.

Rotifers are produced from eggs, although in one species (*Actinurus Neptunius*) we have distinctly seen the young one in the body of the parent, and not only so, but have noticed its jaws going as if the creature was feeding. The red eyes of the young Actinurus could also be distinctly seen.

When swimming, the *Rotifer* is a very graceful creature, with his crown of cilia extended, he glides across the field of view with amazing swiftness.

We well remember when young at microscopy, the anxiety experienced to possess a Rotifer; the quantities of infusions of leaves of all sorts we made, including hay, straw and sage, but all to no purpose. We could get lots of monads and other varieties, but no rotifer. For two years this state of things went on, when we were tempted to bottle some water from one of the street puddles, taking some of the sediment with it. The bottle was placed, uncorked, in the window, so that the full benefit of the sun-light might be obtained. As soon as business was over that day the bottle was produced, the animalcule cage filled, the focus of the microscope adjusted, and, to our delight, the water was swarming with rotifers; and, from that day to this, we have been close companions. This water was kept for nearly three years, and fresh water now and then added to compensate for evaporation, with a little piece of pond weed (*Anacharis alsinastrum*,) or duck-weed (*Lemna*,) to keep the water sweet. Many generations of Rotifers lived and died in that bottle, as their siliceous skeletons testified, the sediment being full of them.

Temperature has very little effect on *Rotifera*. We have had a bottle of water containing these creatures frozen solid, and, on thawing them, they were as lively as ever. We have also placed a large-sized drop of water on a slip of glass, and held it over the flame of a lamp, long enough for the glass to be uncomfortable to the fingers, with the like result. They only appeared to be a little more active after their warm bath.

The old experiment of evaporating a drop of water on a slide containing Rotifers we have also tried, and, on again wetting the spot, have resuscitated some of them. We have had them the twenty-fifth to the thirtieth part of an inch in length; about the fiftieth part of an inch is the usual size.

A little to the left of the Rotifer, attached to a piece of *Conferva*, is a beautiful cluster of bell-shaped animalcules, *Vorticella campanularia*. They are attached to the plant by means of a stalk, which has a contractile muscle running from the base to the upper end: they have a ciliated mouth. Just watch that little cluster of crystal bells. They have, by means of the muscle, drawn back, until they look like an irregular mass of gelatine. Now they slowly move out again, as if all were guided by the same will. Now they are at full stretch, with cilia revolving, fishing and feeding. Again, they are all retracted with a jerk. Some of them look as if they were double. Reproduction is going on in these: it is effected by fission. Bye-and-bye these will separate and detach themselves, and swim about till matured, when they attach themselves, to go through the same existence as their progenitors.

A smaller species, *Vorticella nebulifera*, is to be found attached to the bodies of some *Entomostraca*, as *Cyclops quadricornis*, and on *Lynceus*. Another species (*Carchesium polypinum*) is also found attached to these creatures. We have a specimen of Cyclops mounted as a microscopic object, having *Vorticella nebulifera* attached to the back of the crustacean. The presence of the *Vorticella* on the slide was accidental, as the object was intended to be *Volvox globator* only. It evidently got in either attached in some way to some of the *Confervæ*, or from the water.

The stalks in *Carchesium* are not retractile; the body, however, has the power of closing up by muscular action. These we have not found in numbers in our aquarium, but in the ponds near the city they are to be met with in abundance.

Another beautiful creature—the Blue Stentor (*Stentor cæruleus*)—has attached itself to a little bit of weed; its beautiful crown of cilia is expanded, and moves rapidly, creating quite a small whirlpool, into which the unfortunate monads are drawn in and engulphed into its stomach. It is of a beautiful blue colour, and is found in great abundance at times on the tops of ponds, which look then as if the water was covered with coal dust.

On taking another drop of water from the aquarium, with more of the vegetable matter, we observe other and different creatures, resembling snakes, twisting and entwining each other in their folds: these are called *Lurcos* or Gluttons. They are well named, for they are very voracious, feeding on animal and vegetable life; their bodies are annulose, or composed of rings having hair-like processes on each segment, which enables them to move about with considerable quickness; their mouth is capacious and ciliated; the intestinal canal is plainly seen, and their food can be well observed through their transparent bodies. We have seen them devour rotifers, monads, bell animalcules, and other species; in fact, they refuse nothing. They are produced from eggs.

That slipper-shaped species is very common, and found in great numbers: it can be seen by the unassisted eye as a tiny speck coursing across the animalcule cage. It is called the Chrysalis animalcule (*Paramecium aurelia.*) It is ciliated all round the sides of its body, and moves about very swiftly; it is like a porpoise in a shoal of herrings—dashing here and there, devouring the smaller species, such as monads, in all directions. It undergoes many changes, and assumes many shapes during its metamorphosis; it is produced by fission as well as from the egg.

That restless little fellow with four horns is *Cyclops quadricornis.* The only way to get a good look at him is to bring a little pressure to bear by giving the cover of the live-box a slight squeeze so as to keep him still. He is very active, and measures about the sixteenth of an inch in length. His head is furnished with four antennæ or horns, and the creature is provided with five pairs of feet, and a long tail, which is terminated by bristles. It has, in the centre of its forehead, a single red eye—hence the name Cyclops, after Vulcan's Workman. The legs of the Cyclops, at each of the joints, are furnished with hairs, evidently to help the creature in swimming, as is also the case with aquatic beetles. The female carries two ovaries at the extremity of the abdomen, where the eggs are hatched, and, on the young leaving these sacs, they fall off. The young, according to Carpenter, undergo five changes in their development.

Besides these little creatures we have mentioned there are many more about which much might be said.

We have monads, vibrios in great numbers, always present in the water of our aquarium: not only there, we may state, but in the Montreal water this spring we detected, in two instances, living vibrios in the water immediately taken from the pipe.

In concluding this sketch of the inhabitants of our aquarium the following remarks may not be out of place.

How little is known, by the great mass of mankind, of the various creations possessed with the wonderful and unknown principle, "life," respecting which much more might, perhaps, be known by means of patient microscopic research. By its aid we may learn how admirably each little organ plays its part, and how the various members contribute to each of these creatures happiness in their struggle for life, for, for some wise purpose, every animated being, from the monad to the whale, is battling for existence.

There is not, perhaps, a single species of animated being whose existence depends not, more or less, upon the death or destruction of others.

In the plan of nature death and dissolution seem to be indispensable for the support and continuance of animal life.

Man may be said, with a few exceptions, to have universal empire over the other animals. Carnivorous animals and birds are also engaged in this general work of destruction.

In fishes, also, as their habits demonstrate, from the least to the greatest, their appetite is almost insatiable, and their object in life seems to be either to devour other fishes or to avoid their own destruction.

Insects, also, are no exception to the rule. We find the same struggle going on among them, each preying on, or being preyed on by other species.

Even in our aquarium this struggle can be witnessed, as illustrated in the first part of these sketches; also among microscopic creatures, the subject of the present paper. They also have their enemies, the fish swallow them in countless thousands, while the smaller ones supply the larger with food.

In the economy of nature no creature lives for its own happiness alone, but, by its destruction, contributes to the happiness of others. The balance of power is not entrusted to any particular class or species, and He who in wisdom made them all governs and guides the whole.

ON FORAMINIFERA FROM THE GULF AND RIVER ST. LAWRENCE.

By G. M. Dawson.

By way of introduction to these notes, I may state that the reader will find some account of the curious and interesting animals to which the paper relates, with figures of characteristic examples, in Vol. IV, new series, of this Journal, page 413; and that several species found in the Gulf of St. Lawrence have been catalogued by Principal Dawson, in the same Journal, Vol. V, page 188 *et seq.* The following table is, however, the only approach to a complete view of the species and their distribution hitherto attempted.

Many of the deeper samples were small quantities of mud brought up in sounding, by Capt. Orlebar, R.N., of the Coast Survey, and by him kindly presented to Dr. Dawson.

The specimens from Labrador were obtained from material dredged by the officers of the Geological Survey; those from Prince Edward Island, were from a specimen secured by C. Robb, Esq.; and those from the Bank of Newfoundland, were obtained from the late Sheriff Dickson, of Kingston.

The somewhat extensive series from Gaspé Bay was obtained during a dredging expedition in the summer of 1869. The mud was sampled when brought up by the dredge, and reserved for examination, the depth being ascertained as carefully as possible. Several very rich and interesting samples are also from the dredgings of Mr. J. F. Whiteaves, F.G.S., in Gaspé and its vicinity. Mr. Whiteaves has also gone over this material with care, and has detected some additional species.

The means were unfortunately not at hand for ascertaining the temperature at the bottom. But, though there is reason to believe that the water at Gaspé Bay is somewhat warmer than the Gulf of St. Lawrence in general, the mud as it came over the boat's side felt icy cold to the hand, showing even here what a great effect the iceberg-laden Arctic current has on the bottom temperature. The number of species tabulated must not in every instance be taken as a criterion of the relative richness of the localities, as much often depends on the amount of material at disposal. This is especially the case when comparing dredgings with soundings.

The general aspect of the Gulf of St. Lawrence Foraminifera is northern, and in many places closely resembles the fauna of the Greenland coast and the Hunde Islands, as given in Parker & Jones' Memoir.* The Gulf, at least so far as its Foraminifera are concerned, evidently belongs to the Arctic province, the limits of which skirt the Banks of Newfoundland and pass from thence southward to Cape Breton.

The refrigeration of its waters depends on the Arctic current, which, entering the Straits of Belle Isle, floods the whole bottom of the Gulf with water almost at the temperature of the Arctic seas. To these conditions the series of collections from Gaspé offers somewhat an exception, and is of a slightly more southern character, both as regards the species represented and the developement which they attain. This difference depends on purely local causes, which, while slightly changing the character, give opportunities for a very abundant developement of Foraminifera, more especially of the arenaceous forms. Gaspé Bay in no part exceeds 50 fathoms in depth; is about 20 miles in extreme length, well land-locked, and disturbed by no other current than that caused by the ebb and flow of the tide. The depth is not so great as to allow of the incursion of the cold and deep layer to any great extent, and the proximity of land and the shelter thus afforded tend still further to modify its temperature.

The bottom, in most of the deeper parts, is composed of fine sand and mud, and this it is which favors the very large development of arenaceous forms.

Past the mouth of Gaspé Bay sweeps the very strong tidal current of the St. Lawrence, and immediately we pass the shelter of Ship Head and come within its influence, the changes in the Foraminifera become strikingly apparent. The bottom consisting for the most part of clean gravel or coarse sand, most of the arenaceous forms disappear at once, and instead of the abundance of Nonioninas and Miliolas previously found, a very large proportion consist of Planorbulina lobatula, which can hold its own, attached to seaweeds and polyzoons. Polystomella Arctica also becomes somewhat prominent, while the Lagenidæ and Entosolenidæ appear in abundance.

What few sandy forms do occur are depauperated and composed of very coarse particles. The Foraminifera as a whole however are very abundant, and in some samples dredged by Mr.

* Philosophical Transactions, 1865.

Whiteaves almost equal in quantity those in the deeper Atlantic soundings.

In the estuary of the St. Lawrence itself, Bulimina pyrula becomes a somewhat common form. Among forms which in the Gulf of St. Lawrence may be mentioned as specially characteristic of deep water, are Nodosaria (Glandulina) lævigata, Globigerina bulloides, very small; Bulimina, principally B. squamosa, also small; Uvigerina pygmœa, Cassidulina.

From depths greater than 100 fathoms all the Foraminifera are very small and delicate; and Lagenidæ, Buliminidæ, Globigerina bulloides, together with a few depauperated Nonioninæ, constitute the greater part of the fauna. From these depths also come many Diatoms, mostly Coscinodiscus, and Sponge spicules. Polystomella striatopunctata is almost everywhere prevalent, though it nowhere attains to any very great size, and below about 30 fathoms, becomes small and generally rare, and continues increasing in rarity till it almost disappears at 300 fathoms. In some localities, at about 30 fathoms, P. Arctica is abundant, and greatly surpasses in size the ordinary Polystomellæ occurring along with it. The remaining P. striatopunctatæ also at this depth often show a remarkable proneness to run into modifications resembling one or other of the numerous species and varieties into which the genus is subdivided, but as the transition series are complete, it is very difficult to place the bulk of the specimens satisfactorily under them. It has been thought better in the table to include as many as are easily seen to be modified striatopunctatæ under that name. Nonionina Labradorica, though not so universally distributed as the above, is a very characteristic species in the Gulf. It seems to be best developed and in largest numbers at about 30 fathoms. It thins off both in numbers and size as we go into shallower water, and decreases much in size, though not so perceptibly in numbers as the water deepens to 100 fathoms and below. There is a remarkable absence of Miliolas in the estuarine parts of the Gulf, which strongly contrasts with their abundance in Gaspé Bay, and also on the Atlantic coast of Nova Scotia, and south.

One specimen of a curious sandy form of Cornuspira foliacea was obtained at a depth of 18 fathoms at Gaspé.

Biloculina ringens scarcely occurs above 30 fathoms.

At Murray Bay, which is only about 60 miles below the point where, at least, the surface of the St. Lawrence becomes permanently fresh, the Foraminifera become very scarce and poor. Polystomella striatopunctata is the most common, but it has become very small. Nonionina Labradorica, Lituola Canariensis, and Trochammina inflata also occur, but all much reduced in size, and scarce relatively to the amount of material examined. On passing from the Gulf to the east of Newfoundland, or to the south of Cape Breton, a change from the Gulf Fauna is immediately detected. Polystomella striatopunctata, there so common, becomes rare. Nonionina Labradorica to a great extent ceases to appear, and Uvigerina pygmæa and Cassidulinidæ become more frequent.

The arenaceous Hippocrepina, (Fig. 2,) and Lituolæ (Figs. 1 and 3) are most plentiful at depths less than 20 fathoms. Lituola scorpiurus (Fig. 4) goes down to the greatest depths in Gaspé Bay, and is yet abundant at 10 fathoms, while the immense Rhabdopleura abyssorum (Fig. 6) only appears at about 20 fathoms, and continues from that point increasing in numbers and size to the depth of 50 fathoms, which is the greatest depth in Gaspé Bay, where alone it has been found.

The distribution of these Foraminifera would tend, with other facts, to show that these organisms, together with most other marine animals of low organization, do not depend, to any great extent, on the depth or intensity of daylight, but almost entirely on the *temperature* of the water, as Dr. Carpenter maintains in his account of his recent deep-sea dredging, so that they would not give very satisfactory evidence of the conditions of deposit of Postpliocene or other beds, unless other facts were at disposal to show the depth, when the Foraminifera would give valuable assistance with regard to the climatic conditions at that depth. The quality of bottom has however, much to do with the general *facies* of the Foraminifera, as with other animals. For, as shown above, calm water, with a bottom composed of fine sand and sediment, is particularly favorable to the arenaceous forms, though, even under these conditions, they do not thrive in the very cold, deep water (such as that below 100 fathoms) in the open Gulf. A strong current at once causes all sandy forms to disappear, mostly, no doubt, from want of the fine materials necessary for their shells, and brings in a large preponderance of Truncatulinas, Lagenidæ, &c.

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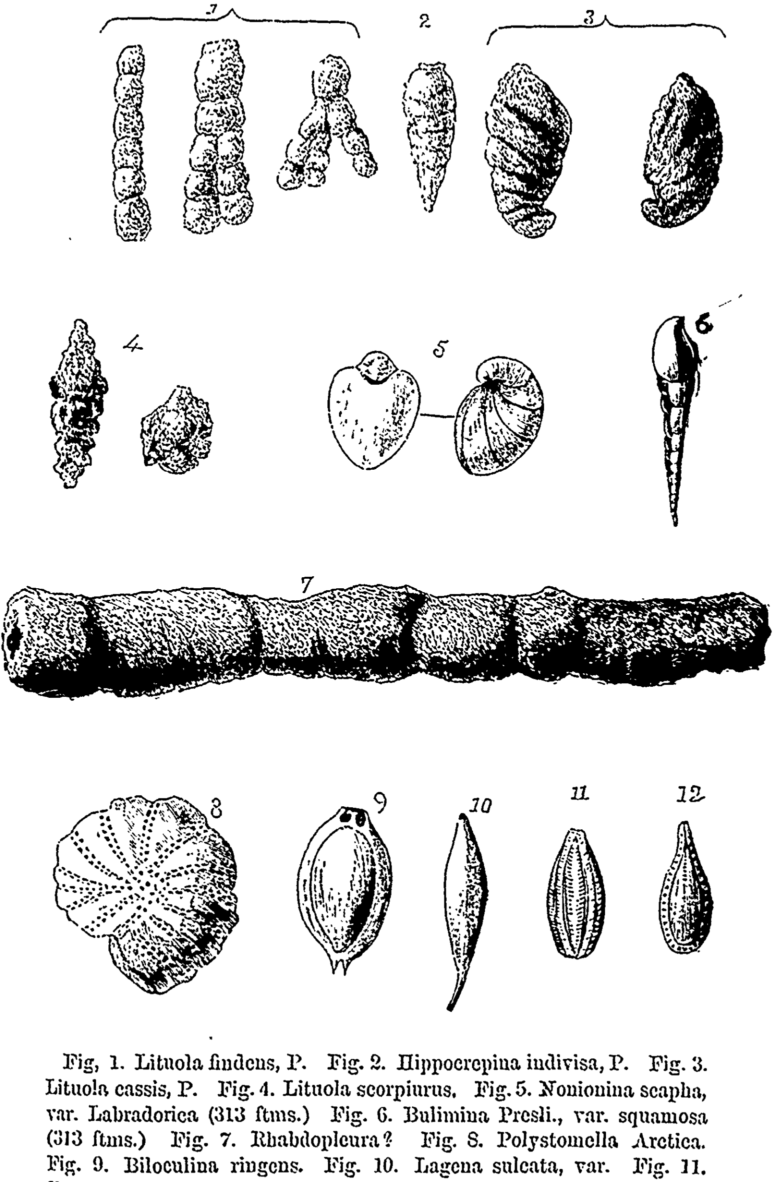
* The figures refer to the numbers of the wood-cuts.

