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MODERN IDEAS OF DERIVATION.

Address of Principal DAWSON, as President of the Natural History Society of Montreal. Read at the Annual Meeting, May 18th, 1869

The sphere of this Society as a modest collector and preserver of local facts in Natural History, does not preclude its glancing at the more difficult and abstruse questions which agitate Naturalists elsewhere; and perhaps no place is more fitting for this than the annual address of the President. I propose, therefore, on the present occasion, to direct your attention to the present state of those exciting questions agitated in our day by Geologists, Zoologists and Botanists, as to the origin of Species and Genera, and the law of their creation.

Time was when Naturalists were content to take nature as they found it, without any over curious inquiries as to the origin of its several parts, or the changes of which they might be susceptible in time. Geology first removed this pleasant state of repose, by showing that all our present species had a beginning, and were preceded by others, and these again by others. Geologists were, however, too much occupied with the facts of their science to speculate on the ultimate causes of the appearance and disappearance of species, and it remained for Zoologists and Botanists, or as some prefer to call themselves, Biologists, to construct hypothesis or theories to account for the ascertained fact that successive dynasties of species have succeeded each other in time. In our day, Darwin has given to such speculations a form and coherency which they did not before possess, by his doctrine of Natural Selection; and theories of derivation and transformation are perhaps more popular than at any previous time, and are impressing themselves legibly on the practical every day work of science. In these circumstances it becomes necessary to watch the phases of opinion on this subject, to examine the various doctrines propounded, and to ascertain what progress they are making, if any, toward the goal of truth.

A very important contribution to this work has recently been made by Professor Owen in the concluding chapter of his great book on Physiology, just completed; and I shall take this as the basis of some remarks on the present state of the question of derivation.

Prof. Owen, availing himself of the privileges of a father in Science, goes back to 1830 in reviewing the history of doctrines of derivation, and shows that in his student days the question of the origin of species was agitated by the great Cuvier and his contemporary, Geoffroy St. Hilaire, and that both of these great masters of Natural Science had doubts as to the permanency of species in geological time, though neither had before him enough of biological evidence to establish this as a fact, or to frame any certain theory as to the relation of modern to extinct species; and Cuvier, at least, saw evidence against derivation in the apparent want of connecting links between fossil and recent species. Owen endeavours to arrange the questions raised in 1830 under several heads, and to state each as then agitated, and to "post it up," so to speak, to the present period—his evident intention being to show that the views of Darwin and other recent advocates of theories of derivation are by no means so original as they are supposed to be.

The first great question agitated by the French naturalists forty years ago is that grand one—Is there unity of plan or final purpose in living creatures? Are the homologies or resemblances of structure in organized beings merely parts of the general plan, or do they point to genetic or other relations of derivation? Are the beautiful adaptations of organs to functions, and of organisms to places in nature, evidences of deliberate purpose working out its ends by means, or have the external necessities given form to the organs? On this question Cuvier, in his assertion of teleology, evidently took the broader and more philosophical view, that which commends itself to the grander and higher style of mind; but neither he nor his opponent were in a position to see fully the bearings of the question. Owen himself, though largely in advance of most other writers of this time, is not free from misconceptions. He clearly sees, with all the more profound thinkers among naturalists, that whichever view we adopt, the problem can be solved only on the hypothesis of a "predetermining intelligent Will." Without this, nature is only a riddle without a solution—man himself a contradiction and impossibility. But, admitting this, are those resemblances which we call homologies, those adaptations which we call analogies, results of direct creative acts or of the operation of secondary causes? If the former, they are ultimate facts, referable directly to will; if the latter, we may study their more immediate causes, and the laws under which these operate. Cuvier and many of his most illustrious disciples have been content to adopt the former alternative. Owen declares that in this he has been led to differ from his great master. The reasons which he gives under this head are, it must be confessed, feeble. He found it necessary to assume an "archetype" or ideal type in explaining the vertebrate skeleton; but this would have been equally suitable under the hypothesis of direct creation or that of secondary causes. He saw in the recurrence of similar segments in a vertebral column and other cases of repetition of similar parts, something analogous to the repetition of similar crystals, as the result of "polarizing force in the growth of an inorganic body." But there is scarcely more philosophy in this than there is in the process by which a savage, ignorant of manufacturing processes, might explain, as the result of some unknown process of crystallization, the recurrence of forms in the pattern of a piece of calico or in the beads of a necklace. Still we are willing to allow due value even to the impressions made upon the minds of naturalists by such facts, and to go on to the next question of the series. Before doing so, however, we must take exception to one expression of the great English naturalist, which, in various forms, recurs in several places. He calls the theory of derivation a principle "more especially antagonistic to the theological idea" of creation. Now, if by the theological idea he means that promulgated in the first chapter of Genesis, he should explain wherein the antagonism consists. The object of the writer in Genesis is obviously to illustrate and enforce the existence and attributes of the Supreme Intelligent Will as opposed to Polytheism, Pantheism and Atheism, and the fact of an orderly and serial origin of things. But if he says that animals were made "according to their kinds," has any modern naturalist a right to hold that the kinds or species of Genesis are equivalent to those of any school of zoologists in our day? Further, all who profess to be acquainted with this part of theology should know that the word "create" is applied in Genesis only to the first animals, and to man considered as an intelligent and moral agent. The other animals and all plants are said to have been "made," "formed," "brought forth," implying that the writer had before his mind the idea of a primary and secondary kind of origin of organized beings. I endeavoured many years ago, in a work well known to members of this Society, and published before Darwin's Origin of Species, to illustrate this old "theological idea." Since naturalists will bring up such subjects, I may be excused for reminding them that if they should come to believe, on zoological and geological grounds, that some of the entities which we call species have been produced by a method which may be properly termed creation, and others by secondary processes, they may possibly find themselves to be in perfect harmony with the oldest and most authoritative theological ideas on the subject.

The second great question as to Derivation is that which relates to the succession of species in Geological time. Was this broken or uninterrupted? Did new species die out and were old ones created in their room, or were the new ones derived by some secondary process from those which preceded them? This question can only be finally settled by inductive investigation, and unfortunately our knowledge of extinct animals and plants is still too imperfect to give us the necessary accumulation of facts. We can only inquire as to a few cases a little better known to us than others. One curious feature of the inquiry is that it seems easier to show relationships between large groups of animals than between particular species. The reasons of this will appear farther on. Prof. Huxley, with his usual dexterity in presenting these problems to the popular comprehension, has recently taken advantage of this in tracing the links of connection between birds and reptiles.* By a series of cleverly arranged transitions, he has succeeded in constructing such a series as no doubt sufficed to

* Royal Institution Lecture on Animals intermediate between Birds and Reptiles.

convince many of his auditors that the gigantic and grotesque Iguanodons of the Mesozoic rocks might have been the progenitors, if not of wrens and titmice, at least of ostriches and cormorants. Yet he could not have placed together any two members of the supposed series without convincing any naturalist that an enormous gap had to be filled between them. Prof. Owen, writing to naturalists, does not attempt this sort of intellectual sleight of hand, but presents, as a case in point, the supposed progenitors of the horse. That useful quadruped was preceded in the tertiary period (Miocene and Pliocene) by a horse-like animal, the Hipparion, which, among other things, differed from its modern representative in having its splint bones represented by two side toes, a conformation supposed to adapt it to locomotion on soft and swampy ground. The Hipparion was preceded in the earlier tertiary (Eocene) by the Palæotherium, in which the side toes were still further developed so as to touch the ground, giving the foot a tridactyle character. These relations induce Owen to believe that these forms may be an actual genetic series, the species of Palæotherium passing through a succession of changes into the modern horse. Perhaps this case, as put by Prof. Owen, affords as fair an example as we can obtain of the bearing of a derivative hypothesis. The three genera in question are closely allied. They succeed each other regularly in Geological time. The horse shows in his splint bones rudiments of organs, which, serving little apparent purpose in him, were more fully developed and of manifest use in his predecessors. Modern horses have occasionally shown a tendency to develop the side toes, as if returning to the primitive type. Taking this as a fair example of derivation, and admitting, for the sake of argument, its probability, let us consider shortly some of the questions that may be raised with regard to it. These are principally two.