The arenaceous forms, with the exception of those which are tubular, constitute a series parallel to the calcareous forms, and the members of which graduate into one another. It seems not improbable that the individuals of the same species may assume either appearance. It does not appear, however, that the same individual can present both forms at successive periods. On the other hand, the sandy forms may really constitute a distinct group parallel to the others. Sketches of some interesting forms are given which do not appear to be precisely similar to described species. These have been kindly examined by Dr. Parker, of London, who regards the Lituolæ represented in figs. 1 and 3 as new species, to which he assigns the names *L. findens* and *L. cassis*. The form represented in fig. 2 he regards as the type of a new genus, to which, from the horse-shoe shaped form of the aperture, he gives the name *Hippocrepina*, naming the species *H. indivisa*.



Fig, 1. Lituola findens, P. Fig. 2. Hippocrepina indivisa, P. Fig. 3. Lituola cassis, P. Fig. 4. Lituola scorpiurus. Fig. 5. Nonionina scapha, var. Labradorica (313 ftms.) Fig. 6. Bulimina Presli., var. squamosa (313 ftms.) Fig. 7. Rhabdopleura? Fig. 8. Polystomella Arctica. Fig. 9. Biloculina ringens. Fig. 10. Lagena sulcata, var. Fig. 11. Entosolenia striato-punctata. Fig. 12. Entosolenia marginata. Figs. 1, 2, 3, 4 and 7 are drawn to a scale half that of the other figures.

TABLE I.—*Showing the Distribution of Twenty-three Gatherings of Foraminifera, from the Gulf and River St. Lawrence, and neighbouring parts of the Atlantic.*

(C) common. (R) rare. (S) small specimens. (L) large specimens.

FORAMINIFERA.	313 Fathoms, Gulf St. Law. Lat. 48° 25′; Long. 60° 20′	250 Fathoms between St. Pierre and Scatari.	200 Fathoms, Cape Camille.	144 Fathoms, North-east of Anticosti.	140 Fathoms, Gulf St. Lawrence.	40 Fathoms, Cape St. Nicholas.	Labrador.	Banks of Newfoundland.	Off West Cape, Prince Edward Island.	Off South Coast, Cape Breton, 90 Fathoms.	Gaspé, North-west Arm, 7 Fathoms.	Gaspé Bay, 10 Fathoms (sand.)	Gaspé Bay, 10 to 15 Fathoms.	Gaspé Bay, 16 Fathoms.	Gaspé Bay, 16 to 17 Fathoms.	Gaspé Bay, 18 to 20 Fathoms.	Gaspé, bet. Ship Head and Cape Bon Ami, 30 Fathoms.	Gaspé Bay, off Grande Grève, 35 Fathoms.	Gaspé, off Ship Head, 30 to 40 Fathoms.	Gaspé Bay, off Grande Grève, 40 to 50 Fathoms.	Gaspé Bay, Grande Grève, St. George's Cove.	Gaspé, River St. Lawrence, off Cape Rosier Village.	Riv. St. Lawrence, Murray Bay, 15 to 20 Fathoms.
Nodosaria (Glandulina) lævigata	*R			*R	*R												*	*S		*		*R	
Dentalina pauperata	*R																						
— communis																	*RL			*		*L	
Lagena sulcata														*R		*R	*	*	*R	*L	*R		
— — var. distoma	*	*R		*								*R						*					
— — var. semistriata							*										*	*	*R	*L		*R	
— — var. lævis		*R																					
— — var. substriata										*													
Entosolenia globosa	*						*R								*R			*	*		*R		
— costata							*R		*R			*R		*			*	*RS	*R		*		
— melo, D'Orb.							*R	*R				*L					*R		*R	*R			
— caudata, D'Orb.								*									*S		*R				
— marginata, var. ornata							*R										*S						
— marginata																	*RS						
— squamosa																	*RS		*				
— striato-punctata																	*R						
Polymorphina lactea	*R					*								*	*S		*					*R	
— — var. compressa							*		*RL			*RL	*CL	*L			*L				*RS		
Uvigerina pygmæa								*R		*CS							*RS		*RS		*R		
Globigerina bulloides	*CS	*CS		*			*R	*R									S		*RS				

	Sounding.	Sounding.	Sounding.	Sounding.	Sounding.	Sounding.	Dredging.	Dead Balanus, bro't up on cod hooks.	Sand from an Anchor.	Sounding.	Sounding.	Dredging.	Dredging.	Dredging.	Dredging.	Dredging.	Dredging.	Dredging.	Dredging.	Dredging.	Dredging.	Dredging.	Dredging.
Textularia agglutinans								*R							*R S								
— — var. *biformis*							*R																
— — var. Verneuilina polystropha							*					*		*		*R							
Bulimina Presli, type	*																						
— — var. pyrula		*	*C	*C	*						*R									*R L			
— — var. squamosa	C	*C		*			*R																
— — var. Bolivina costata		*																					
— — var. marginata		*		*																			
— elegantissima																*C							
Cassidulina lævigata							*R	*					*			*R	*	*	*	*	*	*	
— crassa																	*	*	*	*R	*	*	
Truncatulina lobatula							*C L	*C			*S	*R					*C		*C		*L		
Rotalia Beccarii	*	*R																					
Pulvinulina repanda, sub. var. Karsteni		*R					*			*C S							*	*	*R	*R	*R S		
Patellina corrugata																			*R S				
Polystomella crispa, var. striato-punctata	*R S	*R		*R S	*		*		*C		*C S	*S	*C	*C S	*	*S	*C	*R S	*C S	*R S	*S		*C S
— — var.									*R														
— Arctica																	*L		*L		*L		
Nonionina scapha								*C										*			*		
— — var. Labradorica	*	*	*	*C	*C		*	*R			*C		*		*	*	*L	*C	*	*C L	*R	*	*S
Lituola nautiloidea, var. Canariense			*				*				*R S		*	*	*C		*R S	*C L		*C	*C L	*C	*S
Trochammina inflata												*C S		*		*C S			*R S				*S
Cornuspira foliacea?		*R S												*R S		*L					*R S		
Quinqueloculina seminulum	*R		*R	*			^		*			*C L	*C L	*C S		*R S	*R S	*L		*L	*L	*C L	
— — var. subrotunda							*R																
— — var. agglutinans							*						*S	*		*S		*	*R S	*R	*R S	*	
— — var. Ferussacii							*R											*L		*L		*L	
— bicornis, var. elegans									*R														
Triloculina tricarinata																*R	*R S	*R S				*R	
Biloculina ringens	*						*R													* R	*R	*R	

TABLE II.—*Supplementary List of Peculiar Arenaceous Forms.*

(See Figs. 1 to 4, and Fig. 7.)

FORAMINIFERA.	Labrador.	Gaspé Bay, 10 Fathoms, (sand.)	Gaspé Bay, 10 to 15 Fathoms.	Gaspé Bay, 16 Fathoms.	Gaspé Bay, 18 to 20 Fathoms.	Gaspé Bay, 16 to 17 Fathoms.	Gaspé Bay, off Grande Grève, 35 Fathoms.	Gaspé Bay, off Grande Grève, 40 to 50 Fathoms.	Gaspé Bay, St. George's Cove.	River St. Lawrence, off Cape Rosier—Whiteaves.
Lituola findens, Parker—Fig. 1	...	...	...	*C L.	*	*	...	...	*R	...
Hippocrepina indivisa, P.—Fig. 2	...	...	...	*C L	*C	...	...	...	...	...
Lituola cassis, P.—Fig. 3.	...	*	*C	*C L.	...	*	...	...	...	...
Lituola scorpiurus—Fig. 4	*	...	*C	*C L.	*	*C	*C L.	*C	*C	*C L.
Var.—Fig. 4	...	...	...	*C L.	...	...	*C L.	...	...	...
Rhabdopleura—Fig. 7	...	...	...	...	...	*	*C L.	*	*C L.	*C L.

NOTES ON THE STRUCTURE OF THE CRINOIDEA, AND BLASTOIDEA.

By E. BILLINGS, F.G.S., Paleontologist of Geological Survey of Canada.

Reprinted from the Am. Journal, Sc., and Arts, Vol. L., Septr. 1870 : and concluded from this Journal, N. S. Vol. 4, pp 126--133.

6. ON SOME POINTS RELATING TO THE STRUCTURE OF PENTREMITES.

1. 2.

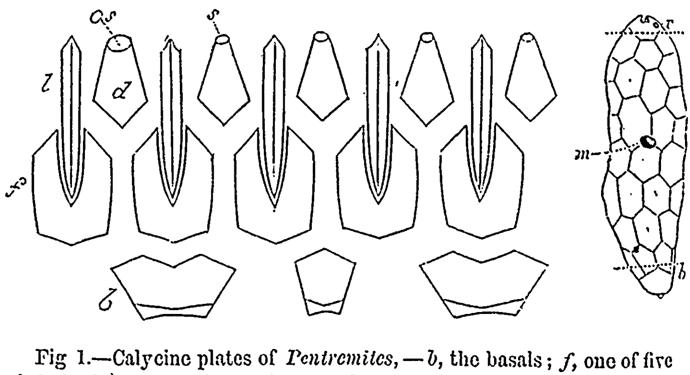


Fig 1.—Calycine plates of *Pentremites*,—*b*, the basals; *f*, one of five forked plates; *d*, deltoid plate; *l*, lancet plate; *os*, oral spiracle; *s*, spiracle.

Fig. 2.—*Caryocystites testudinarius*, Hisinger,—*b*, basal plates; *r*, radials; *m*, mouth.

Professor Wyville Thompson has proposed a division of the skeleton of the existing Crinoid, *Antedon rosaceus* into two systems of plates, which he terms respectively the "*Radial*," and the "*Perisomatic*" systems.* These he considers to be thoroughly distinct from each other in their structure and mode of growth. The radial system consists of the joints of the stem, the centrodorsal plate, the radial plates, the joints of the arms, and also those of the pinnules. In the perisomatic system he includes the basal and oral plates, the anal plate, the interradial plates, and any other plates or spicula which may be developed in the perisome of the cup or disc. This I think a good arrangement, except in so far as it regards the stem, which appears to me to be, always, an appendage of the perisomatic, rather than of the radial system.

Throughout the whole range of the Crinoidea, the plates of the radial and perisomatic system, are easily distinguished from each other. In general, the Cystidea have no radial plates in their calyces except, perhaps, in a small area around the ambulacral orifice. This accords well with an important observation of Professor Thompson's on the structure of Antedon, while in the earlier periods of its growth. "The entire body of the Pentacrinoid is," he says, "at first, while yet included within the pseudembryo and during its earliest fixed stage, surrounded and inclosed by plates of the perisomatic system alone, and it is quite conceivable that plates belonging to this system may expand and multiply so as to form a tessellated external skeleton to the mature animal, the radial system being entirely absent, or represented only in the most rudimentary form." (Op. cit., 541). Such is the structure of all of the Cystidea. On referring to fig. 2, it will be seen that the whole of the body of *Caryocystites testudinarius*, is covercred with polygonal plates, without any trace whatever of a radiated arrangement. The plates are disposed in nine transverse ranges, girding the body like so many rings. This species is, (and so are most of the clongated subcylindrical Cystideans), annulated rather than radiated, so far as regards the external integument. The lower range, below the line, *b*, consists of the basals, whilst the upper, above the line, *r*, may possibly, be radiated. In all the globular or ovate Cysti-

*On the Embryogeny of Antedon rosaceus Linck (*Comatula rosacea* of Lamarck). By Professor WYVILLE THOMPSON, L.L.D., &c. Philosophical Transactions of the Royal Society, vol. clv, Part II, p. 540.

deans, with numerous plates, such as *Sphæronites*, *Malocystites*, *Comarocystites*, *Amygdalocystites*, and others, the shell is neither annulated nor radiated, but composed of an indefinite number of plates, reasing with the age of the individual, and arranged without any well defined or constant order. It seems clear, therefore, that the test of the Cystidea belongs mostly to the perisomatic system.

In *Pentremites* the three plates which are usually called the basals, consist each of two pieces, one placed above the other, and, in general, closely anchylosed together. The lower pieces have each a re-entering angle , in their upper edges, for the reception of the upper pieces which stand upon them. This structure was first pointed out by Mr. Lyon (Geol. Ky., vol. iii, p. 468), and is not generally admitted, although I believe it certainly does exist. It is said that the lower pieces consist of the upper joint of the column, divided into three by vertical sutures. To me they appear to calycine plates. It is true that they do not form the bottom of the visceral cavity, but this may be due to the growth inward of the lower edges of those of the upper series. Something like this occurs in *Antedon*, where, at first, the bottom of the cup is formed by the basals, but afterwards principally by the first radials.

The forked plates are usually called "*Radials*," but they certainly do not belong to the radial system. If they did, they would represent the first radials of the Crinoidea, and therefore they should support the bases of the ambulacra. A little consideration will, however, enable any one to perceive that in *Pentremites* the bases of the ambulacra are situated in the apex of the fossil, and do not come in contact with the forked plates. The apex of *Pentremites* is identical with the actinal centre of Sea-urchins and Star fishes, in which the mouth is situated. It is here that the ambulacra originate and grow outward by the addition of new plates to their distal extremities. There can be little doubt that such was the mode of growth of the ambulacra of the *Pentremites*. The smaller extremity, therefore, of their ambulacra, which is received into the forked plate, is not the base, but corresponds with the apex of the ambulacrum of a Sea-urchin or of a Star-fish. It also represents the tip of the arm of a Crinoid. If the forked plate is radial, then the arrangement of the ambulacrum must be the same as that which would be exhibited in a Crinoid, with the upper end of the arm downward, and resting on the first radial, whilst the lower end would be upward, the tip being formed of the second radial. From this it follows that the forked plates do not belong to the radial, but to the perisomatic system.

The five deltoid plates alternate with the forked plates, and are also perisomatic.

It is not certain that the lancet plates represent any of those plates which in the Crinoidea are usually called "radials." They are so arranged that if they were loosened from the walls of the cup, and their smaller extremities turned upward, whilst their bases or larger ends retained their position, they would stand in a circle around the apex, as do the arms of an ordinary Crinoid. Their bases would alternate with the apices of the deltoid plates. They would form the outside of the arms, whilst the grooves and pinnulæ would be inside. Each would bear, on its outer or dorsal aspect, two elongated sacks, the two hydrospires that belong to the ambulacrum. I believe that the small groove in the ambulacrum of *Pentremites* was occupied by the ovarian tube only. If this be true, and if, also, the lancet plates represent the radial plates of the arms of the Crinoids, then the arm of *Pentremites* would have the respiratory portion of the ambulacral system on its dorsal, and the ovarian portion on its ventral aspect.

In the true Crinoids, both the respiratory and ovarian tubes are situated in the groove in the ventral side of the arm.* In the Crinoids the pinnulæ are attached to the radial joints of the arm. In *Pentremites* they are not connected with the lancet plate, but with the pore plates. In *P. pyriformis* they appear to me to to stand in sockets excavated in the suture between the pore plates. Müller compared them to the series of azygos

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* Thomas Say, who was the first to recognize the Blastoidea as a group distinct from the Crinoidea, also supposed the function of the ambulacra to be respiratory. He says, "I think it highly probable that the branchial apparatus communicated with the surrounded fluid through the pores of the ambulacræ, by means of filamentous processes; these may also have performed the office of tentacula, in conveying food to the mouth, which was, perhaps, provided with an exsertile proboscis; or may we not rather suppose that the animal fed on the minute beings that abounded in the sea water, and that it obtained them in the manner of the Ascidia, by taking them in with the water. The residuum of digestum appears to have been rejected through the mouth." (Jour. Acad. N. S. Phil., vol. iv, p, 296, 1825).

plates, which underlie that portion of the ambulacrum of *Pentacrinus* that runs from the mouth to the base of the arm. These resemble the lancet plates, in their being azygos and not connected with pinnulæ; *but then, on the other hand, they differ* from them in having, a portion at least, of the respiratory tubes on their ventral aspect. Mr. Rofe says that, "in many species of Pentremite, if not in all, this lancet plate is in reality a compound plate, formed of two contiguous plates, extending from the bottom to the to the top, and then turning right and left round the summit-openings, they pass down the adjoining sinus to form half its lancet-plate, leaving at the apex of the body a pentagonal aperture supposed to be the mouth. In some weathered specimens, the two parts of the lancet plate are separate; and in many they appear to meet only at the top and bottom of the cross section, leaving a lozenge-shaped opening between them." (Geol. Mag., vol ii, p. 249.) In a large specimen of *P. obesus* (Lyon and Cassiday) which was given to me by Mr. Lyon, a polished section shows that one of the lancet plates is thus divided, but in general no trace of a suture can be seen in these plates.

There are several points in the structre of the ambulacra of *Pentremites* that are well worthy of the study of those who have plenty of well preserved specimens. Among these, I would direct special attention to the markings in the ambulacrum of *P. pyriformis.*. The median groove, which I suppose to have been exclusively occupied by the ovarian tubes, sends off branches right and left alternately, towards the sides of the ambulacrum. These branches do not run directly to the ambulacral pores. Each of them terminates at a point between the inner extremities of two of the pores. There is at this point a small pit which appears to be the socket of an appendage quite distinct from the pinnule. The groove does not reach the socket of the pinnule, which is situated further out, between two of the pores. On the other hand a small groove runs from each pore inward, and terminates at another socket, about half-way between the pore and the main median groove of the ambulacrum. It would thus appear that besides the ordinary pinnules, there were two other rows of appendages on each side of the median groove.

The general conclusions at which I have arrived from the above, are, that all the principal plates that compose the shell of *Pentremites*, belong to the perisomatic system of Professor

Wyville Thompson; that it is doubtful whether or not the lancet plates are homologous with the radial plates of the Crinoids; and that the ambulacra are more complicated in their structure than is generally supposed.