1. What limits, if any, must necessarily be set to such an hypothesis, and what relations does it bear to the origin of life at first and to the succession of animals in Geological time?

2. What causes may be supposed to have led to such derivation?

Under the first head, we have to enquire as to the limits set to derivation by the structure of organic beings themselves, and by the physical conditions and changes which may affect them. It will be convenient to consider these together.

Supposing that Palæotherium, Hipparion and Equus are links in a chain extending from the Eocene Tertiary to the present time, can we suppose that by tracing the same series further back it might include any Mammal. We must answer decidedly not, for if the whole time from the Eocene to the present has been required to produce the comparatively small change required from Palæotherium to horse, that in other cases would carry us back to the Mesozoic period, long before we have any evidence of the existence of "placental mammals." In other words, the Tertiary and Modern Periods will give us time enough only to effect changes of Mammals within the order Pachydermata, and perhaps in only one section of that order. The other orders must therefore constitute separate series, and these series must have been advancing abreast of each other. Had each series a separate origin, or is there any Mammalian stock in the Mesozoic from which, at the beginning of the Tertiary, these several lines of types may have diverged? Here our information fails. We know only a few small Marsupial Mammals in the Mesozoic. On our hypothesis it is possible that these may have been the progenitors of the more varied and advanced Marsupials of the Tertiary and Modern periods, but scarcely of the placental Mammals of the Eocene. There may have been placental Mammals, unknown to us, in the Mesozoic, which may constitute the required stock. The reptiles of the Mesozoic utterly fail to give us the necessary links. If they were changing into anything it was into birds, not into Mammals.

Again, the time in which the horse and its supposed progenitors have lived is one of continuous, unbroken succession of species. More especially in the later Tertiary there seems the best evidence of gradual extinction and introduction of species, without any very wide-spread and wholesale destruction, and this notwithstanding the intervention of that period of cold and of submergence of land in the Northern hemisphere, which has given rise to all the much-agitated glacial theories of our time. Can we affirm that such piecemeal work has continued throughout Geological time? At this point opens the battle between the Catastrophists and Uniformitarians in Geology, a battle which I am not about to fight over again here. I have elsewhere stated reasons for the belief that neither view can be maintained without the other, and that Geological time has consisted of alternations of long periods of physical repose and slow subsidence in which our more important fossiliferous formations have been deposited, with others of physical disturbance and elevation, with extinction of species. Dana has well shown how completely this view is established by the series of Geological formations as seen on the broad area of the American continent. Now the question arises, how would the law of derivation operate in these two different states of our planet? Let us suppose a state of things in which far more forms were being destroyed than were reproduced—another in which introduction of species was more rapid than extinction. In the latter case we may suppose an exuberance of new species to have been produced. In the former there would be a great clearance of these, and perhaps only a few types left to begin new series. Do we now live in one of the periods of diminution or of increase? Perhaps in the former, since there seems to have been, in the case of the Mammalia of the Post-pliocene, an enormous amount of extinction of the grandest forms of life, apparently without their replacement by new forms. If so, how far can we judge from our own time of those which preceded it? They may have been far more fertile in new forms, or perhaps farther in excess in the work of extinction. The question is further complicated with that which asks if these differences arise from merely physical agencies acting on organic beings from without, or is there in the organic world itself some grand law of cyles independent of external influences? The answers to such questions are being slowly and laboriously worked out by Geologists and Naturalists, and all the more slowly that so many inevitable errors occur as to the specific or varietal value of fossils and the relative importance of Geological facts, while the great gaps in the monumental history are only little by little being filled up.

Nothing can more forcibly illustrate the amount of work remaining to be done toward the settlement of these questions than a glance at the elaborate and most valuable "Thesaurus Siluricus" of Dr. Bigsby, recording, as it does, nearly 9,000 species of animals already found in the Silurian rocks. The rapid increase in the number of known species shows that we know as yet but a fraction of this ancient fauna, while the facts relating to introduction, extinction, geographical distribution and distribution in time, show that we are still a very long way from any definite conclusions as to the general law of succession and its relations to physical changes.

The application of these questions to the animals referred to by Owen, will serve farther to shew their significance as to limitations of derivation. Pictet catalogues eleven species of Eocene Palæotheria. Without inquiry as to the origin of these, let us confine ourselves to their progress. Under the hypothesis of derivation, each of these had capacities for improvement, probably all leading to that line of change ending in the production of the horse. If so, then each of our Palæotheria, passing through intermediate changes, may be the predecessor of some of the equine animals of the Post-pliocene and Modern periods. But if, as seems probable, the time intervening between the Eocene and the Modern was unfavourable to the multiplication of such species, then several may have perished utterly in the process, and all might have perished. Supposing, on the contrary, the time to have been favourable to the increase of such creatures, we might have had hundreds of species of equine animals instead of the small number extant at present. Again, what possibilities of change remain in the horse? Can he be supposed capable of going on still farther in the direction of his progress from Palæotherium, or has he attained a point at which further change is impossible? Will he then, in process of time, wheel round in his orbit and return to the point from which he set out? Or will he continue unchanged until he becomes extinct? Or can he at a certain point diverge into a new series of changes? We do not know any Palæotherium before the Eocene. Is it not possible that they may have originated in some way different from that slow change by which they are supposed to have been transmuted into horses, and that in their first origin they were more plastic than after many changes had happened to them? May it not be that the origin of forms or types is after all something different from derivative changes, and that new forms are at first plastic, afterwards comparatively fixed—at first fertile in derivative species, and afterward comparatively barren. Certainly, unless something of this kind is the case, we fail to find in the Modern world a sufficient number of representatives of the Palæotheria, Anoplotheria, Lophiodons, Elephants and Mastodons of the tertiary. On the other hand, it is scarcely possible to find a sufficient starting point in the

Eocene for the multitude of Ruminants and Carnivores and Quadrumana of the Modern time.

But it may be said, and truly, that these higher forms of life put the doctrine of derivation to the severest test. If we take marine invertebrata, we may trace analogues of these back into the earliest geological periods, and as the species are very numerous, and their structures more simple, it is easier to imagine a continuous derivation with respect to them. Still, even here such facts as the vast multiplication of species of Trilobites, Ammonites, Belemnites, and Ganoid Fishes, at different periods of Geological time, and their disappearance without modified successors, point to limitations of any law of derivation that may be suggested.

To sum up where all is so uncertain is not easy; but we may, I think, affirm that if existing animals are derivative as modified descendants of others—(1) They belong to a vast number of lines of modification which would require to be traced backward separately. (2) That many of these lines end abruptly in comparatively recent periods, perhaps in consequence of our defective information, perhaps because of some other law of creation. (3) That in some periods a series must suddenly bud forth into many ramifications, and in others contract to a few representations or be altogether dropped. (4) That the beginning of such series may take place in a different manner from derivation, and that the law of new series is probably different from that of those of longer derivation. (5) That it is absurd to suppose that any modern animal has originated from any now contemporary with it (e.g., man from the gorilla or bears from seals), since all these existing species must belong to series to be traced backward through species now extinct, and possibly unknown to us. (6) That while it is obvious that such derivation must be related to contemporary physical changes, our views of the nature of that relation must depend on those which we take of the causes of derivation itself.