7. On the Structure of the genus Nucleocrinus.

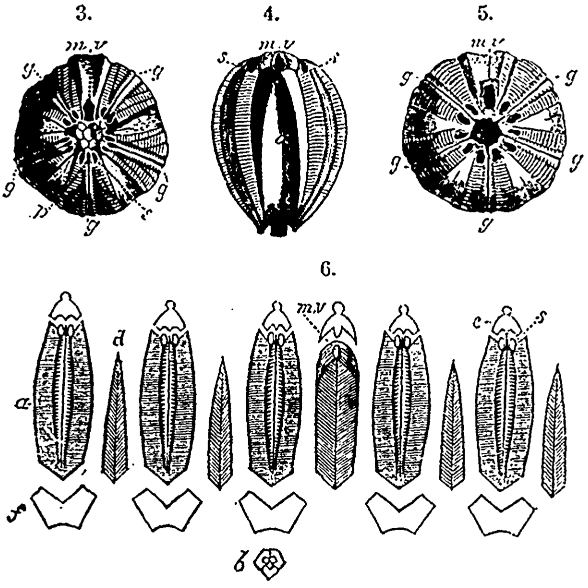


Fig. 3.—Apex of *Nucleocrinus Verneuilii* Troost. *g*, ambulacral groove; *p*, pore through which groove enters into the interior; *s*, one of the ten spiracles; *mv*, oro-anal aperture. 4. Anterior side of a specimen; *a*, the anterior interradial. 5 Apex of a specimen which has lost the integument that covered the centre. 6. Diagram of the plates of the test; *a*, ambulacral plate; *b*, the basals; *c*, plates of the apex; *d*, one of the interradials; *f*, forked plate.

The body of this remarkable genus is ovate, elliptical or oblong, and inclosed in a shell of strong perisomatic plates, which are, in general, so closely anchylosed that the sutures between them cannot be distinguished. According to Mr. Lyon, who, through his long continued geological researches. has collected and studied a vast number of specimens, there are three minute lozenge-shaped, or quadrilateral basal plates, situated at the bottom of the columnar pit; always concealed when the column is *present*. These are surrounded by three other plates, the six altogether corresponding to the six pieces which constitute the compound basal plates of *Pentremites*. They are represented at fig. 6, *b*, as figured by Mr. Lyon (Geol. Ky., vol. iii, pl. v, fig 1, *b*.)

In the next series there are five plates which are undoubtedly the homologues of the five forked plates of *Pentremites*. They are very short and confined to the base of the body. They form a shallow basin with ten re-entering angles in its margin. Fig. 6, *f*.

Alternating above the forked plates, are five pieces corresponding to the deltoid or interradial plates of *Pentremites*. Some of these are lanceolate in form (fig. 6, *d*), their broader extremities fitting into the angles between the forked plates. They taper to a point upward, and their sides are bevelled so as to pass under the ambulacral plates, to which they are, in general, so closely united, that the line of junction is indicated only by the difference in the markings of the surface. Owing to this structure, these plates have not always been recognised by the authors who have described this genus. They were first pointed out by Mr. Lyon. The fifth deltoid or interradial plate is truncated at its apex for the reception of the oro-anal orifice (*mv*, figs. 4, 6). The sutures on each side of this plate are generally distinctly visible, especially in the upper part of the body.

The ambulacra are narrow—one line wide in a specimen fifteen lines in length, with a fine median groove, about large enough to accommodate a tube of the size of a horse-hair. There are two rows of pores, those on one side of the groove alternating in position with those on the other side. These pores lead into the hydrospires. There appear to be only two rows of ambulacral ossicles. The pores are situated in the sutures between them. On each side of the ambulacrum there is a broad transversely grooved marginal plate. From each pore a small rounded ridge runs across this plate. The grooves between the ridges originate at the outer extremities of the ambulacral ossicles. In well-preserved specimens the surface of these marginal plates exhibits no other structure than the transverse grooves and ridges; but in one weathered specimen that I have examined, they seem to be composed of a number of narrow elongated pieces, arranged transversely, in such a manner that two of them abut against the outer extremity of each of the ambulacral ossicles, and extend outward toward the interradials. This seems to prove that the marginal plates belong to the ambulacra, as pointed out by Mr. Lyon, and not to the interradials, as represented by other authors. Although I have studied a large number of specimens, none of them were sufficiently perfect to enable me to make out the whole structure of this part of the test of *Nucleocrinus*. I have, however, seen enough to convince me that the ambulacra are much more complex than is usually supposed. The lancet plate, if it occur at all in this genus, must be very narrow. The ambulacral groove, as in *Pentremites*, sends off branches, right and left. There is also evidence of the existence of minute marginal plates on each side of the groove.

7.

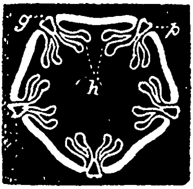


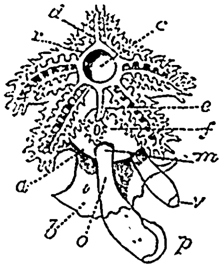
Fig. 7. Transverse section through a specimen which has all the hydrospires preserved. *h*, the two anterior hydrospires; *p*, pore leading into the hydrospire; *g*, one of the grooves.

The hydrospires are ten elongated sacks, each with two deep folds. They are perfectly homologous with those of *Pentremites*, only differing therefrom in not being united in pairs; consequently there are ten spiracles instead of five. The mouth, or oro-anal orifice, is larger in proportion to the size of the body than it is in *Pentremites*. Mr. Meek informs me that the mouth in some of the Blastoidea is protected by a single valve that covered it like the lid of a jug. From the structure of the orifice, I am inclined to think that in *Nucleocrinus* it possessed a similar protection.

In the apex, nearly all the space within the circle of apertures is covered by a thin integument of small plates, fig. 3. When this is not preserved, a large sub-pentagonal aperture is seen, as shown in fig. 5. This aperture occupies the position of the mouth in the existing echinoderms. The integument, as will be shown further on, represents that which covers the mouth of an embryonic Star-fish. Mr. Conrad described this genus in 1842, as having only one aperture in the summit. "This genus differs from PENTREMITES, Say, in having only one perforation at top, which is central." (Jour. Acad. Nat. Sci. Phil., vol. viii, p. 280, pl. xv, fig. 17). His figure represents the fossil with the apex downward. Dr. Ferd. Roemer, showed that, when perfect, there is no central opening, and he made this one of the grounds for separating the genus from *Pentremites*. He described the apex as being provided with six apertures, five of which were divided by a partition within each. These he considered to be the ovarian orifices. The sixth he supposes to be both mouth and vent, which accords with my view. (*Mon. der Blastoideen*, p. 378). In 1868 I discovered the five small pores at the apical extremities of the ambulacral grooves. (This Jour., II, xcvii, p. 353, and Annals Nat. Hist., IV, vol. 4, p. 76). In general it is difficult to to see these pores, but if a silicified specimen, which has been fossilized in a calcareous matrix, be placed in an acid for two or three minutes, the acid cleans them out and they then become distinctly visible. I believe these to be the pores through which the ovarian tubes passed outward along the grooves to the pinnulæ. There are thus, sixteen apertures in the apex of *Nucleocrinus*,—ten spiracles, five ovarian orifices, and one oro-anal aperture. There are no true radial plates. The whole of the test with the exception, perhaps, of the ambulacra belongs to the perisomatic system.

8. On the occurrence of Embryonic forms among the Paleozoic Echinoderms.

8.



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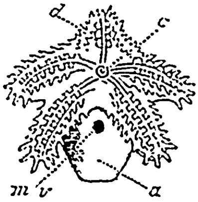

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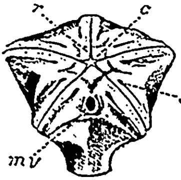

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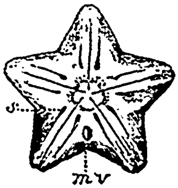


Fig. 8. *Bipinnaria asterigera* Sars, (copied from Muller). *a*, the stomach; *b*, part of the body of the larva; *c*, ambulacral centre, position of the permanent mouth, in this stage not open; *d*, one of the five ambulacral canals; *e*, sand canal; *f*, madreporic plate; *m*, entrance into the stomach; *o*, œsophagus; *p*, larval mouth or pseudostome; *r*, œsophageal ring; *v*, vent. 9. Ideal figure described below. 10. *Codonites stelliformis*, oblique view to show both body and summit. 11. Summit of fig. 10.

No proposition in Natural History has been more clearly demonstrated than this:—That, in general, the paleozoic animals resemble, both in external form and internal structure, the embryonic stages of those of the same class at present existing. Prof. Agassiz has long taught in his lectures and various publications, that this is especially observable in the Echinodermata. Judging from the figures and descriptions of Muller, Agassiz, Thomson, Carpenter and others, I should say, that in this class, the most striking resemblance is that which occurs between the adult stages of the Cystidea, Blastoidea, and paleozoic Crinoidea, on the one hand, and the embryonic Star-fishes on the other. The structural character that has the most important bearing on the subjects discussed in these notes, is, that in all four of these groups, the mouth is situated in one of the interradial areas,—not in the ambulacral centre, as it is in the adult forms of the existing Echinodermata.

In *Bipinnaria asterigera* Sars, according to Muller, the digestive cavity is a sub-globular sack without any extensions into the rays, as there are in the adult Star-fishes. The œsophagus, fig. 8, *o*, is a fleshy, consistent tube, with a large mouth or pseudostome, *p*. It passes through the wall of the stomach by an opening somewhat smaller than the mouth, and situated in one of the interradial spaces at *m*. The madreporic plate, *f*, and sand canal, *e*, the latter holding the convoluted plate (when it occurs), are situated above the orifice, *m*, and between it and the ambulacral centre, *c*. The circular space at *c*, is undoubtedly the homologue of the central space in the apex of *Nucleocrinus*, figs. 3 and 5, and of *Codonites*, figs. 10 and 11. It is also the position of the mouth in the adult Star-fish; but in the larval stage it is completely closed by the soft external skin and sarcode of the body. In the fossils it is also closed, by an integument of thin calcareous plates. The *Bipinnaria* is nourished by minute particles of matter diffused through the water, and drawn into the digestive sack through the mouth and œsophagus by the action of internal cilia. I believe that all the fossil Crinoidea, Blastoidea and Cystidea, ingested their food in this way, and without any aid whatever from the arms or pinnulæ.

Perhaps there is no embryologist who will not admit, that it is possible for an animal like *Bipinnaria* to develope organs of reproduction and propagate its species, none of its other parts making any further advance. Such an animal, with some slight modifications, would not be very widely different from a paleozoïc Crinoid. If the sarcodic body wall were to be consolidated into a thin calcareous integument, with the mouth even with the surface, the swimming appendages aborted, and the vent closed up, it would resemble the cup of an *Actinocrinus*, fig. 9, *a*. The lateral orifice would then be both mouth and vent, as it is, at first (according to Prof. A. Agassiz, Seaside Studies, p. 125), in the embryo of *Asteracanthion Berylinus*. The ambulacral canals of *Bipinnaria* are the homologues, in a general way, of those which are found beneath the vault of *Actinocrinus*, and extend out into the grooves of the arms. If the ventral perisome of the Crinoid were to be removed (the internal organs remaining undisturbed) the arrangement disclosed would be that represented in fig. 9,—a convoluted plate in the centre with the canals radiating from it. The most striking difference is the absence of the œsophageal ring. According to the organization of *Actinocrinus* there could be no œsphagus at that point, and consequently there is no ring. The convoluted plate represents the madreporic apparatus. The sucking feet of the Star-fish, most probably, represent the respiratory tentacles that border the grooves of the Crinoids, but modified into prehensile and locomotive organs. *Bipinnaria* and *Actinocrinus* agree in having the mouth in one of the interradial areas, and in the absence of an orifice through the perisome at the ambulacral centre. These two characters are enbryonic and transitory in the Star-fish, but they were permanent in most paleozoic Crinoids.

In *Codonites stelliformis* (*Pentremites stelliformis* Owen and Shumard), figs. 10, 11, the ambulacral centre, *c*, is completely closed. Five minute grooves radiate out to the extremities of the five angles of the disc. These grooves are identical with those of *Pentremites* and *Nucleocrinus*, and were occupied by the ovarian tubes. The ambulacral canals of the true Crinoids and of the Star-fishes are represented in a rudimentary condition, in this species, by the hydrospires which open out to the surface through the ten fissure-like spiracles, *s*. The oro-anal orifice is interradial. *C. stelliformis* in external form, the interradial position of the mouth, and the closed ambulacral centre, resembles *Bipinnaria* and *Actinocrinus*, but differs importantly in having its respiratory organs arranged in ten separate tracts, all totally disconnected from each other. It is a lower form than *Actinocrinus*, which in its turn is lower than *Bipinnaria*, and yet all three are constructed on the same general plan.

C. stelliformis, although much resembling a *Pentremite*, is a true Cystidean. Its affinity to *Codaster* was first pointed out by Dr. C. A. White, who also suggested that it should be assigned to a distinct group. (Bost. Jour, N. H., vol. vii, pp. 486,487). The main difference between the Cystidea and the Blastoidea is, that in the former the hydrospires do not communicate with the pinnulæ, whilst in the latter the cavities of the pinnulæ and hydrospires are directly connected by the ambulacral pores.

The developement of the recent Crinoid, *Antedon rosaceus*, as described by Prof. Wyville Thomson (Phil. Trans., 1866), pursues a course that could not possibly result in the production of such an animal as *Actinocrinus*. The pseudembryo, as it is called by Prof. Thomson, is a small ovate organism, with four transverse, ciliated bands, a large key-hole-shaped mouth (pseudostome), and a small circular vent (pseudoproct). These orifices are connected by a rudimentary intestine (pseudocele). In this stage there is no trace of radiation, and the mouth, therefore, cannot be said to be interradial in its position.

The nascent Crinoid originates within the pseudembryo, but developes a mouth, vent and and stomach, of its own, all quite distinct from those of its nurse. The new, or permanent mouth, is for a short time both oral and anal in its function, but although in this respect it resembles that of *Actinocrinus*, its position in the centre of the ambulacral system, shows it to represent the mouth of the adult Star-fish, while that of *Actinocrinus* rather homologates with the oral orifice of the *Bipinnaria*. At no time during its development does the ventral perisome exhibit the structure of that of the paleocrinoids, *i. e.*, no orifice in the ambulacral centre, and at the same time one in an interradial space. In the central position of its mouth, and in the possession of an œsophageal ring, *Antedon* stands above *Actinocrinus* in rank, and between it and the adult Star-fish. In none of its stages does it resemble a *Bipinnaria* either in form or in structure.

9. ON SOME OF THE OBJECTIONS THAT HAVE BEEN ADVANCED AGAINST THE VIEWS ADVOCATED IN THE PRECEDING NOTES.

In all the known species of the existing Echinodermata, the mouth is situated in the centre of the ambulacral system, and it is contended that this fact proves that such must have been its position also in the paleozoic forms.

This reasoning is not strictly logical. It is true that in the known existing species, the mouth is in the centre, but it does not certainly follow that it is so in all the Echinodermata, living and extinct. Whether it be so or not in any particular fossil species, whose structre may be under investigation, *is a question of which fact can only be positively determined by direct observation of specimens.* On appealing to these we find that, in a large proportion of the fossil forms, there is no aperture in the perisome at the ambulacral centre. It also becomes evident by the comparison that, in general, the paleozoic species resemble the embryonic stages of some of the recent Echinoderms, and that in these, (*Bipinnaria* for instance), the mouth is interradial. Rules such as are relied on in this case, afford a certain amount of presumptive evidence, which, however, cannot prevail against material and visible facts. When we can see clearly that there is no aperture in that point in the vault of a Crinoid, beneath which we know the ambulacral centre is situated, it is perfectly useless to supply one by deduction.*

The second objection is, that many of the fossils have a *Platyceras* attached to them, in such a position so as to cover the aperture which I call the mouth, and under such circumstances as to induce the belief that it lived parasitically on the Crinoid. The only answer I can make to this is that, admitting the facts, we must suppose that space was left for a stream of water to pass under the edge of the shell, into the mouth of the Crinoid. In general, where one animal lives parasitically upon another, it does not destroy his host. Some of the gasteropods of the Devonian and Carboniferous ages, were carnivorous, as is proved by the bored shells and Crinoids that are occasionly found. I have seen a great number of such specimens, and several years ago I read a paper on the subject (which was never publiished) before the Natural History Society of Montreal. There were several good Conchologists present, and the specimens exhibited were compared with bored shells of existing species. All pronounced the style

* The position of the ambulacral centre may thus be found. When the mouth is eccentric, the ambulacral tubes usually converge to the centre of the vault. But when the mouth is central, we first find the azygos interradius, in general easily recognized by its possessing a greater number of plates than do any one of tho other four interradii. On the opposite side of the fossil is the azygos arm. The ambulacral centre is always situated between this arm and the mouth, never on the side of the mouth torward the azygos interradius.

of workmanship to be precisely the same. I have the proboscis of an *Actinocrinus* that is bored near the base, and among the fossils lent me by Mr. Wachsmuth is a *Codonites stelliformis*, that is bored through one of the ambulacra. The view I took of the subject in my paper, was that the gasteropod ascended the stalk of the Crinoid, and thrust its proboscis into the mouth of the latter. The Crinoid then slowly drew its arms together and held the shell fast until both died.

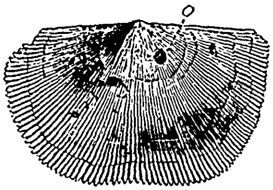


Fig. 12. *Streptorhynchus Pandora*. A specimen bored at *o* by a carnivorous gasteropod. From the Corniferous Limestone, Devonian, Canada.

A third objection is the small size of the aperture in some of the species. In general, where there is no proboscis the orifice is from one-twentieth to one-tenth of an inch in diameter, quite sufficient for an animal that subsists on microscopic organisms. It is stated by Meek and Worthen that where there is a proboscis, the aperture is sometimes scarcely "more than *one-hundredth* of an inch in diameter." I believe in many such instances the tube is filled up by calcareous deposits on its inside, and that when entirely obstructed, either a new aperture is opened out in the side of the proboscis, or that the animal died. In Mr. Wachsmuth's collection, I saw a specimen with a second aperture in the process of formation. A ticket was attached to it by him, giving this explanation. I am also informed that in some of the existing species of *Antedon* "the mouth is an exceedingly minute aperture."

A fourth objection is that the aperture is so situated that the arms could not have conveyed food to it. It is however proved by Dr. W. B. Carpenter, that in the recent Crinoids the arms are not prehensile organs. The animal while feeding remains motionless, attached by its dorsal cirrhi to a stone, shell, or other object on the bottom. Its arms are either stretched out to their full length, or more or less coiled up, but quite immovable. As Dr. Carpenter's remarks have a very important bearing upon the subject, I shall take the liberty of quoting the following:—

"Whatever may be the purpose of the habitual expansion of the arms, I feel quite justified that it is *not* (as stated by several authors whom I cited in my historical summary) the prehension of food. I have continually watched the results of the contact of small animals (as Annelids, or Entomostracans and other small Crustaceans) with arms, and have never yet seen the smallest attempt on the part of the animal to seize them as prey. Moreover, the tubular tentacula with which the arms are so abundantly furnished, have not in the slightest degree that adhesive power which is possesed by the "feet" of the ECHINIDEA and ASTERIADA; so that they are quite incapable of assisting in the act of prehension, which must be accomplished, if at all, either by the coiling-up of a single arm, or by the folding-together of the arms. Now I have never seen such coiling up of an arm as could bring an object that might be included in it into the near neighbourhood of the mouth; nor have I seen the contact of small animals with a single arm produce any movement of other arms towards the spot, such as takes place in the prehensile apparatus of other animals. Moreover, any object that could be grasped either by the coiling of one arm, or by the consentaneous closure of all the arms together upon it, must be far too large to be received into the mouth, which is of small size and not distensible like that of the ASTEROIDA." *

Farther on Dr. Carpenter says:

"It was affirmed by M. Dujardin (l'Institut, No. 119, p, 268) that the arms are used for the acquisition of food in a manner altogether dissimilar to ordinary prehension; for recognizing the fact that the alimentary particles must be of small size, he supposed that any such, falling on the ambulacral (?) furrows of the arms or pinnæ, are transmitted downwards along those furrows to the mouth wherein they all terminate, by mechanical action of the digitate papillæ which fringe their borders. This doctrine he appears to have abandoned; since in his last account of this type (Hist. Nat. des Echinoderms, p. 194) he affirms that the transmission of alimentary particles along the ambulacral (?) furrows is the result of the action of cilia with which their surface is clothed. Although I have not myself succeeded in distinguishing cilia on the surface which forms the floor of these furrows, yet I have distinctly seen such a rapid passage of minute particles along their groove as I could not account for in any other mode, and

* Researches on the Structure, Physiology, and development of *Antedon* (*Comatula*, Lamk.) *rosaceus*.—Part I. By W. B. Carpenter, M.D., F.R.S. Philosophical Transactions of the Royal Society, vol. clvi, Part II. 1866.

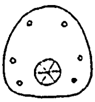
am therefore disposed to believe in their existence. *Such a powerful indraught, moreover, must be produced about the region of the mouth, by the action of the large cilia which (as I shall hereafter describe,) fringe various parts of the internal wall of the alimentary canal, as would materially aid in the transmission of minute particles along those portions of the ambulacral (?) furrows which immediately lead toward it;* and it is, I feel satisfied, by the conjoint agency of these two moving powers that the alimentation of Antedon is ordinarily affected. In the very numerous specimens from Arran the contents of whose digestive cavity I have examined, I have never found any other than microscopic organisms; and the abundance of the horny rays, *Peridinium tripos*, (Ehr.) has made it evident that in this locality that Infusorian was one of the principle articles of its food. But in Antedons from other localities, I have found a more miscellaneous assemblage of alimentary particles; the most common recognizable forms being the horny casings of ENTOMOSTRACA or of the larvæ of higher CRUSTACEA." (Op. cit., p. 700).

The existence of large cilia within the intestinal canal, capable of producing a powerful indraught of water, renders any movement or concurrent action of the arms quite unnecessary in the ingestion of food. It does not matter, therefore in what part of the body the mouth of a Crinoid may be situated, or how remote from the reach of the arms. Attached permanently to the bottom of the sea by their columns, the Crinoidea, Cystidea and Blastoidea remained, while feeding. most probably motionless, drawing in streams of water through their mouths by the action of their intestinal cilia. The long tubular proboscis with which many of the species are provided, would be, thus, analogous in function to the siphon of the acephalous mollusca. The indigestible particles would be, from time to time, thrown out the mouth, just as a Star-fish or a Zoophyte frees itself of the refuse portion of food, by casting it out of the same aperture through which it entered.

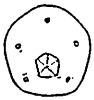
10. ON THE THEORY THAT THE AMBULACRAL AND OVARIAN ORIFICES ARE THE ORAL APERTURES.

Assuming that the four objections above noticed are sufficient to prove that the aperture which I call the mouth is not that organ, it is contended that the Cystidea, Blastoidea and Palæocrinidea ingested their food through their ambulacral and ovarian orifices. This appears to me in the highest degree improbable. In the recent Crinoids the grooves of the arms are occupied by four sets of tubes, which Dr. Carpenter calls the cœliac, the subtentacular, the ovarian and the tentacular canals. None of them communicate with the stomach. It is impossible that the most minute particle of food could gain acess into the interior of the animal through any of them. The structure of the arms of the paleozoic Crinoids is such, that we must presume that their grooves were occupied by similar tubes, which passed through the ambulacral orifices into the perivisceral space. In the Cystidea and Blastoidea the respiratory organs were not situated in the grooves of the arms, and the ambulacral orifices were therefore only ovarian in their function. The improbability of their being also oral apertures is best shown by an illustration.

13.



14.



In fig. 13, is represented (natural size) the apertures of the smallest specimen of *Caryocrinus ornatus* in our collection, selected for the present purpose because in the young of this species, the valvular orifice is larger in proportion to the disc, than it is in the adult. It is in this specimen, about one-third of the whole width of the apical disc, while in a full grown *Caryocrinus* it is only one-ninth of the width. The same proportional size of the mouth according to age, occurs in the *Antedon rosaceus*. The valvular mouth at first is as wide as the disc. But as the age of the animal increases the disc grows wider but the mouth does not. The ovarian pores in *Caryocrinus* are however as large in the small ones (once they make their appearance) as they are in those full grown. For recognizing these as ovarian pores we have the following reasons:—1. They are situated at the bases of the arms where the ovarian tubes must pass from the grooves into the perivisceral cavity. 2. When compared with the ovarian pores of a Sea-urchin they have the same size, form and aspect. Fig. 14 represents the ovarian pores of the Sea-urchin *Toxopneustes Drobachiensis* Ag. natural size and arrangement. It may not appear at first view that this latter comparison has any probative effect. But it has, in this way. If these apertures in *Caryocrinus* were large openings a line wide, as are some of the ambulacral orifices of the Crinoids, I would say that they were unlike true ovarian apertures.

According to the new theory, this Echinoderm, *Caryocrinus* *ornatus*, was a polystome animal, and drew in its food through its six ovarian apertures, the large valvular orifice being the anus. To me this appears uterly incredible.

In fig. 14 I have represented the mouth of *Leskia mirabilis* Gray. Both Dr. J. E. Gray and Prof. Lovén have pronounced this aperture to have the structure of the valvular orifice of the Cystidea. I have not the slightest doubt whatever but that the mouth of the Cystideans foreshadows that of the Sea-urchins. There is nothing whatever in its structure to show that it is not the mouth but the contrary.

The new theory is not founded upon any peculiarities in the structure of the ambulacral orifices, which would show that they are oral apertures, but only upon the four objections above noticed. The first of these is not logical, while at the same time it is purely theoretical, and avails nothing against material and visible facts. The fourth is completely disposed of by Dr. Carpenter's observations, which prove that in the Crinoidea the arms have no share whatever in the ingestion of food. The second and third objections are the same in substance, i. e., according to the second the supply of water to the mouth, is diminished by the occurrence of a *Platyceras* over it, while, according to the third, the same effect is produced by the small size of the aperture itself in some instances. It does not require much consideration to convince one, that if these two objections are fatal to my views, they are equally so to the opposite theory. In *C. stelliformis*, for instance, the pores through which we must suppose the ovarian tubes issued from the interior are only large enough to admit of the passage of a fine hair. They are scarcely visible to the naked eye. The tube, under any circumstances, must have filled them entirely. If any space at all were left for the passage of a stream of water through the pore by the side of the tube it must have been exceedingly minute.

When weighed as above, therefore, the evidence gives the following results:—The first and fourth objections avail nothing. The second and third militate against both theories. But when we take into account that in no instance in the existing Echinodermata, where ovarian pores occur, are they at the same time oral orifices, the balance seems to be in favour of my view. This is all I desire to say upon the subject at present. Although I now firmly believe that the valvular orifice in the Cystidea, the larger lateral aperture of the Blastoidea, and the so-called proboscis of the paleozoic Crinoids are all oro-anal in function, yet I shall not maintain that view obstinately against good reason shown to the contrary.

ON THE GEOLOGY OF EASTERN NEW ENGLAND.

BY DR. T. STERRY HUNT, F.R.S.

(From a letter to Prof. JAMES *D.* DANA, *reprinted from the American Journal of Science and Arts, Vol. L., July,* 1870.)

When, more than twenty years since, my attention was turned to the geology of New England, there was no evidence of the existence between the old gneisses of the Adirondacks and the coal measures, of any other stratified rocks than those of the Huronian series, and the New York system, from the Potsdam formation, upward. It is true that Emmons had, before that time maintained the presence, in western Vermont and Massachusetts, of a system of fossiliferous sediments, lying unconformably beneath the Potsdam, but the evidence up to this time adduced with regard to these so-called Taconic rocks, has failed to show that they include any strata more ancient than the Potsdam, while most of them are certainly younger. The researches of Sir William Logan, up to 1848, had led him to refer to a period not older than the Lower Silurian the crystalline sediments of the Appalachian region of Canada, between Lake Champlain and Quebec. These form a chain of hills, the continuation of the Green Mountains, and were found by him to *be followed immediately, to the southeast, by more or less* calcareous and somewhat altered strata, associated with Upper Silurian fossils, and succeeded across the strike, near the sources of the Connecticut River, by a series, several miles in breadth, of micaceous schists and quartzose strata, occasionally containing chiastolite, garnet and hornblende. These two series of rocks, extending from the base of the Green Mountains to Canaan on the Connecticut, it was suggested by Sir William Logan, in his Report on the Geological Survey, 1847–1848, might be the altered representatives of the rocks of Gaspé, including the Lower Helderberg group, and the succeeding members of the New York system to the top of the Chemung. I then as now conceived that these micaceous and argillaceous schists, often holding garnets and chiastolite, were identical with those which make so conspicuous a figure in the White Mountains and elsewhere in Eastern New England, and when, in 1849, I laid before the American Association at Cambridge, the results of the Geological Survey of Canada (Sill. Jour., II, ix, 19), suggested that to the Gaspé series, as above defined, "may perhaps be referred, in part, the rocks of the White Mountains." Lesley, subsequently, in 1860 (Proc. Philad. Acad. Nat. Sciences, page 363), adduced many reasons for believing that the rocks of these might be strata of Devonian age.* In the large geological map of Canada and the northern United States, lately published by Sir William Logan, no attempt is made to delineate the geology of New Hampshire, but the rocks in question, to the north of the United States boundary, are represented as Upper Silurian, with the exception of a belt of the Quebec group, which has been recognized in that region.

In fact the schists and gneisses of the White Mountains are clearly distinct, lithologically, from the Laurentian, the Labradorian and the Huronian, as well as from the crystalline rocks of the Green Mountains, and from the fossiliferous Upper Silurian strata which lie at the southwestern base of the Canadian prolongation of the latter. Having thus exhausted the list of known sedimentary groups up to this horizon, it was evident that the crystalline strata of the White Mountains must be either (1) of Devonian age, or (2) something newer (which was highly improbable); or (3) must belong to a lower and hitherto unknown series. In the absence of any proof, at that time, of the existence of such a lower system, the first view, which referred these strata to the Devonian period, was the only one admissible.

* In this connection should be recalled the views put forth in 1846, by Messrs. H. D. and W. B. Rogers, in a paper on the Geological Age of the White Mountains, (Sill. Journal, II, i, 411). They there, for the first time, pointed out that the great mass of these mountains consists of more or less altered sedimentary strata, which upon the evidence of supposed organic remains they referred with some little doubt, to the Clinton division of the Upper Silurian. In 1847, however, they announced that the supposed fossils, on which this identification had been founded, were not really such, (Sill. Journal, II, v, 116). Future explorers may, it is hoped, be more successful, and yet discover among the strata of the White Mountains evidences of organic life, probably of primordial Silurian age.

When, however, further investigation showed that the great and progressive thickening which takes place in the paleozoic formations from the west, eastward, is not confined to the augmentation of existing subdivisions, but includes the intercalation of new ones; when the few hundred feet of typical Potsdam sandstone in New York are represented in Vermont, Quebec and Newfoundland, by thousands of feet of strata lithologically very unlike the type; while the Quebec group, not less in volume, appears representing the beds of passage between the Calciferous and Chazy divisions of New York, we begin to conceive that conditions of sedimentation, very unlike anything hitherto suspected in the west, prevailed to the eastward. When, moreover, we find widely separated areas of *Labradorian and Huronian rocks,*—remaining fragments of great series,—resting upon the Laurentian, from Lake Huron to Newfoundland, we get evidences of a process of denudation in past ages, not less remarkable than the sedimentation.

My observations of last year have led me to a conclusion, which had previously been taking shape in my mind, that there exists above the Laurentian, a great series of crystalline schists, including mica-slates, staurolite and chiastolite-schists, with quartzose and hornblendic rocks, and some limestones, the whole associated with great masses of fine-grained gneisses, the so-called granites of many parts of New England. The first suggestions of this were given me by the observation of Dr. Bigsby, confirmed by specimens since received from that region, that there exists to the northwest of Lake Superior, an extended series of crystalline schists, unlike the Laurentian, and resembling those of the White Mountains. I have already called attention to this resemblance in a review of the progress of American Geology, in 1861 (*Can. Naturalist*, VI., 84). It was contrary to my notions of the geological history of the continent to suppose that rocks of Devonian age could, in that region, have assumed such lithological characters, and I was therefore led to compare these rocks with a great series of crystalline schists, abounding in mica-slates and micaceous limestones, which occupy considerable areas in the Laurentian region in Hastings county, to the north of Lake Ontario. The distribution of this series has been traced out by Mr. Vennor, who in 1869, was able to show that, although much contorted, it rests unconformably upon the old Laurentian gneisses, while it is, at the same time overlaid by the horizontal limestones of the Trenton group. This intermediate series, which attains a thickness of several thousand feet, is terminated by calcareo-micaceous schists, in which *Eozoon Canadense* has been found, both in Madoc and in Tudor. In these localities, as shown by Dawson and Carpenter (Sill. Jour., II., xlvi, 367), the calcareous skeleton of the Eozoon, instead of being injected by serpentine or another silicate, is simply filled with impure calcareous and carbonaceous matter. The presence of this fossil serves to connect these rocks with the Laurentian system, with which they had provisionally been classed, although their lithological dissimilarity had long been noticed, and in 1866 Sir William Logan had remarked their resemblance to the mica-slate series found near the sources of the Connecticut River (Report Geol. Survey, 1866, p. 93).

Mr. Alex. Murray's report of his explorations in Newfoundland, published in 1866, throws much light on the history of the rocks immediately succeeding the Laurentian in that region. He found in the great northern peninsula, about the Clouds Mountains and Canada Bay, not less than 5400 feet of strata, referred by him to the Potsdam group. Of these the lower 2500 feet consist of bluish-gray slates, holding near the summit, beds which become conglomerate from the presence of quartz pebbles, and are followed by a mass of purplish amygdaloidal diorite, holding epidote and jaspery red iron ore. Then follow 2000 feet of argillaceous and somewhat micaceous slates with beds of quartzite and of limestone, generally impure. These contain, besides numerous fucoidal markings, the remains of a Lingula, and of *Olenellus Vermontanus*, a fossil characteristic of the Potsdam group. To this second division succeeds a third, consisting of about 900 feet additional of limestones and slates. Somewhat farther southward, at Great and Little Coney Arms, the lower half of the above series is not observed, but a succession of strata, supposed to represent the upper portion of the Potsdam, is more particularly described. It consists, at the base, of 300 feet of pale bluish-gray mica-slates, with iron stains, "softer more finely laminated, and more uniform both in colour and in texture" than some micaceous strata described by Mr. Murray as occuring in the Laurentian in that region. To these succeeded 430 feet of similar soft bluish-gray mica-slates, holding numerous thin seams of dark colored limestone, and followed by 1000 feet of impure limestones and slates, often micaceous and calcareous, among which are a few beds of white compact marble. No indications of fossils, save fucoidal markings, were met with in this section. At Coney-Arm Head there is seen a series of "whitish granitoid, very quartzose mica-slates," which appear to have a thickness of from 1500 to 2000 feet. The same rock is found in White Bay, where it overlies what is supposed to be Laurentian gneiss. The relations of these whitish granitic mica-slates are still obscure, but Mr. Murray was inclined to regard them as occupying a position beneath the Potsdam group. The latter, in Canada Bay is immediately followed by the unaltered fossiliferous limestone, and shales of the Quebec group. From these investigations of Mr. Murray we learn that between the Laurentian and the Quebec group, there exists a series of several thousand feet of strata, including soft bluish-grey mica-slates and micaceous limestones, belonging to the Potsdam group; besides a great mass of whitish granitoid mica-slates, whose relation to the Potsdam is still uncertain. To the whole of these we may perhaps give the provisional name of the Terranovan series, in allusion to the name Newfoundland.