Before proceeding farther we may remove another of the "theological" misconceptions under which Owen and some other writers on this subject seem to labour. They think that the "Biblical flood" interposes some difficulties in the way of their speculations as to the origin of species. They may readily be relieved from all embarrassment on this subject. The language of the Noachian record in Genesis implies that the Deluge was universal only in so far as man was concerned. The catalogue of animals taken into the Ark, five times repeated, and that of animals destroyed, twice given, show that only a very limited number of species we in the Ark, and that of the rest some certainly survived—others may have perished. Farther, the catastrophe does not require us to suppose either that coral polypes and other marine animals were overwhelmed with fresh water or under an abyssal depth of ocean, for the submergence of the dry land, or of a portion of it, by the "breaking up of the fountains of the great deep," does not imply a deepening of the ocean, but possibly to some small extent a shallowing of it. If the Royal Institution, of London, which has recently done so much in its courses of lectures to ventilate new and sometimes questionable scientific hypotheses, would employ some one to give a few exegetical lectures on the earlier chapters of Genesis, without entering into any disputed questions of criticism, but merely explaining the literal meaning of the terms of the record, it would confer an inestimable benefit on those Naturalists who seem to have derived their notions of the Biblical Creation and Deluge from the picture books and toy Noah's Arks of their childhood, with the comments of their nursery-maids thereon.

It still remains to us to inquire whether the doctrine of derivation can throw any light on the origin of life at first. Nothing in the doctrine of derivation itself necessitates the belief that change has always been in the direction of improvement or of increased complexity; but the Geological history of the earth and the succession of fossils lead to the belief that the general tendency of creation has been from more generalized to more specialized forms, and from simpler to more complex organisms. Still, it is evident that this general doctrine of improvement is to be held with some limitations of detail. For example, the very lowest forms of life have continued down to the present, and some of them—for instance, the sponges and Foraminifera—have apparently attained to their greatest extension in number of species in comparatively late periods. Further, every new form when first introduced appears to be at its maximum in point of development; or, if not so, it rapidly attains to this, and again deteriorates when being supplanted by other and newer forms. Numerous examples of this will occur to every Geologist. Admitting, however, that development has in some cases been indefinitely postponed, and that in others it has advanced by successive waves, each retreating before the advance of the next, still, we may hold that it would be fair to assume a gradual progress from lower to higher forms. Assuming this, and that the lower have preceded the higher, we may limit our inquiry as to the origin of life to the lowest forms, and ask what is involved in the question of their origin. Now, it is easy to affirm that the lowest animals and the lowest plants are but Protoplasm, which is only another name for the chemical compound Albumen, and that if we can conceive this to originate from the inorganic union of its elements, we shall have a low form of life from which we can deduce all the higher forms of vital action. In making such affirmation we must take for granted several things, none of which we can yet prove:—(1) That vital force is merely a modification of some of the forces acting in unorganized matter; (2) That such force can be spontaneously originated from other forces without the previous existence of organization; (3) That being originated, it has the power to form Albumen and other organic compounds. Or, if we prefer another alternative, we may take, instead of the last statement,:—(1) That Albuminous matter can be produced by the union of its chemical elements without life or organization; (2) That being so produced it can develop vital forces and organization, including such phenomena as sensation, volition, reproduction, &c. To believe either of these doctrines in the present state of science is simply an act of faith, not of that kind which is based on testimony or evidence, however slight, but of that unreasoning kind which we usually stigmatize as mere credulity and superstition. It will not help us here to say that vegetable and animal infusions, destitute of germs, will produce a "mucous layer" or "proligerous pellicle" from which organisms may arise, for in the first place such infusion itself contains organic matter, and, as Tyndall has lately shown incidentally in his experiments with the electric light, we have to operate with air and water and vessels, which it is wholly impossible by any chemical or mechanical process to free completely from the smaller kinds of germinal matter.

It is rather discouraging thus to find that, on the philosophy of derivation, as our faith advances the demands upon it increase, until, from belief in the derivation of Horses from Hipparia, we are finally obliged to believe that life with all that it involves is nothing but a peculiar manifestation of dead inorganic forces. In order that, if possible, we may relieve ourselves from this burden, let us now turn to our second inquiry, and consider the causes which are alleged to produce the transmutation of species.

Leaving out of the account many fanciful and untenable hypotheses, both ancient and modern, we may notice:—(1) The Lamarckian theory of Appetency; (2) The Darwinian theory of Natural Selection; (3) The Owenian doctrine of "Innate tendency to deviate from parental type;" (4) The doctrine of arrested or advanced embryonic development;—with the view of ascertaining how far these several hypotheses may be employed to account for observed facts.

(1.) The Lamarckian theory is essentially that of effort in certain directions giving power in those directions, and consequently altering organs. That it has a real basis in nature no one can doubt who has observed the effect of use and effort in determining the development of organs. That it can produce only varietal forms and not species, and that it is practically very limited in its operation, are facts equally patent. It is a mistake, however, to suppose that Lamarck confined himself to the effect of will in producing change. He considered also the effect of external circumstances, and of habits induced by such circumstances, in which respect his theory differed less than is generally supposed from that of Mr. Darwin. The main difference is, that Lamarck supposed animals to be acted on by an attractive influence from before, Darwin by a propelling influence from behind. In this respect Lamarck's hypothesis is the more philsophical, when regarded as means of real progress; but it is less applicable to the lower animals and to plants than to animals of high grade.

(2.) The most popular theory of derivation in the present day is undoubtedly that of Darwin. This view is, essentially, that all organized beings are engaged in a struggle for existence; that in this struggle certain varieties arise, which, being more suited to the conditions, prosper and multiply more than others; that this amounts to a "Natural Selection" similar in kind to the artificial selection of breeders of stock; that members of the same species, isolated from each other and subjected to struggles of different kinds, will in process of time become specifically distinct. The difficulties of Darwinism are many. The following may be stated as fatal to it in its capacity of a sole mode of accounting for derivation: — (1) Conditions which involve a struggle for existence are found by experience to result in deterioration and final extinction rather than improvement, and are directly opposite to those employed by breeders for their purposes. (2) Even if we include along with the struggle for existence, the action of all conditions, favourable and unfavourable, tending to change, we fail to find any evidence of this other than the formation of varieties and races. True species, no longer capable of interbreeding, have not been observed to be produced. (3) Though it is conceivable that species may have been produced during the lapse of time, yet even this is rendered improbable by the enormously long periods which Mr. Darwin himself admits to be necessary, and which seem to overgo the possibility of the existence of the creatures in question as far back in geological time as the theory demands.

(3.) Owen desires to substitute for the above views "an innate tendency to deviate from the parental type operating through periods of adequate duration." According to this hypothesis "a change takes place first in the structure of the animal, and this when sufficiently advanced may lead to modifications of habits." It is difficult to understand this as anything more than a mere statement of a belief in derivation as a fact. It seems to mean that species change because they tend to change. We may add to this, if we please, that they change independently of external circumstances, and by virtue of a creative plan embodied in them, or rather in the matter of which they are composed; for Prof. Owen appears to stretch his theory so far as to assert the formation of species spontaneously from inorganic matter, thus giving us the additional thesis that species tend to be before they actually exist. It is also to be observed that the tendency to change, though not caused by external circumstances must act in unison with physical changes, otherwise it would be worse than useless. Taking the case of the Hipparion and horse, Lamarck would inform us that the former endeavoured to accommodate itself to drier and harder ground, and thus changed the character of its feet. Darwin would say that as the ground became harder those individuals which had the most equine feet would succeed best in the struggle for existence. Owen very properly demurs to both views, holding that there were dry and wet places suitable for horses and Hipparia both in the Miocene and Modern periods, and that the increase of dry ground would merely limit the range of Hipparia and not produce horses; but he holds that the Hipparia changed into horses merely because they tended to do so, and that if the change suited the conditions of the case, that was a correlation arising from the plans of the Creator, and with which their poor brains and greater or less safety and comfort had nothing to do. If we were disposed to accept this hypothesis of Owen, we should not in doing so arrive at any true cause, and we should at the same time find ourselves involved in the old difficulties. That a Hipparion should change into a horse it would be necessary that not only his feet but his teeth and other structures should change in harmony with each other. This must take place either at once or gradually. If at once, then a pair of horses must be born from Hipparia in one herd, and must be isolated from the rest so as to produce a herd of horses. This is hard to believe; and if we resort to gradual change, the required isolation of the breed will be still more difficult to secure. The demands upon our faith are obviously greater here than even in the hypothesis of Darwin,—that is if we can be induced to place any reliance on the argument of the latter as to struggle for existence.