Imperfect gneisses and schists are found in several parts of the province of New Brunswick, associated with what has been described as a great grantic belt. These rocks have been examined by Prof. Hind, and by Mr. Robb, on the St. John and Mirimichi rivers; and the former of these observers some years since pointed out the indigenous character of the so-called granites. In the summer of 1869 I had an opportunity of examining, with Prof. L. W. Bailey, the region about St. Stephen, on the river St. Croix, where he had already observed a series of ferruginous quartzites and imperfect gneisses, accompanied by soft bluish mica-slates sometimes holding chiastolite, staurolite, and garnet. These highly crystalline schists are not more than five miles removed from unaltered shales of the Gaspé series containing fossils of Upper Silurian or Lower Devonian types, and rest unconformably upon older granitoid rocks, which Prof. Bailey regards as probably Laurentian. We subsequently examined the crystalline schists of the St John, which are apparently identical with those of the St. Croix, and these also overlie, unconformably, an older granitoid gneiss.*

* Subsequent examination and comparison leads me to conclude that the underlying granitic rock here referred to, which occurs on the St. John near the mouth of the Shogamoc is not an indigenous rock, but an

More recently Prof. Hind has pointed out that some of the so-called granites of Nova Scotia are ancient gneisses, probably of Laurentian age, and have shown that between these and the gold-bearing slates of that province, there is found, near Windsor, and near Sherbrooke, a series of beds of no great thickness, consisting of imperfect gneisses, quartzites and micaceous schists, which rest unconformably on the Laurentian, and are sometimes wanting altogether. These include mica-schists with chiastolite and garnet, and appear identical with those already observed by Dr. Dawson in other parts of Novia Scotia, which I had already recognized as the same with those of the White Mountains, and those of the St. Croix, just noticed. Prof. Hind, in a late paper, has called these, from their position in Nova Scotia, Huronian; but the Cambrian or Huronian rocks recognized by Messrs. Matthew and Bailey in New Brunswick, where they are widely spread along the north side of the Bay of Fundy, consist of massive diorites and quartzose feldspar-porphyries, with occasional sandstones and conglomerates, and are very unlike the gneissic and micaceous rocks in question, which I believe to belong, like those of the St. Croix and the St. John rivers, to the great Ierranovan series. The micaceous and hornblendic schists, with interstratified fine grained whitish gneisses (locally known as granites) which I have seen in Hallowell, Augusta, Brunswick and Westbrook, in Maine, appear to belong to the same series; which will also probably include much of the gneiss and mica-schist of eastern New England. If this upper series is to be identified with the crystalline schists which in Hastings County, Ontario, overlie unconformably the Laurentian, and yet contain *Eozoon Canadense*, the presence of this fossil can no longer serve to identify the Laurentian system. To this lower horizon however, I have referred a belt of gneissic rocks in eastern Massachusetts, which are lithologically unlike the present series, and identical with the Laurentian of New York and Canada. To the upper series appear to belong the great endogenous granitic veins so well known to mineralogists as containing beryl, tourmaline and other fine crystallized minerals.

The fine-grained white granitoid gneisses, often present an apparently bedded structure, which enables them to be removed in large plates or layers, lying at no great angle, and apparently con-

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intrusive granite. The same view must probably be extended to the granite rocks of the St. Croix.

formable to the present surface of the country. This structure, which I conceive to have been superinduced by superficial changes of temperature, is often quite independent of the bedding, as may be seen in the quarries near Augusta in Maine, and in the cuttings on the Grand Trunk Railway near Berlin Falls, New Hampshire. It is also observed in exotic or intrusive granites, like those of Biddeford, Maine. This is, in fact, the concentric lamination of granite, long since observed by Von Buch, and, I believe, correctly explained by Prof. N. S. Shaler to be due to movements of contraction and expansion in the mass, caused by variation of temperature during the changes of the seasons. He has not however observed this structre at greater depths than from three to five feet, while in some rocks I have found it penetrating probably twenty feet. (See Shaler's paper, read before the Boston Nat. History Society, Feb. 3, 1869, and published in the Proceedings of the Society, vol. xii, page 289).

While however I admit the existence in the Dominion of Canada and in eastern New England, of a great series of crystalline schists, distinct from the Laurentian, and apparently the same with those found by Mr. Murray between the Laurentian and the Quebec group in Newfoundland, it is not less certain that we have in these regions rocks of Upper Silurian and Lower Devonian age, holding the characteristic fossils. These strata in Maine and New Brunswick are generally but little altered. In the Connecticut valley at Bernardston, Massachusetts, near Lake Memphremagog in Vermont, and further northward in the province of Quebec, fossils of this horizon are found in rocks which in some localities, are more or less altered and crystalline. I believe however that much of the calcareous mica-slate of eastern Vermont will be found to belong to the Terranovan series. The extent of these newer rocks, and the limits between them and the more ancient schists, of the ruins of which they are probably in part composed, remain problems for farther investigation. For the solution of these Prof. C. H. Hitchcock, by his labours in Vermont, is already well prepared, and it cannot be doubted that he, with his able assistants, will in the Survey of New Hampshire, now in progress, throw much light on New England geology. It is worthy of remark, that strata holding fossils of Lower Helderberg age, or thereabouts, are not confined to the shores of Maine and New Brunswick, and the valleys of the Connecticut and St. John rivers, but are found beyond the Green Mountains;

in the valley of the St. Lawrence near Montreal; where, on the island of St. Helen they rest unconformably on the Utica slate, and at Belœil Mountain, near by, on intrusive diorites, which there break through the shales of the Hudson River group.

The relations of this Terranovan series to the porphyries and diorite rocks which, in New Brunswick, have been called Cambrian and Huronian by Mr. Matthew (first distinguished by him as the Coldbrook group), yet remains to be determined. These rocks are found near to the city of St. John resting directly on what has been regarded as Laurentian, and are overlaid by the uncrystalline schists which contain the primordial fauna now so well known by the descriptions of Prof. Hartt. Rocks which I regard as identical with the same Coldbrook or Cambrian group, are found along the coast of New Brunswick, and constitute the diorites and porphyries of Eastport, Maine. They appear moreover to be the same with those met with near Newburyport, and Salem, Lynn, and Marblehead, Massachusetts. Farther researches about Passamaquoddy Bay, where the mica-slates are found not far removed from these porphyries, will probably enable us to determine their relation to each other.

It will be remembered that Gümbel has found, in Bavaria beneath the oldest fossiliferous clay-slates, a mica-schist (and hornblende-schist) series, reposing upon the Hercynian gneiss, which contains crystalline limestones, with graphite, serpentine and *Eozoon Canadense*, and which he has identified with the Laurentian of North America. He distinguishes beneath this a great mass of red gneiss, apparently without limestones, to which he has given the name of the Bojian gneiss. It will however be remembered, that in his studies of the Laurentian system on the Ottawa, Sir William Logan has shown that this immense series (his Lower Laurentain), some 20,000 feet in thicknesss, includes four great masses of gneiss and quartzite, divided by three limestone formations, and that it is in the uppermost of these, which is, in some parts, 1500 feet thick, that the *Eozoon Canadense* has been found. Some of the lower gneisses of this vast system may very well represent the Bojian of Gümbel, who has not recognized in Bavaria either the Labradorian (Upper Laurentian) or Huronian series. (See Gümbel on the Laurentian of Bavaria, translated and published in the Canadian Naturalist for December, 1866). Comparative studies of this kind should not be neglected in the investigation of our American rocks.

NATURAL HISTORY SOCIETY.

PROCEEDINGS AT THE ANNUAL MEETING,

Held May 18th, 1870.

The annual meeting of this Society was held at its rooms on the evening of May 18th, the Acting President, Rev. A. De Sola, LL.D., in the absence of Sir W. E. Logan, in the chair. Mr. J. F. Whiteaves, the Recording Secretary, read the minutes of the last annual meeting; after which the usual annual address was delivered as follows:—

In the notice calling this meeting, it was announced that there would be an address by the Acting President. I fear, however, that I shall have now to prove there would be more of courtesy than of justice in dignifying my few remarks, illustrative of the work done in the past year, with a title that has frequently, even if not invariably, conveyed on such an occasion the idea of a scientific treatise. When I had the honor of last filling the presidential chair, I called your attention to "some points of interest in the study of Natural History"; but this evening, I do not follow this course, for two reasons, which I trust you will regard as quite sufficient. The first is, that I—and I venture to add most others in my situation—would but little desire to give opportunity of contrast with what, had he been present, our learned President, Sir Wm. Logan, would have favored us. And the second is, that multifarious and urgent official and other duties would have prevented me, however I might have felt disposed to intrude in such a direction. In uniting with me, as I am sure you will, in regretting the absence of our President on this occasion, we may yet have the satisfaction of recalling the fact that on Sir William Logan's recent retirement from the active duties of Director of the Geological Survey, this Society, which in the past had done something to help Sir William in creating the Survey, availed itself of the occasion of his withdrawal to present him with its silver medal, accompanied with resolutions expressive of the Society's desire—although it could not add appreciably to the many honors which Sir William had received, by presenting to him its medal—yet its earnest desire to place on record, not merely on its own behalf, but on that of all the students of natural science in Canada, its high estimation of the value of his services in creating, as well as directing, the Geological Survey of this country; in promoting the development of its mineral resources; in stimulating and aiding the efforts of scientific institutions, and in extending throughout the world the name of Canadian science. The resolutions also express our high appreciation of Sir William's admirable personal qualities, our hope that he may be spared for many years to Canada and science, and that the relief from official cares may give him the opportunity to pursue to completion the researches in scientific geology in which he is now engaged. In the sentiments of these resolutions I am sure all who are here to-night, but who were absent when they were offered, will full and cordially concur, and at the same time unite with me in felicitating the "Survey" and the cause of geological science, that Sir William's mantle should have fallen on so worthy a successor as Mr. Selwyn, whose laurels, already gathered as director of the Geological Survey in Victoria, will doubtless multiply and extend themselves in the new and larger field to which he has been called.

The proceedings to which I have just adverted will find record in the Society's organ, *The Canadian Naturalist*, and it may be proper that I should here say a few words respecting this publication, especially as I have not been editorially or otherwise connected with the volume just completed. This volume forms the fourth of the new series and the first of its publication as a quarterly, and I venture to say that we have much cause for gratification and pride at its appearance, especially when we look to the difficulties attendant upon its production. These difficulties are both of a financial and literary character—the various valuable articles consisting entirely of voluntary contributions—and it is to be feared that not all the members of this Society sufficiently realize or ponder these great difficulties. It must be a source of congratulation to the Editing Committee that they have been enabled to publish the volume within the year—a feat not always accomplished either by the *Naturalist*, or by the publications of sister societies in the Dominion. We need but look at the varied and valuable contributions in this volume to be satisfied that it has not been surpassed by any before it. And what will be considered a very gratifying fact is, that the original articles of the *Naturalist* are now copied *in extenso* in some of the scientific journals of the Mother Country and the United States. Thus, not less than six of these articles of the last volume have been wholly reproduced in the London *Scientific Opinion*, to wit two by Dr. Edwards, one by Dr. Hunt, one by Mr. Ritchie, and two by Dr. Smallwood. Articles and the monthly proceedings of this Society are also copied in *Nature* and other periodicals. This important testimony to the value of the book must needs prove especially gratifying to those engaged in this labor of love, and should stimulate members to extend to the journal a more general and earnest support.

I would ask leave to bring before you here a list of the original papers read by members during the past year, some of which appeared in the *Naturalist*, and reappeared, as I have said, in English periodicals. These are in addition to the interesting lectures given in the Sommerville course, which have been six in number, and which I will enumerate first:—

1. Feb., 10th, 1870. "Explorations in the Nipigon Country," by Professor R. Bell, C.E., F.G.S.

2. Feb. 17th. "Recent discoveries in Solar Physics, and the total eclipse of August 7th, 1869," by James Douglas, jr., President of the Literary and Historical Society, Quebec.

3. Feb 24th. "The Chemistry of Iron and Steel," by Dr. T. Sterry Hunt, F. R. S.

4. March 10th. "On Deep Sea Dredging," by Principal Dawson, L.L.D., F.R.S.

5. March 17th. "On Gold," by Dr. G. P. Girdwood.

6. March 24th. "On Economic Mineral Deposits," by G. Broome, Esq., F.G.S.

I will notice and classify the papers read as follows:—

I. GEOLOGY.

Principal Dawson's paper on "some new Gaspé fossils," after giving a general sketch of the geology of the peninsula of Gaspé, adds some newly acquired information as to the fossil plants of the Devonian rocks of that locality, and records the occurrence in these beds of fossil fishes of the genus *Machairacanthus*, also of the genus *Cephalaspis*,—the first time this latter genus has been observed in America.

Mr. Billings has contributed two papers in the department of palæontology. In the first, he shows that the puzzling fossils called *Scolithus* and *Arenicolites* are not the burrows of marine worms, as was formerly supposed, but casts of sponges. In the other, he states that marine univalve molluscs, of the genus *Ophileta*, occur in beds several thousand feet lower down in the geological series than had been hitherto recorded.

II. ZOOLOGY.

Mr. A. S. Ritchie has brought before the Society three suggestive papers in this department of Natural History. In the first, the history of the introduction of the white cabbage butterfly, from Europe to the immediate vicinity of this city, is given. A careful description follows of the species in its three stages, with its peculiar habits, and suggestions are offered as to the best means to be adopted to check the ravages of the caterpillar of this species in our fields and gardens. The second attempts to answer the difficult question: "Why are insects attracted to artificial light?" The third is an interesting account of the habits of some of our smaller fresh water fishes, reptiles, and crustaceans, as observed in the writer's own aquarium.

Professor R. Bell has contributed observations on the Zoology and Botany of the Nipigon country, a district rarely visited by the naturalist. It is to be regretted that when parties are sent by the Geological Survey to explore places of which little is known, that a Zoological and Botanical investigation of the region in question should not, as in the United States, be made in addition to the Geological Survey. Professor Bell also read a paper on the intelligence of animals. It seems a task of no ordinary difficulty to define where animal instinct ends, and the reasoning power is clearly seen to commence.

The recent dredgings by Mr. Whiteaves in the Gulf of the St. Lawrence, have added many facts to our knowledge of the creatures which inhabit Canadian seas. The marine mollusca have been carefully monographed, and instead of 60 or 70 species, we now know of nearly 130, the number having been thus nearly doubled. The careful identification of the inhabitants of the deep sea, in addition to its Zoological importance, will do much to illustrate the conditions under which the Canadian post-tertiary peposits have been accumulated.

Dr. P. P. Carpenter has given a verbal account of the recent dredgings by Mr. McAndrew, in the Red Sea, those of Captain Pedersen in the Gulf of California and by Mr. Dall in Alaska.

III. GENERAL.

The peculiar appearances of the rose-coloured prominences of the Sun's chromosphere during the solar eclipse of last August, have been described in detail in a paper read by Dr. Smallwood. On that occasion I referred to the want of good astronomical instruments in the city, and now revert to it as a circumstance much to be deplored by those interested in the progress of physical science in our midst.

Besides the subjects already mentioned Dr. Carpenter favored the Society with two papers. The first on the Vital Statistics of Montreal for 1869; with special reference to the great disproportion in death rate between the French, the Irish, and the English portions of the population. And the second, on different modes of computing Sanitary Statistics, with special reference to the opinions lately published by Mr. Andrew A. Watt.

Although not issued under the immediate auspices of the Natural History Society, yet I may be permitted here to refer to a publication emanating from one, of whose valuable services to this society and to education generally, we can never too highly or too gratefully speak; one who, with our President, shares largely the respect and applause of the scientific world—I need scarcely say I refer to Principal Dawson, whom we trust to see soon among us again, occupying the highest place in the directorship of this Institution, for its benefit, and our gratification. The issue of the text-book of Canadian Zoology during the past year, must be a matter of congratulation to all members of this Society. The want of such a volume has been long felt, and the name of Principal Dawson is in itself a sufficient guarantee of the able way in which the subject has been treated. Let us hopefully look forward to a new edition, in which further details respecting the vertebrata of Canada will be included.

The list of papers just recited may be fairly regarded as evincing the desire of members to carry out as fully as possible the objects of the Society in one direction; but they have not been idle in others. One of their efforts to advance the study of natural science in the past year, and which is most likely to be crowned with useful and beneficial results, was their determination to avail themselves of an offer made them by their esteemed curator, Mr. J. F. Whiteaves, to place his private collection of shells and fossils in the Society's museum, in such a way as to be accessible to students and visitors, on the very liberal conditions that the collection be kept separate—that the Society find cabinets, &c., for its reception, and insure the collection, Mr. Whiteaves himself undertaking to mount and label the specimens. In availing themselves of such an offer, and voting the amount required to carry out its conditions, the Society was merely doing what other Societies in the mother country have done before them, and in this way: Possessors of a large and valuable collection which they were unable or unwilling to part with entirely, and still desired that the votaries of science generally should benefit by, would offer to deposit, under certain restriction, their collection in the museum of a society such as ours, which not having present means to acquire a valuable collection, would only be too glad to avail themselves of such an offer, and thus the cause of science would become well served. Now, although Mr. Whiteaves deposits his collection in this way, and retains the right of withdrawing it after notice be given to that effect, yet I am sure I do but echo the general opinion that the Society is greatly indebted to that gentleman for his liberal and considerate offer, and indulge the hope that ultimately both Mr. Whiteaves and the Society will find the way of securing his unusually valuable and varied collection as a permanent addendum to the Society's Museum.

Another of the members' efforts in the good cause calling for notice on this occasion, was the originating of the Montreal Microscopic Club. Although formed in 1868, this Club has not hitherto received the notice at our annual retrospects of work done, which I think it deserves. Founded for the promotion of microscopic knowledge among its members, by regular meetings for practical microscopic work, and for the interchange of ideas and experiences on microscopical subjects, it has done good and useful work at its fortnightly meetings, which are eminently of a social character, and are held during the winter season. I need scarcely say here how very acceptable we find the presence of our microscopic-brigade, with their costly, improved instruments and beautifully prepared specimens, at our annual conversazione, and how pleasant we regard the evidences of their useful investigations, not merely on those occasions, but in the pages of the Society's journal and in other directions. In England, such clubs have proved very useful and successful. The *modus operandi* is very simple, and is thus described by the honorary secretary of our Montreal organization. "The club appoints a secretary, who arranges for the meeting, and suggests a special subject for illustrations at each. The host for the evening is the president of the club; minutes are recorded and read; visitors introduced; miscellaneous business discussed and microscopic investigations proceeded with. At 10.30 p.m., the president announces the adjournment, the microscopes are returned to their cases, and a parting cup of coffee closes the seance." The chairman of the Council, in his report, will doubtless refer to the Society's more general social reunions, the field day at Belœil, and the annual conversazione, both of which were very successful. The latter occasion was distinguished by the presence of His Royal Highness Prince Arthur, to whom the Society presented an address. It was cause of great regret to the Committee to feel that, while they could safely direct the special attention of the Prince to the museum, at the extent and arrangement of which, indeed, His Royal Highness expressed to me much gratification and approval, they felt more than ever, that the library might be considered as displaying evidence of apathy and neglect—evidences which it is earnestly hoped will soon give way to others of a more fitting and gratifying character.

One of the most important measures contemplated by the Society outside its immediate sphere of action, during the past year, is the dredging of the Gulf and River St. Lawrence. Those who were privileged to hear Dr. Dawson's most interesting lecture on deep sea-dredging, delivered during the past winter's Sommerville course, will need no farther exposition of the importance for pursuing such investigation, as will certainly not those who have attentively read the proceedings of the last meeting of the British Association at Exeter. Professor Forbes had previously surmised as a result of his investigations in the Ægean and Mediterranean Seas, that life probably did not exist in the sea below 300 fathoms in depth. His views never received, however, anything like general acceptance with scientific men, and at that Exeter meeting, a most interesting letter was read from Professor W. Thompson on the successful dredging of H.M.S. "Porcupine," in 2,435 fathoms. Professor Sars, in a communication on the distribution of animal life in the depths of the sea, has enumerated not less than 437 species; and as a result of an expedition originated by the British Government, who sent the "Lightning" to dredge in the sea between the Hebrides and the Faroe Islands, we learn —and especially from an account of the expedition, given by Dr. Collins, in the Transactions of the Royal Society—that there were found to be currents of different temperature running side by side. In one place the temperature of the surface was 54°, and at the bottom 48°, and in the other the surface was 54° and the bottom 38°. Dr. Collins considered that one was the back current of the water that had coursed from the tropics to the poles. These and many other interesting facts which time will not permit me to notice, however briefly, on this occasion, may be some warrant for the desire evinced by the Society to do its share of labour in this field, and would be sufficient apology, if any were needed, for the resolutions unanimously adopted by the Society in March last, which affirmed it to be important to the cause of science and conducive to the interests and reputation of this Dominion, that researches by dredging should be prosecuted in the Gulf and River St. Lawrence, in order to ascertain the character of marine life in the greater depths and at the confluence of the fresh and salt waters of the river. And as this Society and individual members thereof, have so far entered upon such researches as to prove their feasibility and importance, but have not the means of continuing them effectually, the Society was of opinion that aid should be afforded to such operations by the government, in the manner in which this has been done in Great Britain and other countries, especially by giving for a short time in summer, facilities on board a government vessel to a party to be furnished and fitted out by this Society, which would undertake to procure observers and scientific apparatus and make reports upon such results as might be obtained. A committee, consisting of Drs. Smallwood, P. P. Carpenter, and Messrs. E. Hartley and J. F. Whiteaves, was organized to correspond with the Dominion Government, through the Hon. the Minister of Marine, with the view of effecting the desired results, and Principal Dawson has been requested, while in London, to obtain information as to the best methods of making such subsidiary observations on the temperature, chemical quality, &c., of the water at great depths, as have been made by the recent dredging operations under the auspices of the British Government, and, if possible, to procure specimens of the necessary apparatus. I will only say further on this subject that the committee have already taken steps in the matter, which may be safely left in their hands for a successful issue, and should—which is by no means impossible—the Government decline to allow our investigators a free passage in one of their ordinary cruisers, it will then become the duty of this Society to decide whether they themselves will provide the necessary means for the investigations contemplated by the resolutions, which would really not involve a very large expenditure.

I have already detained you so long, that I must leave for some other occasion a few minor topics on which I had proposed to say a few words. Permit me, before sitting down, to ask your earnest attention to the important matters referred to in the reports about to be read, and your cordial co-operation, not merely with reference to the details of those reports, but in all that can subserve the interests of the Natural History Society, and verify and realize its motto—TANDEM FIT SURCULUS ARBOR.

The Chairman of the Council (Dr. J. Baker Edwards, F.C.S.,) then submitted the following:—

REPORT OF THE COUNCIL,

May, 1870.

In reviewing the scientific work of the past Session, your Council feel it especially due to the active members of the Society to recognize the valuable contributions placed on the Society's record, and which they believe will be found equal, both in value and general interest, to those of any preceding session.

Your Council have felt increasingly, of late years, the desirability of popularizing the proceedings of the Society as much as possible, so as to interest a larger number of members in the objects. To accomplish this they have established field meetings; invited ladies to join the Society as associate members; added to the attraction of the annual Conversaziones; secured more comfortable accommodation for their guests; and popularized the character of their scientific periodical, "The Canadian Naturalist."

They cannot but feel, however, that the response to their efforts has been but of a partial character, and much has yet to be done to establish that "*entente cordiale*"—that "*corps d'esprit*" amongst the members which actually prevails in European societies of a like nature.

It is also a matter of regret that a succession of our wealthy and influential citizens are retiring from the annual subscription list, without placing their names upon the life members' roll, a course your Council would strongly recommend to those who desire to retire from active participation in the Society's affairs. A sufficient loss is felt by the Society even by such retirement; and the withdrawal of some fifteen members from active subscription to and interest in the work of the Society, to the roll of life membership, forms a serious episode in the history of the present year, as it too often follows that life members lose some of their interest in the practical working of a voluntary association.

A vigorous effort has been made during the past two years to extinguish the debt upon the building, and this effort has been attended with considerable success. The mortgage debt on the building amounts to $2,600, and towards this $1,630 have already been promised, and it behoves the earnest friends of the Society to raise the balance if possible during the present year. In the meantime it is absolutely necessary to pay some attention to the drainage of the building, which is now flooded in the winter, and to paint and whitewash the premises; and it may be necessary to devote some portion of this subscription to the temporary use of putting the premises in necessary repair. The Council, therefore, feel the necessity of a renewed effort towards the liquidation of this debt, and also to replace on the roll of annual subscribers the number of members who, from various causes, have retired therefrom.

Our losses have numbered thirty subscribers during the past session, whilst we have added only seven to the list. The number of lady associates we regret to say has not been extended. An appeal is therefore necessary to existing members to add to the ranks of the Society.

Theoretically, subscriptions are due in advance, in order to meet the current expenses of the year, but practically, members are apt to defer their payments, so that the income of the year becomes a debt instead of an asset. This practice is a source of embarrassment to the Treasurer, which your Council trusts will not become chronic.

Again, the "Naturalist" is a charge upon the Society of a grave character. In addition to the 100 copies purchased for the members, the Society distributes, for the purpose of exchanges, about 70 copies gratuitously. It is quite necessary, therefore, that the subscription list should be *free from arrears*. At present 30 subscriptions only have been received out of a list of 85. The Council feel that it will be impossible for them to maintain the efficiency of this periodical, in which they take a literary pride, unless supported by the prompt discharge of those obligations which the subscribers have undertaken, and upon the good faith of which the Council have assumed the responsibility of its publication.

Three objects present themselves to your Council as most desirable to secure, and they commend their consideration to their successors, viz :—

1st. The funding of the Somerville bequest, so as to apply the interest thereof to the extension and success of the Somerville lectures.

2ndly. The discharge of the debt on the building, so as to enable the Society to be rent free.

3rdly. The appropriation of the Government grant to the maintainance and increased efficiency of the "Canadian Naturalist" and to the extension of the museum.

In order to secure these objects, your Council desire to see the current expenses of the Society borne by the annual income by subscription, and to this end feel the necessity of a large accession to the list of members and associates.

Your Council have been called upon to relinquish the services of their faithful janitor and skilful taxidermist, Mr. W. Hunter, under the painful circumstances of failing health and of domestic bereavement; and it has been a matter of anxious consideration whether his valuable services can be replaced.

The retirement of Sir Wm. Logan from the direction of the Geological Survey, has deprived the Society of his valuable presence and aid in the Presidental Chair; but your Council desire to express their obligations and thanks to the Senior Vice-President, Dr. DeSola, who has so efficiently filled his place during the present session. In his able hands the Council have left the review of the ordinary business of the past session.

The extraordinary meetings, with which so much pleasure was combined with science, were the charming excursion to Belœil, on the 9th June, to the success of which Dr. T. Sterry Hunt so largely contributed; and the Conversazione of 9th March, when the Society had the honor of receiving *H. R. H. Prince Arthur*. It is to be regretted that, whilst great efforts were made upon these occasions to interest the members, the amount of their response did not accomplish a financial success. The excursion prize was awarded to Miss I. McIntosh, for a large collection of named species, and juvenile prizes were awarded to Master R. Dawson and G. T. Robinson. Very creditable gatherings were also made by Master R. Lewis and E. P. Peavey. Full reports of these agreeable re-unions will be found in the "Naturalist."

Your Council has accepted the offer of our esteemed Curator, Mr. Whiteaves, to deposit his valuable private collection of shells and fossils in the Museum of the Society, for the inspection of members and students, which will add greatly to the attraction of the Society's collection.

The Council, in retiring, desire to acknowledge the very valuable services of their active officers, who have carried through the business of the session.

J. BAKER EDWARDS,
Chairman.

After which, Mr. Whiteaves read the following:—

REPORT OF THE SCIENTIFIC CURATOR.

In consequence of the protracted ill health of our taxidermist, Mr. Hunter, also, in some measure, from the want of funds, my attention, so far as the Museum has been concerned, has been almost exclusively devoted to the lower animals, and to the Society's collection of fossils. Consequently, not many new mammals or birds have been added during the past session. A fine example each of the Canadian Otter, from Gaspé, and of the White-Bellied Mouse, from Labrador, have been added to our series of mammals. Six weeks, during the past summer, were spent in careful dredging round the peninsula of Gaspé, and the results obtained are of considerable interest and importance. So many specimens were obtained that the whole of the material has not yet been worked up. Commencing with the molluscs, 16 species, new to Canada, one of which is new to science, were procured. This group of animals has been very closely studied; and where there were any doubts about the identification of species, the specimens have been sent to the best English authorities. An exhaustive monograph of the sea shells inhabiting the river and gulf of the St. Lawrence, has been published in the last volume of the "Canadian Naturalist." In it 118 marine shells and 5 naked molluscs are described as inhabiting the seas of Canada, only about 65 species being previously recorded. Thus the dredging expeditions of 1867 and 1869 have just doubled the number of species previously *known to occur in our waters.* These Gaspé species are, in many instances (say 50 per cent. of the whole), conspecific with those discovered by Moller in Greenland, and described by him. Unfortunately, Moller's work on the shells of Greenland (published in Denmark) is very rare and out of print. Not having access to the work, my Gaspé snells have nevertheless been carefully compared with specimens in the British Museum and in the cabinets of Messrs. Jeffreys & Hanley, which had been named and distributed by Moller. The importance of such identifications will be apparent, not only to the student of Canadian zoology, but also to those interested in the study of Canadian *post-pliocene* fossils.

Twelve additional species of crustacea, mostly small species, were obtained in these dredgings, named species of each of which will be found in their proper place in the museum.

The Canadian Marine Polyzoa have been submitted to a careful microscopical investigation, and the whole of the collection, including many recent additions, have been re-mounted and labelled. The recent receipt of an elaborate monograph of the recent Bryozoa of Scandinavia, by F. A. Smitt, published by the Royal Society of Stockholm, will, however, necessitate a re-study of this group. The Foraminifera obtained in the recent dredgings have been also subjected to microscopical examination, and, so far, 22 species or varietal forms have been observed. It is proposed to mount a series of the larger species for the collection, and a number of Canadian and exotic specimens have been put aside with that end in view. Materials are being collected for a paper on the distribution of the Marine Protozoa of the River and Gulf of the St. Lawrence which will embody some of the results of both Principal Dawson's and my own collections and study.

Several rare sponges and other marine animals, especially Hydrozoa, have been added to our fauna, but these have not yet been worked up. Duplicates of the rarer Canadian sea shells have been sent to well known collectors in England, in exchange for other specimens. In this way we have received a fine series of English cretaceous and crag fossils (about 80 species), and hope shortly to receive other interesting specimens which have been promised. The fossils above alluded to have been mounted and labelled.

I have concluded to place my own collection of recent shells and

British Jurassic fossils, under certain restrictions, in the Society's Museum, so as to make it available for purposes of reference.

A large proportion of time during the past session has been devoted to the editing of the "Canadian Naturalist." Delays in the appearance of the journal have occurred more frequently than might be wished, this has been owing to the difficulty of getting sufficient original matter in time. It is hoped that the volume for the past year. notwithstanding some almost inevitable shortcomings, is, nevertheless, on the whole, creditable alike to the Society and to the Editing Committee. Attention has been given, as in former years, to the publication of abstracts of our proceedings in the public press, and in the "Naturalist." Copies of these reports have been punctually sent to the scientific journals in England, by whom they have been reprinted. In the library, as much work has been done as our limited means would allow; a few standard works have been added; some of our incomplete sets of periodicals have been completed and bound; and the two new microscopical journals, so far complete, have been added.

J. F. WHITEAVES, F.G.S., &c.

The following financial statement was submitted by the Treasurer, James Ferrier, jr.:—

Dr. THE NATURAL HISTORY SOCIETY OF MONTREAL IN ACCOUNT WITH JAMES FERRIER, Jr., TREASURER. Cr.

1869 '70.	
To Cash paid Mr. J. F. Whiteaves, salary	$400.00
" " Mr. Hunter "	200.00
" " J. E. Pell, Commission on Collections	40.00
" " Interest	120.00
" " For Coal and Wood	167.12
" " Gas Bills	22.82
" " City Taxes, $46.40, and Water account, $40.65	40.65 46.40
" " Insurance	39.00
" " Repairs and Petty Expenses	192.35
" " Books, Printing and Advertising	173.73
" " Balance Excursion account	9.35
" " " Conversazione	66.92
" " For "Naturalist," 100 copies	200.00
1870, May 1.	
To Balance in Treasurer's hands, towards liquidation of mortgages on Building	886.15
	$2604.49

1869, May 1.	
By Balance in Treasurer's hands	$ 60.99
1869 '70.	
By Donations towards Liquidation of Debt	875.00
" Government Grant	750.00
" Members Yearly Subscriptions	780.00
" Subscriptions to "Naturalist"	30.00
" Museum Entrance Fees	21.00
" Rent of Lecture Room	37.50
" Life Member's Subscription—J. T. Molson	50.00
	$2604.49

STATEMENT OF LIABILITIES OF THE SOCIETY, MAY 1, 1870:

Mortgage on the Society's Building, favor Royal Institution	$2000.00
Samuel Robertson's Account, Carpenter Work	16.20
Thomas Robinson's " Glazing	13.71
Gas Account	15.84
	$2045.75

Errors and Omissions excepted,

JAMES FERRIER, Jr.

Montreal, 1st May, 1870.

It was then moved by Dr. John Bell, seconded by E. E. Shelton, and unanimously resolved:

"That the reports just read be adopted, printed and distributed to the members."

The following resolution, having been moved by John Leeming and seconded by Dr. Smallwood, was carried by acclamation:

"That the thanks of this meeting and of the Natural History Society be presented to Rev. Dr. De Sola, acting President, for his able and interesting address, also to the officers of the Society for the past session, and especially to Mr. J. F. Whiteaves as Scientific Curator, and for the deposition of his valuable collection of shells and fossils in the Society's Museum under the very reasonable restrictions which he has placed thereunto."

The following gentlemen were elected officers for the session 1870-71, Messrs. Ritchie and Marler acting as scrutineers.

OFFICERS FOR 1870-71.

President.—Principal Dawson L.L.D., F.R.S.

Vice-Presidents.—Dr. T. Sterry Hunt, F.R.S.: Rev. A. De Sola L.L.D.: Dr. P. P. Carpenter: E. Billings F.G.S.: C. Smallwood, M.D., L.L.D., D.C.L.: A. Selwyn: John Leeming: G. Barnston: Sir. W. E. Logan L.L.D., F.R.S.

Treasurer.—On motion of Dr. T. Sterry Hunt, seconded by Dr. Trenholme, James Ferrier Esq. Jun. was re-elected by acclamation, the form of balloting being dispensed with.

Corresponding Secretary.—Prof. P. J. Darey M.A., B.C.L.

Curator and Recording Secretary.—J. F. Whiteaves F.G.S., &c.

Council.—G. L. Marler: D. A. P. Watt: M. H. Sanborn: A. S. Ritchie: J. H. Joseph: D. R. McCord, M.A., B.C.L.: Dr. J. Baker Edwards F.C.S.: Champion Brown, and E. Hartley F.G.S.

The library and membership commitee of the past session were re-elected.

It was moved by Dr. T. Sterry Hunt, seconded by E. Hartley and duly resolved:

"That the meeting do now adjourn."

GEOLOGY AND MINERALOGY.

CEPHALASPIS DAWSONI.—Mr. E. Ray Lankester describes this species in the *Geological Magazine* for September as follows:—

Principal Dawson, of Montreal, Canada, has placed in my hands for description a remarkably interesting specimen, indicating a species of the genus *Cephalaspis* in transatlantic Silurio-Devonian beds. He writes, "The specimen was found by one of my assistants, Mr. G. T. Kennedy, B.A., when collecting with me, in a bed charged with remains of *Psilophyton*, on the north side of Gaspé Bay. The geological horizon is below the middle of the Gaspé Sandstones, but several hundreds of feet above their actual base, so that the specimen may be regarded as either Lower Devonian or Lower Middle Devonian. It occurred in beds containing *Psilophyton princeps* and *P. robustus*, and also drift-trunks of *Prototaxites Logani*, the latter in the sandstones associated with the coarse shaly bed containing the *Cephalaspis*. In these sandstones there are also spines of *Machairacanthus sulcatus* of Newberry—a large fish characteristic of the Devonian of Ohio. No marine remains were found in the bed holding the *Cephalaspis*, which is blackened with vegetable matter and holds many fragments of land plants; but in shales at no great vertical distance there are shells of *Lingula* and *Modiomorpha*, resembling species found in the Hamilton group of New York."