(4.) The last of these hypotheses which I shall notice, and, in my view, the most promising of them all, is one which has recently been ably advocated by Mr. Edward D. Cope in a memoir on the "Origin of Genera," published in the Proceedings of the Academy of Natural Sciences,* and which is based on the well-known analogy between embryonic changes, rank in the Zoological scale and Geological succession. It may be illustrated by the remarkable and somewhat startling fact, that while no authenticated case exists of animals changing from one species to another, they are known to change from one genus or family to another, and this without losing their individuality. Prof. Dumeril, of Paris, and Prof. Marsh, of New Haven, have recently directed attention to the fact that species of *Siredon*, reptiles of the Lakes of the Rocky Mountains and of Mexico, and which, like our North American *Menobranchus*, retain their gills during life, when kept in captivity in a warmer temperature than that which is natural to them, lose their gills, and pass into a form hitherto regarded as of a different genus and family,—the genus *Amblysoma*. In this case we may either suppose that the Amblysoma, under unfavourable circumstances, has its maturity and reproduction prematurely induced before it has lost its

* Philadelphia, 1869.

gills, or that the Siredon has, under certain circumstances, the capacity to have its period of reproduction arrested until it has gone on a stage further in growth and has lost its gills. In any case the same species—nay, the same individual—is capable of existing in a state of maturity as a creature half fish and half reptile in regard to its circulation, or in a more perfect reptilian state in which it breathes solely by lungs. Further, we may suppose conditions of the earth's surface in which there would only be Siredons or only Amblysomas, and a change in these conditions inducing the opposite state. Here we have for the first time actual facts on which to base a theory of development. These facts point to the operation of two causes—first, the possible *Retardation* or *Acceleration* of development, and secondly, the action of outward circumstances on the organism capable of this retardation or acceleration. We here substitute for the tendency to vary of Owen's theory, the ascertained fact of reproductive retardation or acceleration, and for the struggle for existence, the action of changed physical conditions, and for the question as to the change of one species into another, the change of the same species from one genus into another. Further, instead of vague speculations as to possible changes of allied animals, we are led to careful consideration of the embryonic changes of the individual animal, and as to the differences that would obtain were its development accelerated or retarded. We can thus range animals in genetic series within which anatomical characters would show change to be possible. I cannot follow these series out into the elaborate lists tabulated by Mr. Cope. but may proceed to notice the limitations which his views put to the doctrine of derivation. It is obvious that, if this be the real nature of derivation as a possible hypothesis, then derivation must follow the same law with metamorphism and embryonic development. Those animals which undergo a metamorphosis must be those most liable to such changes; for example, a Batrachian would be more likely to be so than a true reptile,—consequently those lower forms of animals in which metamorphosis is most decided would be those in which derivation would be most active, and when they had attained to a condition in which metamorphosis is of less amount, the tendency to change would be diminished. When we compare this with the actual succession of animals in geological time, we can see, as many Palæontologists have remarked, that order of succession in time and order of embryonic development correspond with one another to a remarkable degree. We see also, however, that in the higher animals changes of species have taken place more rapidly than in those of lower grade, though in the latter metamorphosis is usually more marked—a fact not apparently in accordance with our hypothesis.

According to this view, also, a species once created may have in itself a capacity for passing through several generic forms, constituting a cycle which ever tends to return into itself, or to advance and recede by steps more or less abrupt under the law of retardation and acceleration, combined with the influence of external circumstances. Yet the dimensions of the orbit of each species must be limited, its duration in time must also be limited, and its capacity to pass into a really new species must still be a point subject to doubt, but open to anatomical investigation and inference. As already hinted, it is a most important point of this theory, that when we have ascertained the series of embryonic changes of any animal, we have thereby ascertained its possibilities in regard to accelerated development. Its possibilities in regard to retarded development may be inferred by similar studies of animals higher in the scale. Now, if we knew the embryonic history of every animal, recent and fossil, in its anatomical details, we should be able to construct out of this a table of possible affiliation of animals, and should be able to trace our existing species through the same genera, families, orders and classes in which they might have existed in geological time, and to predict what they might become in time still to come. This hypothetical scheme of creation would approach to the actual one in as far as we were able to correlate it with the physical changes which have occurred or will occur on our planet. Let us take as a crucial test the case of man himself. The actual anatomical and physiologic differences which obtain between those races in which maturity is latest, and those in which it is earliest, and a comparison of these with embryonic characters, would give us the modern data. The comparison of these with the most ancient human remains might enable us to infer whether retardation or acceleration has been the tendency in historic or geological time. From this we might infer what might be the condition of man under a still more accelerated development than any now known, or under that antediluvian condition in which immaturity is said to have been protracted over half a century, or that still future time predicted in Holy Writ when the days of a man shall be as those of a tree. Having worked out these problems, we would be in a position to inquire as to the possible transition of Homo from or towards any other generic form. I would by no means put forward this theory of embryonic development as including the whole law of introduction of species or genera* any more than the others reviewed, but I must say that to my mind it appears to hold forth the most promising line of investigation, with the hope of arriving ultimately at some true expression of the law of creation with reference to organized beings.

What that law will ultimately prove to be, and to what extent it may include processes of derivation, it is impossible now to say. At present we must recognize in the prevailing theories on the subject merely the natural tendency of the human mind to grasp the whole mass of the unknown under some grand general hypothesis, which, though perhaps little else than a figure of speech, satisfies for the moment. We are dealing with the origin of species precisely as the Alchemists did with Chemistry, and as the Diluvialists and Neptunists did with Geology; but the hypotheses of to-day may be the parents of investigations which will become real science to-morrow. In the meantime it is safe to affirm that whatever amount of truth there may be in the several hypotheses which have engaged our attention, there is a creative force above and beyond them, and to the threshold of which we shall inevitably be brought after all their capabilities have been exhausted by rigid investigation of facts. It is also consolatory to know that species, in so far as the Modern period, or any one past Geological period may be concerned, are so fixed that for all practical purposes they may be regarded as unchanging. They are to us what the planets in their orbits are to the Astronomer, and speculations as to origin of species are merely our nebular hypotheses as to the possible origin of worlds and systems.

One word in conclusion with reference to our own work here as a Society, and as individual collectors of facts. We may not be in a position to take any leading place in the agitation of the

* It is but fair to say that Mr. Cope himself admits the action of natural selection as one cause of change.

questions to which I have referred; but we are well situated for the useful task of accumulating the necessary data for their settlement. The broad area of the American continent, the wide space occupied by its geological formations, the completeness of the series of its palæozoic rocks, the unbroken connection of its post-pliocene and modern fauna and flora, the meeting on this continent within recent times of multitudes of indigenous and exotic species of plants and animals, the existence up to our own time of feral and aboriginal conditions which are pre-historic in the Eastern continent,—these are all points of vantage on which we can seize in dealing with these questions; and if we properly inform ourselves as to what is being done elsewhere, and diligently improve our own opportunities, I see nothing to prevent us from taking the lead of those who in the Old World are pursuing such inquiries in a comparatively narrow field, and under conditions in many respects less favourable. I must insist, however, that this is not to be done by vieing with them in crude speculations and hypotheses, or in building up specious fabrics of conjecture to dazzle the popular eye, but in patient, honest, and careful accumulation of facts.

We should also bear in mind that in the greater centres of literary and scientific life, there is a strong temptation, especially on the part of ambitious men who have their own fortunes to build up, to deal in that sensation science with which the popular literature of the day is deluged. In our own comparatively obscure field there is little inducement to this or opportunity for its display, and this is so far in favor of a healthy scientific tone, which we should endeavour to preserve and cultivate. Our danger arises from being too ready to follow the extreme views put forth elsewhere, and from impatience with the slow returns for honest and careful work.

ON THE OCCURRENCE OF ARCTIC AND WESTERN PLANTS IN CONTINENTAL ACADIA.

By G. F. Matthew.

(Read before the Natural History Society of New Brunswick, 13th April, 1869.)

To the botanist as well as to the geologist this portion of the North American continent presents an inviting field for research; and the more so as till within a few years its flora has received but little attention. Although one cannot expect to find new species in a region, a large part of which, when viewed from a geological stand-point, has but recently emerged from the ocean, and has, therefore, received its flora from countries older and better known; yet the many peculiarities which may be observed in the distribution of plants in Acadia, form of themselves a subject in the study of which leisure hours may be profitably spent. To bring some of these peculiarities into notice by the public, and to indicate, though very imperfectly, the causes which have produced them, are the objects of the following remarks.

From the correspondence of natural features in Maine and New Brunswick, and from their situation, being alike exposed to the same variations of temperature, we would naturally expect to find no very marked differences between the floras of the two countries. This, indeed, is in a great measure the case, if we look upon Maine as a whole; but if we separate from it that portion of the State northward of the mountains which cross its centre, and eastward of the Penobscot River, a palpable difference in the vegetation of the section north and south of this divisional line is apparent.

The northern section, including the province of New Brunswick, may be designated Continental Acadia. Apparently merging into New England on the south—for there is no conspicuous natural barrier between the two countries—it is, nevertheless, as regards the indigenous plants which grow within its borders, closely allied to the neighboring province of Quebec, although a mountain range intervenes. This portion of Acadia contains four principal districts, viz.: an upper plain or plateau varying from about 200 to 500 feet above the sea, watered by the Upper St. John and its tributaries, the northern affluents of the Penobscot, and the River Restigouche. A triangular plain expands from a point within a few miles of the Maine boundary to a width of 150 miles or more, where it passes beneath the waters of the Gulf of St. Lawrence. This *Lower Plain* rarely rises more than 300 feet above the sea. Between the upper and lower plain lies a broken country rising into a knot of high hills in Northern New Brunswick. Lastly, there is a series of parallel ridges in the south, forming a hill-country of less altitude than the last, lying along the north shore of the Bay of Fundy. About two-thirds of this region is drained by the River St. John, which breaks from the level of of the upper plain at the Grand Falls; and, descending through several rapids and quick-waters, reaches tide-level at the western border of the lower plain, whence its course to the sea (distant 90 miles) is comparatively sluggish.

The rest of the Maritime Provinces of Canada, consisting of Nova Scotia and the twin islands of Prince Edward and Cape Breton, may be comprised under the term Insular Acadia.

Before describing in detail the peculiar groupings of species in this region, it may not be amiss to mention a few of the agencies which have given rise to the diversified forms of vegetation now existing on the earth; and then to add some remarks upon their peculiar manifestation in that part of America to which these observations more particularly relate, and to show their influence upon the range of plants within it.

Of these agents perhaps the most important is *Variation of Temperature*. It is well known that there are two directions in which this variation occurs, one on going north or south from the Equator, and the other in ascending from the level of the ocean to the tops of mountains. In both of these the temperature becomes lower in proportion to the elevation in the one case, or to the distance from the equatorial circle in the other. This decrease in temperature exerts so great an influence over plants that few species are found to be common to places widely differing either in latitude or altitude.

Soil is another influential agent in the limitation of species and the modification of individuals; some plants being peculiarly adapted to certain kinds of soil, and rarely found growing in any other, while others, although they may exist, present a puny and sickly appearance when found growing in soils not adapted in texture and composition to their nature.

Moisture also is of the utmost importance to the well-being of all cellular bodies, as well vegetable as animal; and is in fact so much a necessity that when deprived of it they cease to live. These three agencies are those which have played the most important part in diversifying the vegetation of the globe; but two of them, viz.: temperature and moisture, present themselves under a somewhat peculiar aspect in Acadia.

The renovation of the ocean by the interchange of waters throughout its vast expanse, is affected through the medium of ocean currents, flowing alternately to and from the poles. Such of these "ocean rivers" in the northern hemisphere as flow northward are continually thrown further and further east as they approach the arctic circle, by the retarded rotation of the earth from west to east; while such as run southward are thrown to the west. Hence, while Europe is bathed in the warm waters of the Gulf stream, running in a long arc northward across the Atlantic, the polar current, having a westerly momentum, clings to the American coast, and Acadia not only shares the cool climate prevalent along this seaboard, but owing to its semi-insular position, has its temperature still further lowered. This is strikingly evident when the climate of St. John is compared with that of cities in Europe —such as Bordeaux, Turin and Venice,—under the same parallel of latitude. The principal cause of this difference of temperature is the fact that here we have the north-east a refrigerator in the Gulf of St. Lawrence, traversed as it is by a branch of the polar current, which entering at the Straits of Belleisle, sweeps around the shores of the Lower Provinces and finds an outlet in the Gut of Canso and further east. We have also a cool vapor bath in the sea fogs, which in summer bathe our south-eastern shores, and whose influence on vegetation will be noticed in the sequel. Thus we see that within the limits of these maritime provinces there are variations of temperature, which mere extent of surface or elevation of land will not account for, but which are mainly dependent on ocean currents and their concomitants.

In comparing the relative heat and cold prevalent in various parts of Acadia, and other portions of the British possessions, it has not been thought necessary to notice the temperature of the colder months of the year, during which nature, in these latitudes, sinks into partial inaction, but only of those when she is in full activity.

The following table, condensed from the Canadian Year Book for 1868, will enable the reader to follow these changes during the five warm months, and to effect a comparison of the mean summer temperature in various parts of the Dominion. It also serves to show that the summer temperature of St. John is comparatively low. It is probably this, and the want of any observations by which an estimate of the climate of the interior could be formed, which has led the author of that portion of the Year Book from which this table is drawn, to include the whole of New Brunswick in the same climatic division with Prince Edward's Island, and that portion of the south shore of the St. Lawrence between Gaspé and Quebec. As regards the northern part of New Brunswick, this would appear to be a natural division; but when the climate of central New Brunswick is better known, I am inclined to think it will fall within the division comprising the eastern townships and that part of Upper Canada between Lake Ontario and the Ottawa River. Instead of falling within the region where wheat can scarcely be grown with profit, this portion of New Brunswick is likely to be recognized hereafter as a country much more favorable to farming operations than might be inferred from the classification given in the work above cited. It is distinguished from other parts of the Province by the presence of a group of plants, which indicate a climate in which Indian corn can be brought to perfection. The analysis of the Acadian flora given on succeeding pages will, it is believed, fully bear out this opinion.

TABLE No 1.

	May.	June.	July.	Augt.	Sept.	Oct.	Sum Mean
Labrador	35.0	42.0	48 0	51.0	42.0	31.0	47.0
St. John's, Newfoundland	39.3	48.0	56.2	57.9	53.0	44.5	54.0
St. John, N. B.	47.3	54.5	59.7	60.0	55.0	45.7	58.1
Thunder Bay, L. Superior .	48.9	58.7	62.2	58.8	48.2	41.9	59.9
Halifax, N. S.	48.0	56.3	62.3	63.7	57.0	47.0	60.8
Toronto	51.5	61.0	66.3	65.7	57.4	45.0	64.3
Wolfville	51.6	61.9	67.5	65.5	58.3	49.2	65.0
Quebec	51.6	63.1	67.5	65.9	57.6	44.6	6.55

Not only the coldness, however, but the humidity of the atmosphere, in many parts of Acadia, exercises a powerful influence upon its flora.