The specimen presents in slight relief a small *Cephalaspis*, with head-shield and greater part of the body, and is much flattened. The shield appears to be larger in proportion to the body than in any British species. The orbits are not shown, and the matrix has not preserved the scales of the body with much distinctness, though it is possible to make out the lateral and marginal series. No trace of pectoral, dorsal, nor caudal fins is to be made out. This species clearly belongs to the section *Eu-cephalaspis* as defined in my Monograph of *Cephalaspidæ*. Its best character as a species is to be found in the very fine, almost granular, tubercles which are preserved on some parts of the surface, and represent the apparently universally present tubercular ornament of the *Osteostraci*. These fine tubercles are more minute than on any British *Cephalaspid*, and, though seemingly not very well shown in this specimen, furnish a specific mark. Amongst other fragments from this bed, which Dr. Dawson has submitted to me, is a small piece of tubercle ornament, possibly belonging to the same species of *Cephalaspis*. In this, the tubercles are very sharply moulded and nearly hemispherical. Various other fragments which cannot be identified, but are probably bits of fish bones, etc., are amongst the collection.

A very fine fish-spine—the *Machairacanthus sulcatus*—was also obtained in the sandstones associated with the shale which furnished the *Cephalaspis*. This sandstone is not unlike the sandstone of Glamis, and other parts of Perthshire and Forfarshire which furnish *Cephalaspis*; whilst the shale strongly recalls the Forfarshire shale, which has furnished Mr. Powrie with his beautiful *Cephalaspis Pagei*.

The spines which occur in the Cornstones of Herefordshire, which have not yet been worked out, are of various forms and are usually "lumped" as *Onchus*. None, however, appear to resemble *Machairacanthus*, with its remarkable keeling like the petiole of a sweet-pea. I propose to call the new American *Cephalaspis* after the illustrious geologist who has allowed it to be figured here: *Cephalaspis Dawsoni*.

EMBRYOLOGY OF LIMULUS.—Dr. Packard has presented to the American Association a very interesting account of the early stages of the development of the *Limulus polyphemus* of the American coast. In one of its earlier stages it bears a remarkable resemblance to such Trilobites as *Trinucleus*. In a subsequent stage the abdominal segments became consolidated, and it resembles not the adult but the larva of *Trinucleus*. The development in these two groups is thus in opposite directions—that of Limulus tending to the consolidation of the abdominal segments, that of Trilobites to the addition of new segments between the original head (cephalothorax?) and abdomen. In this way Dr. Packard's facts raise new questions as to the grade and affinities of Trilobites, especially when taken in connection with Mr. Billings' observations as to their feet. The alliance between the two forms is evidently very close. Dr. Packard thus sums up his conclusions :—

Conclusions.—The eggs are laid in great numbers loose in the sand, the male fertilizing them after they are dropped. This is an exception to the usual mode of oviposition in Crustacea;

Squilla and a species of *Gecarcinus* being the only exception known to me to the law that the Crustacea bear their eggs about with them. Besides the structureless, dense, irregularly laminated chorion, there is an inner egg membrane composed of rudely hexagonal cells; this membrane increases in size with the growth of the embryo, the chorion splitting and being thrown off during the latter part of embryonic life. Unlike the Crustacea generally the primitive band is confined to a minute area, and rests on top of the yolk, as in the spiders and scorpions, and certain Crustacea, *i.e.*, *Eriphia spinifrons*, *Astacus fluviatilis*, *Palæmon adspersus*, and *Crangon maculosus*, in which there is no metamorphosis.

The embryo is a Nauplius; it sheds a Nauplius skin about the middle of embryonic life.

This Nauplius skin corresponds in some respects to the "larval skin" of German embryologists.

The recently hatched young of Limulus can scarcely be considered a Nauplius, like the larvæ of the Phyllopoda, Apus and Branchippus, but is to be compared with those of the trilobites, as described and figured by Barrande which are in *Trinucleus* and *Agnostus* born with only the head and pygidium, the thoracic segments being added during after-life. The circular larva of *Sao hirsuta*, which has no thorax, or at least a very rudimentary thoracic region, and no pygidium, approaches nearer to the Nauplius form of the Phyllopods, though we would contend that it is not a Nauplius.

The larva passes through a slightly marked metamorphosis. It differs from the adult simply in possessing a less number of abdominal feet (gills), and in having only a very rudimentary spine. 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* has demonstrated that Asaphus possessed eight pairs of five-jointed legs of uniform size. The trilobate character of the body, as shown in the prominent cardiac and lateral regions of the body, and well marked abdominal segments of the embyro, the broad sternal groove, and the position

*Proceedings of the Geological Society of London. Reported in "Nature." June 2, 1870. In this communication Mr. E. Billings announces the important discovery of a specimen of *Asaphus platycephalus*, showing that the animal possessed eight pairs of five-joined feet, widely separated as their insertions by a broad sternal groove.

and character of the eyes and ocelli, confirm this view. The organization and the habits of Limulus throw much light on the probable anatomy and habits of the trilobites. The correspondence in the cardiac region of the two groups shows that their heart and circulation was similar. The position of the eyes shows that the trilobites probably had long and slender optic nerves, and indicate a general similarity in the nervous system. The genital organs of the trilobites were probably very similar to those of Limulus, as they could not have united sexually, and the eggs were probably laid in the sand or mud, and impregnated by the sperm cells of the male, floating free in the water.

The muscular system of the trilobites, must have been highly organized as in Limulus, as like the latter they probably lived by burrowing in the mud and sand, using the shovel-like expanse of the cephalic shield in digging in the shallow palæozoic waters after worms and stationary soft bodied invertebrates, so that we may be warranted in supposing that the alimentary canal was constructed on the type of that of Limulus, with its large, powerful gizzard and immense liver.

COPE'S SYNOPSIS OF THE EXTINCT BATRACHIA AND REPTILIA OF AMERICA.—The second part of this admirable monograph has appeared, and includes the known species of fossil Birds, in addition to the reptiles. It affords an invaluable guide to the student of American Fossil Reptilia, and places for the first time before those who have been engaged in this study, a conspectus of what is known, with the addition of many new discoveries, and profound general observations of the author, who has long been engaged in studies of this kind, more especially in New Jersey and Pennsylvania, and has made himself completely master of his subject. Prof. Cope thus states in his preface his aims and results:—

"It is not designed in the present essay to give descriptions of the known remains of the Batrachia, Reptiles and Birds, which have been more or less fully made known by others. This is left for the day when our knowledge shall more nearly approach completeness. While the subject is in its infancy, I have thought best to describe only those species and types which are new, and those portions of imperfectly known forms which will throw additional light on their relations and affinities. In adhering to this plan, I have been able to add no little to the history of the

Reptiles already described by my predecessors—Leidy, Owen, Dawson, Wyman, Lea, etc. Where, however, I have had nothing to add, I have referred to their published descriptions, which are numerous and well-known. The literature of the subject will then be found under the respective specific heads."

"In the course of these investigations, prosecuted during the past six years, with reference to the structure and relations of the extinct Reptilia, the following general conclusions have been attained to, besides many of lesser significance.

First—That the Dinosauria present a graduated series of approximations to the birds, and possess some peculiarities in common with that class, standing between it and the Crocodilia.

Second—That serpents exist in the Eocene formations of this country.

Third—That the Chelydra type was greatly developed during the American Cretaceous, and that all the supposed marine turtles described from it are really of the first named group.

Fourth—That the Reptilia of the American Triassic are of the Belodon type.

Fifth—The discovery of the characters of the order Pythonomorpha.

Sixth—The development of the characters of numerous members of the Batrachian Sub-order Microsauria in the United States."

MARINE CRUSTACEANS IN LAKES.—Several years ago Prof. Loven discovered in fresh-water lakes in Sweden forms of crustacea previously found only in the sea, and inferred that these species had been left behind in the upheaval of the land, and were thus living witnesses of the great subsidence and re-elevation of the land in the Post-pliocene period. It was, we believe, suggested at the time in this Journal that our Canadian Lakes afforded an admirable opportunity to extend these observations; but in so far as we know this has not been done until last summer, when Dr. Stimpson, by dredging in the deeper parts of Lake Michigan, obtained a species of *Mysis* closely allied to one of the Swedish species; thus apparently indicating a former marine condition of the basin of our great lakes. The subject deserves further attention, and would well repay the exertions of any of our Canadian naturalists residing in the vicinity of the lakes, in the deeper parts of which the dredge would no doubt discover many curious forms of aquatic life, which, if of marine types, might be of great interest with reference to the history of this continent in the Post-pliocene period; and might also help to account for some of the alleged migrations of the fishes of the lakes. Such facts might also illustrate the possibility of the continued residency in lakes of fishes usually migrating to the sea, since in the depths of the lakes they might find food similar to that which they could obtain by visiting the ocean.

FIGURES OF CHARACTERISTIC BRITISH FOSSILS.—The second number of this extremely useful work, by Mr. Bailey, of the Geological Survey of Ireland, appeared some time ago. It continues the series of illustrations up to the Wenlock; and is most interesting and useful to Canadian students, as showing in the clearest manner to the eye the similarity of the succession of fossils in the series in Britain and in this country. Being composed almost entirely of names and figures, the work does not afford materials for quotation, but as a means of comparison it should be in the hands of all students of Canadian geology. Besides the figures and lists of species, there are useful introductory explanations of the structure of the principal types of fossils, with the terms applied to their parts.

BOTANY AND ZOOLOGY.

BRITISH EDIBLE FUNGI. — Mushrooms and their congeners seem never to have been in good repute since Agrippina employed one of the tribe to poison her husband, and Nero with villanous pleasantry called it the "food of the Gods." With proverbial tenacity the bad name thus incurred has clung to the whole family of Agarics, and what within certain limits might be called a wholesome dread has become a deep-rooted and irrational prejudice, excluding from popular use a really valuable class of vegetable esculents. We cannot altogether go along with those enthusiastic mycophagists who recognize a substitute for meat in every edible fungus, and dilate on the ozmazome and other nutritious properties of the tribe; but we readily acknowledge that their merits as secondary sources of food-supply have hitherto been unduly neglected. The great difficulty always felt in advocating the claims of the class to more extensive use has arisen from the want of some definite rules, some formula at once simple in expression and universal in application, by which to distinguish the noxious from the innocent members. Pliny, in his Natural History, goes so far as to say that the first place amongst those things which are eaten with peril must be assigned to agarics, and he expresses his surprise at the pleasure which men take "in so doubtful and dangerous a meat." But his observations show that fungi of all sorts, including even such growths as the *Fistulina hepatica*, were known to his countrymen and eaten by them without scruple. Indeed, in one particular the wisdom of the ancient Romans seems to have been superior to that of their descendants, for, while Horace lays down the rule:—

> Pratensibus optima fungi
> Natura est; aliis male creditur—

the modern Ædiles of the Roman market condemn to instant destruction every specimen of the meadow mushroom (*A. campestris*) which comes within their reach. Although, however, it is not always easy to distinguish the wholesome from the unwholesome fungus, and the organs of sight and smell require some training before they can be wholly trusted in the matter, yet the dangers have been greatly exaggerated, and, as a matter of fact, hogweed is more often mistaken for parsnip and aconite for horse-radish than are *Boletus satanas* and *Amanita verna* for their innocent brethren. No better opportunity for engaging in the study of this branch of natural history could be found than that which the present season affords; and if the treatises of Mr. Berkeley, Dr. Badham, or Mr. Worthington Smith be not at hand, the following notes on the chief edible fungi which are now to be met with may prove acceptable to some of our readers.*

With the ordinary meadow mushroon (*A. Campestris*) and its near relative the horse mushroom (*A. arvensis*), every one is familiar, and both of them have occurred in profusion this autumn. Against the latter an unfounded prejudice prevails in some districts, but its larger size and coarser texture require only a

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* At the conclusion of "Mushroom Culture, its Extension and Improvement" (London: Warne, 1870), Mr. W. Robinson gives some useful information, derived chiefly from the above authorities, and from the Proceedings of the Woolhope Field Club.

little extra cooking to develop the flavour and correct indigestibility. In spite of all that has been said to the contrary, we maintain that these agarics are entitled to the first place, and for the second much rivalry exists between the orange-milk mushroom (*Lactarius delicious*) and the Parasol Agaric (*Agaricus procerus*). Both are readily distinguishable, and may be eaten with equal impunity. The former is chiefly found in plantations of Scotch fir and larch, is of an orange-brown colour, and firm flesh, and yields, when bruised, an exudation of orange-red milk, which turns green after a few minutes' exposure. The latter is common in the pastures, and may be recognized by its tall habit, the stalk gradually enlarging at the base, the umbo of a brownish colour with spots or patches, and the gills white and unconnected with the stem. The plum mushroom (*A. prunulus*) is for the autumn months what the St. George's mushroom (*A. gambosus*) is for the spring—a large fleshy fungus, delicate in flavour, though not so choice as the *Orcella*, for which it is often mistaken. It is to be found in shady places pretty generally throughout England, and is conspicuous from its whiteness. The gills are close together and of a pale rosy hue, and the smell of the plant has been compared to that of fresh meal.

We must mention two other fungi, common enough and easily recognised, but of their culinary virtues we do not entertain a very high opinion. These are the puff-ball, and the maned agaric (*Coprinus comatus*). The former needs no description, and perhaps others may be more fortunate than we have been in detecting the latent flavour of omelette which it is said to possess. The latter is called by Dr. Bull the "agaric of civilisation." We have met with it in farm yards, on lawns, on railway-cuttings, and, in fact, in nearly every waste place. It looks like an attenuated cocoon, snow-white at first, but gradually changing in colour and splitting upwards in a dozen places. The gills, white at first, become pink and then black; the last stage, which is very quickly reached, presaging the immediate dissolution of the plant, which gradually deliquesces into an inky-black fluid.

It would be easy to amplify this list, but we desire to avoid all risks of confusing tho tyro's mind with too many details, and have purposely confined our remarks to those fungi which belong to the autumn season.

One caution must be added. All agarics are more wholesome fresh than stale, and with some the neglect of this rule may lead to unpleasant consequences. It is rigidly enforced in the Roman market, where all specimens which are "muffi, guasti," or "verminosi" are seized and thrown into the Tiber, and it should be distinctly understood in every English kitchen into which even the common mushroom is allowed to enter. The fungus which to-day successfully simulates a sweetbread, may to-morrow simulate with equal success a handful of snuff.—*C. J. Robinson, in "Nature."*

NOTES ON CANADIAN BIRDS.

The following species, more or less rare, have been obtained in the Province of Quebec, with the exception of two species, during the summer of 1870 :—

Falco anatum, Bonaparte. The Duck Hawk.—A fine adult male of this species was obtained by Mr. Marcel at St. Lambert's, near Montreal.

Buteo lineatus, Jardine. The Red shouldered Hawk.—A nest of this species, containing four eggs, was taken in May, by Mr. C. A. Craig, at Longue pointe, near Montreal. The nest was placed in an elm tree, about 50 feet from the ground, the tree itself being 80 feet high. It was large, and roughly constructed of cedar twigs and leaves, and lined with moss. One of the eggs is in the Society's collection. An egg which closely resembles that obtained of Mr. Craig, was given me by Master E. A. W. Kittson, who informs me that it was taken in a wood near Sorel.

Otus Wilsonianus, Lesson. The Long-eared Owl.—Mr. Craig has been so fortunate as to find a nest of this species also, this summer, at Hochelaga (near Montreal) containing four eggs. He informs me that it was built on the branch of a spruce tree some 25 feet high, about 18 or 20 feet from the ground. The nest was like that of a crow's, but larger, and made roughly of twigs and moss. Two of these eggs have been secured for the collection of the Society.

Butorides virescens. Green Heron.—One specimen of this species was shot by a friend of Mr. Craig' s at St. Genevieve. This is the first time, so far as we are aware, that this species has been obtained in the Province of Quebec.

Phalarópus Wilsonii, Sabine. Wilson's Phalarope.—A specimen of this species was shot near the Victoria bridge, in August last. Mr. Craig says that he has met with it not very unfrequently on the Island of Montreal.

Cygnus buccinator, Richardson. Trumpeter Swan.—The late Dr. A. Hall, in this Journal, Vol. 7, page 414, describes the *American* Swan, Cygnus *Americanus*, from a specimen then and now in the Society's collection, which was shot at Longueuil. The individual in question is a young individual of the Trumpeter Swan.

Fulix affinis, Baird. The Lesser Scaup, "Blue Bill," or "Little Black Head"—Occurs occasionally in the neighbourhood of Montreal, in company with the common Scaup Duck.

Aythya vallisneria, Bonaparte. Canvass-back Duck.—Two specimens of this species were shot this autumn at Dundee, by Mr. James Hopkins, and are now in the Society's collection. The species seems rare in Eastern Canada. The pair in question occurred in a flock of the closely-allied red-headed duck.

Bucephala Islandica, Baird. Barrow's Golden Eye.—Rare on, or near, the Island of Montreal; a few were shot in the autumn of 1869, and stragglers are occasionally to be met with among the common species. The male is easily distinguished from the common golden-eye, but to separate the females of the two species is much more difficult: a careful study of the shape and coloring of the bill will enable the student to separate them.