It is a well-known fact that the land and sea breezes which alternately fan districts bordering the sea in inter-tropical regions, result from the periodical heating and cooling to which such lands are subject every 24 hours. Analogous to this is the prevalence of certain sets of wind on the coast of large areas of land in temperate latitudes, during the summer, and of others during the winter months.

It is on these lands in going north from the coast that we meet with a new group of species, which range thence up the St. John River and its tributaries into Northern Maine. The influence of natural drainage of soils upon the distribution of species in the neighboring Province of Canada, has been observed by Mr. Macoun, of Belleville, in some remarks drawing attention to the occurrence of certain western species on the dry gravel ridges in that neighborhood; and the presence of continental forms in certain parts of the interior of Acadia, such as the valleys of Kings County, in the southern hills, the dry terraced lands of the St. John River and its tributaries, and the rich calcareous districts in the south-west part of the upper plain, are but manifestations of the same law of distribution, lands thoroughly drained being in a condition to absorb and retain more heat than those which are wet. Were it not for the depressed position of a portion of the lower plain, along the base of the southern hills, which is little above sea-level, and the imperfect drainage which results from the flatness of this region, there would be a more decided exhibition of western species in the southern countries than we now find.

It is to be regretted that so small a part of Continental Acadia has yet received the attention of botanists, and that the material for working out the subject of this paper is so imperfect. It is, therefore, quite possible that a part of its contents may not be confirmed by more minute and extended investigation. The scantiness of the material may be inferred when it is stated that out of the fourteen counties into which the Province of New Brunswick is divided, a detailed examination has been made in *parts of four* only. The *three* catalogues upon which these remarks are based, comprise species collected in Kent County, by Rev. James Fowler, and Rev. J. P. Sheraton; in Central York, by Prof. L. W. Bailey; and in a part of St. John and Kings, by

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* See article on flora of Canada, by Drummond, Can. Nat., Vol. 1, new series, page 405.

the writer. Reference is also made to notes taken by Prof. Bailey, during a rapid journey through the northern highlands, and by the Rev. James Fowler, when at Dalhousie, as well as to the report of G. L. Goodale, of the Maine Scientific Survey.

In Continental Acadia, as previously defined, there are four principal types of vegetation, exclusive of maritime species, viz.:

I. Arctic and Sub-Arctic.
II. Boreal.
III. Continental.
IV. New England type.

The latter includes all indigenous species which have an extensive range in Acadia, especially in its southern parts.

I. *Arctic and Sub-Arctic* (*or Alpine and Sub-Alpine.*)—This type, as being the most ancient flora of the country, and also being found on the low lands at the parallel of 45° N., half way between the equator and the pole, deserves our first attention.

The species so far as known are the following:

No. 1.—LIST OF ARCTIC AND SUB-ARCTIC SPECIES.

SPECIES.	Southern Hills.	Lower Plain.	Northern Highlands.
Alsine Grænlandica (Greenland Sandwort) - - - - - -	*S′	....	....
*Rubus Chamæmorus (Cloud-berry)	*S′	*E′	....
Solidago virga-aurea (Golden Rod)	*	....	....
Senecio pseudo-arnica - -	*S′	....	....
Vaccinium uliginosum (Swamp Huckle-berry) - - - -	....	....	*
Calluna vulgaris (Heather) - -	....	....	....
*Empetrum nigrum (Crow-berry) -	*S′	*E′	....
Carex capillaris - - - - -	....	*E′	....
Asplenium viride - - - - -	*S′	....	....
*Solidago thyrsoidea (Thyrsoid Golden Rod) - - - - - - -	*S′	....	....
*Vaccinium Vitis-Idea (Hill Cranberry) - - - - - - -	*	*E′	....
*Euphrasia officinalis (Eyebright)	*S′	....	*E′

[Species in this list marked S′, occur only near the sea-shore on the Bay of Fundy and coast of Maine. Those marked E′ have been gathered along or near the shores of the Gulf of St. Lawrence.]

Of these species *Senecio pseudo-arnica* is introduced on the authority of Prof. Asa Grey, as occurring at Grand Manan, and the Mountain Sandwort (*Alsine*, or Stellaria, *Grænlandica*,) is added on the same authority, it having been found at the sea level, on the coast of Eastern Maine. The common Scotch

Heather, (*Calluna vulgaris*,) has been found near Halifax, by Prof. Lawson, and is more abundant at Cape Breton and Newfoundland. It is accredited to New Brunswick, by Loudon. Prof. Bailey noticed the Bog Bilberry (*Vaccinium uliginosum*,) and the Cow Berry (*Vaccinium Vitis Idea*,) growing on Bald Mountain, the culminating point of the Northern Highlands, but does not seem to have met with any other representatives of this type at the north. We may, perhaps, except the mountain Cinquefoil (*Potentilla tridentata*,) gathered on the Tobique River, but which, although commonly considered Sub-Alpine, has such a range in Acadia, as to show that it may perhaps, with more propriety, be looked upon as a Boreal form. These, and the remaining species of the list, not noticed above, find a congenial climate at St. John. One very obvious cause of their presence here, as already observed, with regard to other species, is the abundance of cool sea fogs in summer time, and consequent low temperature and moist atmosphere. The more thoroughly Arctic species, such as the Cloud Berry (*Rubus Chamæmorus*) and the Crow Berry, (*Empetrum nigrum*,) show a partiality for the peat bogs, so common in our "Barrens," where they grow in company with the Bastard Toad Flax, (*Comandra livida*,) and other high northern forms.

The Sub-Arctic species of our list, have been mostly gathered on the cliffs and terrace banks, bordering the Bay of Fundy. On these, the Eyebright, (*Euphrasia officinalis*,) and the Thyrsoid Goldenrod (*Solidago thyrsoidea*) abound. The first of these has also been met with at Dalhousie, on the Bay of Chaleur. The mountain Cinquefoil has an extensive range throughout Acadia, having been seen near Mount Katahdin, on the Lower Tobique, at several points around the Bay of Fundy, and on the coast of Maine. It even flourishes at Windsor, Nova Scotia, where the mean summer temperature cannot be far from 65° Fahr. The Green Spleenwort, (*Asplenium viride*,) a native of Newfoundland, Gaspé, Labrador and the Rocky Mountains, grows on the sea cliffs near this city, in company with *Carex canescens* var. *vitilis*, *Cinna arundinacea* var. *pendula*, *&c.* I may add that the Cowberry, (*Vaccinium Vitis Idea*,) which goes by the name of Hill Cranberry with us, is not only quite common near the coast of the Bay of Fundy, but has also been met with by Mr. Fowler, at Richibucto.

The comparison of the position of this little group of Arctic forms, with that of a similar assemblage of Alpine plants on the White Mountains of New Hampshire, is one of very great interest, when it is considered that the Acadian Sub-Arctic flora grows at the sea level. Let us then look at the vertical range of some of the plants above named on those eminences, the highest peaks of North Eastern America.

Dr. Dawson gives 4,000 feet above the sea as the upper limit of evergreens. Here firs cease to grow, and the mountain side is covered with small shrubs and herbs. On the Plateau between Mounts Washington and Munroe, at a height of 5,000 feet, the Arctic flora is in full possession, and extends thence to the summit. If we note the range of such of our own Arctic and Sub-Arctic species as grow there, we find that they come no lower down the mountain side than to points varying from 4,500 to 3,500 feet above the sea. It is supposed that the principal masses of rain clouds hang at a height of from half a mile to one mile above the earth, in regions near the sea level, encircling the mountain tops with their vapory masses; and the clouds clustering at such a height around Mount Washington, would wrap those little Alpine plants which grow towards the top of the mountain, in those thick mists in which they delight. Need we wonder then that such lowly forms should find a congenial home on the cool mist-covered hills of Maritime Acadia.

By its cool summer temperature, its humid climate, and consequently its vegetation, St. John, when compared with these New England mountains, may be looked upon from a botanical point of view, as standing upon an eminence nearly 4,000 feet high; for it is at this height, on the White Mountains, that evergreens cease and Alpine plants take their place. Fancying ourselves standing upon this elevation, and looking around us through the medium of Mr. Murdock's observations, and those of Acadian botanists, we see across "the Bay" and beyond the fertile valley of Annapolis, the hills of Nova Scotia, rising ridge upon ridge to a mountain range, equal in height to our own, and our sister city of Halifax on its crest; for she has more fog and rain than we have. Around her grow the Scotch heather, the mountain Cinquefoil, and other Alpine forms mentioned in the preceding list.*

* I infer this from the table, (at foot of opposite page,) prepared by Mr. Murdock, from his own notes and data, published by the late Colonel Myers, of Halifax.

Mr. G. Murdock, in a paper on the Meteorology of St. John, read before this Society in 1863, pointed to this phenomenon as exhibited in the vicinity of this city, in the following words: "In the wind "columns it is observed that the increase and duration of "southerly weather follows very nearly that of the temperature. "July is the month of *maximum* southerly weather, and December "of minimum. From July to December, there is a constant "diminution, and from this latter month to July again a steady "increase." Of these southerly winds, the south-west is by far the most frequent, and, if continuous, sooner or later brings upon the southern coast of Acadia those fogs for which St. John is unfortunately so notorious. That such is the case may be inferred from the following table, compiled by the same accurate and pains-taking observer, showing a mean of the number of foggy days per month for the years 1861-1867:—

TABLE No. 2.

	May.	June.	July.	Augt.	Sept.	Oct.	Sum. Mean.
Avrge. number of foggy days	5.3	4.2	6.2	6.7	3.4	2.3	5.7
Rainy days	10.0	6.8	9.9	7.6	8.1	7.6	8.1
Mean estimate cloudy days	6.4	6.4	6.3	6.2	5.5	6.1	6.3

From this table we gather that, during each of the two hottest months of the year, St. John is enveloped for nearly a week in constant fog; and this misty curtain, by its presence, not only excludes the direct rays of the sun, but by its coolness lowers perceptibly our summer temperature.

During the months of July and August, there is also a large rainfall, and if we add to the rainy and foggy days those which are cloudy, but nineteen days out of the two mid-summer months remain during which the sun shines upon us in unclouded splendor.

If we give due weight to these sources of humidity and cold, and consider, also, that our position on the sea-side is an additional cause of a diminished temperature, we need feel no surprise at the sub-arctic summers which prevail at St. John,

TABLE No. 3.—MEAN OF 1864 AND 1865.

	May.	July.	Aug.	Sept.	Oct.	Sum Mean.	June.
Halifax foggy days....................	12.5	6.	6.5	1.5	3.5	6.7	7.4
St. John, N. B., do. do...............	4.	4.3	6.5	1.7	1.	5.3	4.
Halifax rainy days....................	16.	12.5	11.	7.	16.5	15.75	8.
St. John, N. B., do. do...............	12.5	7.5	8.5	6.5	7.5	7.8	5.5

nor at the sub-arctic type of vegetation which flourishes around us. It is well known that humidity, in its influence over the distribution of Arctic plants, in a limited degree represents cold. But when a climate is both cool and moist, as ours is, it presents a double attraction to these little northern adventurers.

Having seen what a chilling effect these south-west winds, with their accompanying fog and rain, have at the coast, let us now follow the same breezes into the interior.

As soon as the fogs pass the coast, they are rapidly absorbed by the atmosphere (expanded by warmth radiated from the heated earth), and may be traced in their progress inland, in the long banks of cumuli-clouds which hang over the southern hills; and are finally dissipated entirely in the onward progress of the southerly winds, which now possess nearly the original warmth and most of the moisture that they had when first they began their journey from the Gulf Stream. Now pre-eminently invigorating and refreshing, these winds course onward toward the shore of the Gulf of St. Lawrence, stimulating the growth of many species of plants, which cannot abide their chilling influences at the coast. As may be inferred, they bear a very different reputation along the Gulf from that which attaches to them with us. In spring and early summer, they blow down the valleys of the Miramichi, and other streams debouching on that coast, as warm breezes, prevalent during the night and morning, giving a great stimulus to vegetation; but in the evening they are pushed back, or forced upward by a strong, cold wind from the Gulf, but lately relieved from its wide fields of floe-ice. The latter (N. E. winds) often blow with much violence about 4 or 5 o'clock in the afternoon, and such is their chilling influence, that flowers which have been in bloom in Fredericton for a fortnight are (about 1st June) only opening their petals on the Miramichi. There is nearly the same difference between St. John and Fredericton at this period, although the first flowers of spring, such as the Mayflower, *Epigœa repens*, usually opens with us a little in advance of their time of flowering at the capital. The advent of spring is undoubtedly first felt at St. John, but the increase of fog and chilly winds in the month of May checks the growth of plants with us, while the very same winds give an increased impetus to their growth and expansion in the interior, where, at the 1st of June, vegetation, in its summer development, is a fortnight in advance of the coast, and subsequently much more.

In table 1 it will be seen that the valley of Cornwallis, in Nova Scotia, has a summer mean of 65 deg.; and it is probable that a large area in the interior of Continental Acadia will be found to have, at that period, a temperature equally high. At Fredericton "90 deg. in the shade" is not rare, and at Woodstock the mercury is said to rise to 100 deg. Fah't.

In default of any meteorological tables shewing the climatic changes of the interior of Acadia, I have been somewhat prolix in thus enlarging on the S. W. winds, in order to give some idea of the varying influence which this important agent exercises over the growth of plants.

Of *soils*, Continental Acadia possesses a great variety, which have a proportionate influence with the causes already noted upon the range of plants within its borders.

The Highlands, both North and South, being mainly made up of metamorphic rocks, which are comparatively impervious to water, the drainage of the soil upon them is thereby much impeded. Hence, it happens that, notwithstanding the hilliness of these districts, there are, especially in the southern hills, numerous peat-bogs, interspersed with bare rocky tracts known as "barrens." These barrens extend for many miles along the coast of the Bay of Fundy, where granite and hard metamorphic rocks prevail, and where the natural drainage is imperfect, and the soil scanty and unproductive. The drier portions are covered with a profusion of ericaceous shrubs, &c., such as blue-berries (*Vaccinium Pennsylvanicum*), Labrador Tea (*Ledum latifolium*), Leather Leaf (*Cassandra calyculata*), Sheep Laurel (*Kalmia angustifolia*), *Rhodora Canadensis, &c.* In the swamps, and on mossy slopes, knee-deep with sphagnum, grow the Sweet Gale (*Myrica Gale*), Marsh Rosemary (*Andromeda polifolia*), Cranberries (*Vaccinium oxycoccus*), &c. The larger depressions are occupied by peat bogs, or lakes and ponds, with which such tracts are often studded. There is a striking resemblance in the aspect of these barrens, dotted as they are with numerous little sheets of water, and interspersed with belts and clumps of evergreen trees, to the open tracts in Newfoundland, so graphically described in your late Vice-President's paper on that island, and to the Laurentian region of Canada.