J. F. W.

ON THE GULLS OF THE NOVA SCOTIAN COAST. BY J. MATTHEW JONES, F. L. S.—According to the catalogue of North American Birds published by the Smithsonian Institution, I find the following species of *Laridæ* inserted, as having been observed on the North-east coast of this continent. 1. Pomarine Skua (*Stercorarius pomarinus*, Temm.) 2. Glaucous Gull (*Larus glaucus*, Brünn.) 3. White-winged Gull (*L. leucopterus*, Fabr.) 4. Great Black-backed Gull (*L. marinus*, Linn.) 5. Herring Gull (*L. argentatus*, Brünn.) 6. Ring-billed Gull (*L. Delawarensis*, Ord.) 7. Bonaparte's Gull (*Chroicocephalus Philadelphia*, Ord.) 8. Kittiwake (*Rissa tridactyla*, Linn.) 9. Ivory Gull (*Pagophila eburnea*, Kaup.) 10. Fork-tailed Gull (*Xema Sabinii*, Bon.) 11. Wilson's Tern (*Sterna Wilsoni*, Bonap.) 12. Arctic Tern (*S. macroura*, Naum.) 13. Least Tern (*S. frenata*, Gambel.) Of this list of thirteen species nine have been identified by myself, and one by Major Wedderburn, (late 42nd Highlanders,) as occurring on the coast of Nova Scotia, and seven of these are in my own cabinet. The ten species identified as Nova Scotian up to the present time, are *Stercorarius pomarinus*; *Larus glaucus*; *L. marinus*; *L. argentatus*; *L. Delawarensis*; *Chroicocephalus Philadelphia*; *Rissa tridactyla*; *Pagophila eburnea*; *Sterna macroura*; *S. Wilsoni*. To this list, it is probable, several other species may be added in the course of time, but in a country like this where the naturalist must rely almost entirely upon his own exertions, to secure specimens and note their haunts and habits, the task of forming anything like a complete list of the several members of any zoological family is not an easy one. I therefore trust my present brief account of the Laridæ frequenting the coast of Nova Scotia may merely be received as the commencement of one more complete.—*Nova Scotia Institute of Natural Science.*

POSITION OF THE BRACHIOPODA IN THE ANIMAL KINGDOM.—For some time past Mr. Edward S. Morse has had reasons for believing that the Brachiopods, with the Polyzoa, had greater affinities with the worms than with the mollusks. He has studied attentively *Terebratulina* and *Discina* as well as their early stages, and in all points of their structure interprets articulated characters, and not molluscan characters. Without entering into particulars at this time, he states that in the structure of the shell he finds the greatest resemblance to the shell of crustacea, both as regards the peculiar tubular structure, and the scale-like appearance, and its chemical composition. In *Lingula*, while the carbonate of lime amounts to only six per cent., the phosphate of lime amounts to forty-two per cent. The horny setæ which fringe the mantle are remarkable worm-like. In worms the bristles are enclosed in muscular sheaths, while in other articulate animals the hairs are simple tubular prolongations of the epidermal layer. In the Brachiopods these bristles are secreted by follicles and are surrounded by muscular fibres, and are freely moved by the animal. The structure of these setœ differs but little, if at all, from those of the worms. The lophophore with the cirri is to be compared to similar parts in the tubicolous worms, and the mantle which covers and conceals their arms is to be compared to the cephalic collar, as seen in Sabella, for instance, where we find it split laterally, and a portion reflected. If this were greatly developed so as to cover the expanded fronds of cirri, we should recognize quickly the relation between the two. Dr. Gratiolet has compared the circulatory system of the Brachiopods to that of the crustacea, and Burmeister has shown a resemblance between the respiratory apparatus of certain cirripedes and that of Lingula. In the reproductive system there is a close similarity existing between the oviducts of Brachipoda, with their trumpet-shaped openings, and simi'.r organs in the worms. In the little knowledge we have of their embryology, the strongest proofs exist of their affinity with the worms. Lacaze-Duthiers figures the embryo of Thecidium, and it is a little animal with four segments. Fritz Muller figures an early stage of Discina, and we have recalled to us a positive articulate and worm-like character. From the body of this embryo prominent bristles project. Smitt figures the same in the embryo of Lepralia, wherein he describes six bristles that appear locomotive; and Claparède figures the embryo of Nerine, a worm, in which we find similar bristles projecting from the body. In this connection it is interesting to note that in the winter eggs, or statoblasts, of Polyzoa we have a relation to similar characters among the lower crustacea, the ephippia of Daphnia and the winter eggs of Rotifers for example. Leuckart places the Polyzoa with the worms, and the close affinity of the Polyzoa with the Brachipoda is now freely admitted, and we now recall those peculiar worms, or early stages of them, which so strongly resembles in almost every essential point of their structure the hippocrepian Polyzoa. As many of the foregoing points need ample illustration, and as the writer has in preparation a memoir on the subject, he will now only call attention to the facts supporting these views, evolved from the study of living Lingulæ. It is but justice to state that six months previous to the observations made on Lingula, he had come to conclusions herein expressed, and had freely argued it with his colaborators. He saw the necessity of examining Lingula, however, before advancing these views, and for this sole purpose had visited North Carolina in company with Dr. A. S. Packard, junr., who with his observations on the worms and crustacea of that region yet found time to follow the writer, step by step, in his studies of Lingula, and was deeply impressed by the disclosures there made. His sincerest gratitude is due to Dr. Elliott Coues, U.S.A., and Major Joseph Stewart, U.S.A., commandant at Fort Macon, North Carolina, for their constant aid and sympathy in furtherance of the object of his visit there. After nearly a week's fruitless search, Lingulæ were found in a sand shoal, left at a low tide. They were found buried in the sand. The peduncle, which was about six times the length of the shell, being encased in a *sand tube* differing in no respect from the sand tubes of neighbouring annelids. In many instances the peduncle was broken in sifting them from the sand, yet the wound was quickly healed and a new sand-tube promptly formed. When placed on the surface of the sand they were noticed to move quite freely, by the sliding motion, in all directions, of the dorsal and ventral plates, aided at the same time by the rows of setæ or bristles, which swung back and forth like a galley of oars, leaving a peculiar track in the sand. The peduncle was hollow, and the blood could be seen coursing back and forth in this channel. It was distinctly regularly ringed, and presented a remarkably worm-like appearance. It had layers of circular and longitudinal muscular fibre, and coiled itself in numerous folds or unwound at full length. It was contractile, also, and quickly jerked the body beneath the sand when alarmed. But the mo-t startling discovery in connection with this interesting animal was the fact that its blood was *red*. This was strongly marked in the gills, which were found in the shape of a series of rows of simple lamellæ, hanging from the internal surface of the mouth; thus proving the correctness of Vogt's observations from alcoholic specimens. At times the peduncle would become congested, *and a deep rose blush was markedly distinct.* The sexes were distinct. The writer believes the Brachiopods to be true articulates, having certain affinities with the crustacea, but properly belonging to the worms, coming nearest the tubicolous annelids. They may better be regarded as forming a comprehensive type, with general articulate features. Possibly they have affinities with the mollusks, through the homologies pointed out by Allman as existing between the Polyzoa and Tunicates. It is interesting to remember that Lingula, though one of the earliest animals created, has yet remained essentially the same through all geological ages to the present time.—*American Naturalist.*

At a meeting of the Brighton and Sussex Natural History Society, held June 9th, 1870, a paper "On Diptera and their Wings," by Mr. Peake, was read in the absence of that gentleman by Mr. Wonfor, Hon. Secretary.

While wings are common to the whole order of insects, the Diptera consists entirely of two-winged flies, which, instead of a second or hinder pair, have little thread-like bodies terminated by knobs and called *halteres*, originally considered balancers, supposed now by some to be organs of hearing, and by others *olfactory* organs. From many points of resemblance, he thought they were analogous to the hind wings of other insects, and that, at present, their special use had not been ascertained. Besides these halteres they had also winglets (*alulæ*), which were thought to be only appendages to the fore-wings. Among the Diptera three classes of fliers were found, differing in the form of their bodies and shape of their wings; first, the slender flies, such as the gnats, having long bodies, narrow wings, and long legs, but without winglets; secondly, those whose bodies, though slender, were more weighty, as the Asilidæ, having larger bodies, shorter legs, and very minute winglets; lastly, those like the house-fly, with short, thick, and often very heavy bodies, furnished with proportionate wings, shorter legs, and conspicuous winglets. From these circumstances it might be inferred that the long legs of the light-bodied flies acted as rudders, while the winglets helped the wings in flying. The wings consisted of two laminæ united by veins or nervures, and upon their arrangement and the form of the antennæ, as seen in the great groups Nemocera and Brachycera, the distinguishing characters of the Diptera are founded. The several parts of the wings and their nerves, and their differences as seen in the two above-mentioned groups, were next pointed out, and the paper illustrated by very beautiful drawings and microscopic preparations of wings.—*Monthly Microscopic Journal.*

GLEANINGS FROM THE BRITISH ASSOCIATION MEETING OF 1870.

—Mr. R. McAndrew, F.R.S., presented a report on the *Marine Mollusca of the Gulf of Suez.* This report gives the general result of a dredging excursion to the Gulf of Suez in February and March 1869. Mr. E. Fielding accompanied the author. Leaving Suez on the 16th February in a boat of about twelve tons burthen, with one about five tons for dredging, and a small boat for landing, the party reached Tur in about three weeks' time. Their crew consisted of Maltese and Neapolitans, an Arab, who proved an excellent diver, and a native of Tur, who acted as pilot. From Tur they crossed over to the Point of Zeite and the desolate islands situated towards the western side of the Straits of Jubal. After working about a week among these, and finding it a very rich collecting ground, they bore away to Ras Mahommed, where they ended their labours, proceeding from this to Tur, from whence they went by land to Suez. The number of species obtained (not including the Nudibranchiates) was 818. Of these 619 have been identified, the remaining being still undetermined. About 355 have not previously been recorded as from the Red Sea. Of these, 53 species, including three genera, are new to Science, and have been described by Messrs. H. and A. Adams. Professor Issel, of Genoa, records 640 species as from the Red Sea, and his list includes 100 new species. Some of these were figured but not described in Savigny's "Description de l'Egypt." Mr. McAndrew dwelt on the extraordinary dissimilarity between the Fauna of the Red Sea and that of the Mediterranean; the number of species common to Japan, the Philippines, Australia, and to the Red Sea, is worthy of further observation. In addition to the Mollusca, a collection of Echinoderms, Crustacea, and Corals, was made and divided among the British, Edinburgh, and Liverpool Museums. The sponges collected were sent to Dr. Bowerbank, except one, which had been described by Mr. Carter as a new genus under the name of *Grayella*.

On the Structure of the Shell in the Pearly Nautilus.—Mr. H. Woodward. After referring to the great interest attaching to the *Nautilidæ* on account of their vast geological and geographical range, the author proceeded to describe the structure of the shell with its septa and siphuncle, the latter structure being only found in the Cephalopoda and nearly confined to the Tetrabranchiate division of the class. The camerated structure, however, is found both among the Bivalves and Gasteropoda, and the author suggested that if any incipient character could be found leading up as it were to the siphuncle, we might fairly infer that that structure was only a more highly differentiated form of shell-growth. Such incipient structure occurs in the *Ostræadæ* and *Spondylus*, in which the shell-muscle dips down from layer to layer, offering a rough similarity to the siphuncle in *Aturia* and some other *Nautili*. Mr. Woodward described the structure of the shell, and showed by actual dissection that no vascular system exists between the shell and the animal by means of the siphuncle. The siphuncle proves only to be a pearly tube, within which is another composed of an extension of the periostracum, and quite destitute of vascular or cellular structure. Shell structure proves, when once formed, to be dead matter, destitute of change, and can only be repaired when in contact with the mantle of the shell.

CHEMISTRY AND PHYSICS.

UNDERGROUND TEMPERATURE.—Shortly after the meeting of the British Association, the secetary of the Underground Temperature Committee addressed a letter to Prof. Henry, secretary of the Smithsonian Institution, United States, requesting his co-operation in furthering the object which the committee have in view, at the same time forwarding one of their protected thermometers. In June of the present year an answer was received from Prof. Baird, assistant secretary in charge, to the effect that Prof. Henry's ill-health during the present season had prevented his communicating to us the results of his labours in response to request. The letter addressed to Prof. Henry made special reference to an artesian well of extraordinary depth which was understood to be in course of sinking at St. Louis, and at the same time a letter was addressed, and a special thermometer sent, to Mr. C. W. Atkeson, the superintendent of the work of boring at St. Louis. No reply has been received from Mr. Atkeson, who appears to have left St. Louis before the letter arrived; but letters have been received through the Smithsonian Institution from Dr. Chas. W. Stevens, superintendent of the County Insane Asylum at St. Louis, this being the institution for whose uses the well was sunk, together with a very interesting newspaper cutting, consisting of Mr. Atkeson's report on the works. The boring of the well was commenced (at the bottom of a dug well 71½ feet deep) on the 31st of March, 1866, and was continued till the 9th of August, 1869, when the work was stopped at the enormous depth of 3,843½ feet, exceeding by more than one-half the depth of Dukinfield Colliery. The strata penetrated consisted in the aggregate of 63 feet of clay, 6 feet of coal, 380 feet of shales, 2,725 feet of limestone, and 620 feet of sandstone. A cast-iron tube of 11½ inches bore was first put down, reaching from the top and secured in the limestone at the bottom. This tube was then lined inside with a wooden tube, reducing the bore to 4½ inches. A 4½-inch drill was put down through this tube on the above-mentioned date. The bore was afterwards enlarged to 6 inches, and subsequently to 11½ inches to a depth of 131½ feet. A sheet-iron tube was then put down, extending from the top to this depth, and the bore below was enlarged, first to 6 and afterwards to 10 inches diameter, to the depth of 953 feet. A sheet-iron tube, 79 feet long, was then put down, which rests on the offset at the bottom of the 10-inch bore. The 4½-inch bore was then enlarged to 6 inches to the depth of 1,022 feet, and a wrought iron tube of 5 inches bore, weiging more than six tons, was introduced, reaching from the top and resting of the offset at the bottom of the 6-inch bore, thus securing the work to this depth, and reducing the bore to a convenient size to work in. The 4½-inch bore has been continued to the depth of 3,843 feet 6 inches without further tubing. *At the depth of 3,029 feet the first observation* of temperature was taken, and the reading of the thermometer was 107° F. This first observation is stated by Dr. Stevens to be specially worthy of confidence, as having been confirmed by several repetions, or rather, to use Dr. Steven's own words, "this was the maximum of several trials." It was taken, as well as those that followed it, by means of a registering thermometer (kind not mentioned); but in answer to our inquiries, Dr. Stevens *states, upon the authority of the carpenter who attached the* thermometer to the pole by which he was lowered, "that no means were taken to defend the bulb from pressure." In the absence of further information (and Mr. Atkeson himself has not yet spoken), we can place no reliance upon the temperature recorded, as the thermometer had to bear the pressure of ⅗ of a mile of water. The temperature registered at lower depths, the deepest being 800 feet lower, were all, strange to say, somewhat lower than this, a circumstance which is all the more remarkable because the pressure (which tends to make the reading higher) must have increased with the depth. At the bottom, or rather at 3,837 feet, being 6½ feet from the bottom, the temperature indicated was 105°. Either of these results, taken apart from the other and compared with the surface temperature, would give a result not improbable in itself. The mean temperature of the air at St. Louis appear to be about 53°, but it seems desirable to avoid publishing calculations till the data are better established. Unfortunately, the apparatus which was employed in boring has all been removed, after the insertion of two wooden plugs, with an iron screw at the upper end of each, one at the offset at a depth of 1,022 feet, and the other at the offset at the depth of 953 feet, for the purpose of separating the fresh from the salt waters. These plugs were driven in with great force, and can only be withdrawn with the aid of a series of poles and other appliances, such as were used in boring, which will be rather costly. The poles alone are estimated to cost $1,152, or £200. If the plugs were withdrawn—and, according to Dr. Stevens, there is nothing but the expense to prevent—the whole well would be available for observation. The committee will make every effort to prevent so rare an opportunity from being lost.—*From third report of the Underground Temperature Committee submitted to the British Association in* 1870.

MISCELLANEOUS.

SCRAPS FROM "NATURE."

— We are glad to be able to state that Dr. Wyville Thompson has entirely recovered from the attack of gastric fever which prevented his taking part in the *Porcupine* expedition this summer. He is at present going over the zoological collection brought home in that vessel, at the University of London, with Dr. Carpenter, and he reports some very remarkable additions to his new group of vitreous sponges, mainly from the coast of Spain and Portugal. These, with some others procured by Mr. Saville Kent, in Dr. Marshall Hall's yacht, will nearly double the number of known forms referred to the order. They are no pigmies. One of them forms a lovely lace-like vase upwards of three feet in diameter at the lip!

—Owens College, Manchester, has lately received a very valuable donation to its large geological collection, in the shape of a collection of fossil Marsupials from Australia. This collection was to have been presented to the British Museum, but the donor ultimately decided to bestow it on Manchester instead.

—In the aquarium of the Dublin Zoological Gardens there are several specimens of the blind fish (*Amblyopsis spelœus*) lately brought from the Kentucky caves by Prof. Mapother. The small specimens, being very transparent, show the vertebral column, the heart, and the optic bulbs very distinctly. In the largest there are dark red spots over the optic bulbs, probably due to their having been kept in an iron vessel, which may have given colour for a rudimentary pigment membrane.

—The *American Journal of Science and Arts*, which has from its commencement been the leading vehicle for the original papers of the scientific men of America, will be continued after the close of the present year as a monthly journal. This increased frequency of publication will, it is believed, meet a wish often expressed by authors for a more rapid interchange of views, and an earlier knowledge of the progress of research; and the editors hope that the friends and patrons of science will aid in promoting its wider circulation. We believe that there are many public and private libraries and reading rooms, throughout the country, which are not yet supplied with this journal, which is certainly one of the most important of existing scientific publications.

— The expedition of Yale College students, under the leadership of Prof. O. E. Marsh, spent several months in the Rocky Mountain regions, investigating its flora and fauna, and collecting for the Yale Museum as fine collections as possible of the extinct animal remains found in such abundance in the tertiaries and cretaceous deposits of Nebraska, Dakota, and Wyoming. Leaving this region they will visit California, and after investigating the geology of the Pacific coast, will return through Colorado and Kansas, reaching New Haven, if possible, in November. We have since learned that their endeavours have been crowned with great success. They spent three weeks examining the geology of the country between the north and south branches of the River Platte, and discovered in Northern Colorado an extensive tertiary deposit, abounding in fossil remains. The formation is identical with the "Mauvaises terres" deposit of Dakota, and apparently forms the south-western border of some ancient fresh-water lake. These beds were traced to the north, and along the North Platte River; several thousand specimens were collected, and among them a number of new species of tertiary mammals.

— There has just been started in the city of Baltimore, U.S., a society of fifteen members, called "The Maryland Academy of Sciences." It is intended to pay special attention to microscopy. The principal officers are Philip T. Tyson, President; John G. Morris, Vice-president; Edwin A. Dalrymple, Corresponding Secretary.

— Prof. Verrill, of New Haven, has just returned from an expedition to the Bay of Fundy. The greatest depth encountered in dredging even as far as fifty miles from the coast, was not beyond 120 fathoms. Very large collections were made, many rare and about sixty new species were discovered, the number of species in Prof. Stimpson's list being more than doubled. We hope soon to have a catalogue of the fauna of the bay from Prof. Verrill.

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