The arable lands along this coast are chiefly clay flats, usually covered with terraced beds of sand. The soil on the ridges is mostly gravelly, and here the forest growth is of Black and Yellow

Birch (*Betula lenta et excelsa*). Beech, Maple, and other forest trees of the interior are seldom or never seen. Beneath the shade of the evergreen growth on the clay flats we find the Tway blade (*Listera Cordata*), the Mitrewort (*Mitella Nuda*), the Rattlesnake plantain (*Goodyera repens*), the Dwarf orchis (*Platanthera obtusata*), the one-flowered Pyrola (*Moneses uniflora*), and other shade-loving plants.

We have seen that the prevalence of a moist climate and impervious soil, coupled with a low temperature, give rise to thick evergreen forests, peat-bogs and swamps saturated with moisture; and while producing, even during clear weather, great radiation of heat and moisture, these causes have contributed to encourage the growth of such northern plants as those above mentioned on the maritime slopes of our southern hills.

On the declension of this hill-country toward the plains of the interior, however, another set of agencies comes into play. It has been already intimated that the summer skies of the central districts are clearer than those of the coast, and the precipitation of moisture less profuse. In the valleys, among the more northerly ranges of the southern hills, much of the soil is loamy, and naturally well drained, as well as fertile. These rich loams are co-extensive with the lower coal formation in New Brunswick. They border the Lower Plain throughout, fill the valleys of the Kennebackasis and Petticodiac Rivers, form islands on it along its N. W. side, and re-appear in the valley of the Tobique among the northern hills. The fertility of other loams, such as those of the internal lands on the St. John River, and the upland tracts around Houlton and Woodstock on the Upper Plain, is evidenced by the growth of such species of plants as the Dwarf Ginseng or Ground Nut (*Aralia trifolia*), Closed Gentian (*Gentiani Andrewsii*), Showy Orchis (*Orchis Spectabilis*), Bass Wood (*Tilia Americana*), *Desmodium Canadense*, the two Osmorrhizas, Wild Ginger (*Asarum Canadense*), and Butternut (*Juglans cinerea*.)

Immediately north of us, but, as regards its flora, about 1,000 feet below, is the elevated plain of the Kennebackasis Bay, beyond which we may look down another 1000 feet, into the sunny valleys of Kings County. Over the Nerepis hills the great plain which occupies the central part of Acadia is visible, and far beyond it the plateau of Northern Acadia stretches away to its junction with the Notre Dame mountains; while to the

South-West our imaginary mountain top connects, by scattered peaks rising through the fogs of the Bay of Fundy, with a similar elevation in eastern Maine, whence it declines, and finally sinks beneath the waters of the Atlantic.

A Boreal or High Northern type of vegetation may be seen mingling with these Arctic forms, but also extending over many parts of Acadia, where they have not been found.

Of this character are the following:—

No. 2.—LIST OF BOREAL SPECIES.

Species.	North-eastern Coast of America.	Valley of St. Lawrence.	North-west Territory.	Southern Hills.	Lower Plain.	Northern Highlands.	Upper Plain.
Anemone parviflora	*	*	*	...	W*	...	N*
—— multifida	*	*	*	...	...	E*	...
Stellaria uliginosa (Swamp Chickweed	...	...	*	S'*	...	...	...
Parnassia palustris	*	*	*	...	W*	...	...
Astragalus alpinus (Phaca astragalina)	*	...	*	...	...	...	N*
——— Robbinsii	...	*	...	...	...	...	N*
Oxytropis campestris	...	...	*	...	W*	...	N*
Hedysarum boreale	...	*	*	...	...	...	N*
Geum macrophyllum (boreal)	*	*	...	S'*	...	...	...
Potentella tridentata (Mountain cinquefoil)	*	*	*	...	W*	*	N*
Ribes rubrum (Red Currant)	...	*	*	...	E'*	*	...
Sedum Rhodiola (Stone crop)	...	*	*	*	...	...	...
Saxifraga Aizoon (Saxifrage)	...	...	*	*	...	...	...
Nardosmia palmata (Sweet Coltsfoot)	...	*	*	*	E'*	*	...
Artemisia borealis (Wormwood)	...	*	*	*	...	...	N*
Aster graminifolius	...	*	*	*	...	...	E*
Tanacetum Huronense (Huronian Tansey)	...	*	*	...	W*	...	...
Vaccinium Canadense	...	*	*	*	E'*	...	...
Castilleia septentrionalis	...	...	*	...	E*	...	...
Primula farinosa	*	*	*	*	...	...	N*
Utricularia minor (Bladderwort)	...	*	*		E*	...	...
Rhinanthus Crista-galli (Yellow Rattle)	*	*	*	S'*	E*	...	...
Halenia deflexa (Spurred Gentian)	*	*	*	*	...	*	N*
Collomia linearis	...	...	*	...	...	*	...
Echinospermum Lappula	...	*	*	...	...	*	...
Shepherdia Canadensis	*	*	*	...	...	E*	N*
Rumex salicifolius (Dock)	*	...	*	S'*	...	..	...
Comandra livida (Bastard Toad-Flat)	*	*	*	*	...	...	...
Betula pumila	*	*	*	...	E*	...	...
Alnus viridis	*	*	*	*	E*	*	...
Populus balsamifera	*	*	*	...	E*	...	...
Pinus Banksiana	*	*	*	*	E*	...	S*
Platanthera hyperborea	*	*	*	*	...	...	...
Spiranthes latifolia (Ladies' tresses)	...	*	*	...	...	*	...
Calypso borealis	*	*	*	...	W*	...	...
Allium schœnoprasum	*	*	*	*	...	*	S*
Tofieldia glutinosa (False Ashpodele	*	*	*	...	E*	...	N*
Juncus filiformis (Thread Rush)	...	*	*	...	E*	...	...
——— Stygius	...	*	*	*	E*	...	...
Scirpus sylvaticus	...	*	...	*	E*	...	...
Eriophorum russeolum	*	*	*	*	E*	...	...
Carex lenticularis	...	*	*	*	E*	...	...
——— flexilis	*	*	*	*	E*	...	...
——— rostrata	*	*	*	*	E*	...	...
——— canescens, var. vitilis	...	*	...	S'*	...	...	...

List of Boreal Species—Continued.

Species,	North-eastern Coast of America.	Valley of St. Lawrence.	North-west Territory.	Southern Hills.	Lower Plain.	Northern Highlands.	Upper Plain.
Vilfa cuspidata	...	..	*	...	E*	...	N*
Festuca ovina, var. duriuscula	...	...	*	..	E*	...	...
Cinna arundinacea, var. pendula	...	*	*	*	...	...	...
Avena striata	...	*	*	S′*	E*	...	...
Elymus mollis	*	*	*	...	...	...	...
Woodsia hyperborea R. Br.	...	...	...	...	...	...	...
(Woodsia Ilvensis, var. alpina Watt)	...	*	*	*	...	*	...
Aspidium fragrans	*		*	...	...	*	..
Polygala pauciflora	..	*	*	...	W*	...	...
Artemisia Canadensis	...	*	*	...	...	...	N*
Nabalus racemosus	*	*	*	*	...	...	N*
Lobelia Kalmii	*	*	*	*	...	...	N*
Platanthera rotundifolia	*	...	*	*	...	...	...
Triticum caninum	...	*	*	S′*	E*	...	...
Pellæa gracilis	*	...	...	...	...	*	...

N.B.—The last seven species of this list have a range intermediate between this type and the succeeding one.

[Species marked S′ have been found at the seaside only in the southern hills. Those in second column marked W., occur on the St. John River, near the centre of New Brunswick. The remainder have been gathered near and on the Gulf Shore. S′ and N′ on the fourth column, designate respectively the southern and northern parts of the Upper Plain, including the Aroostook and St. John districts of Goodale. Species marked E′ in the third column grow in that part of the southern hills bordering the Bay of Chaleur.]

Mr. G. L. Goodale has the merit of first calling attention to the occurrence of this type of vegetation in Acadia. He says:—(2nd Report, p. 125.) "The country lying along the St. John, " from Boundary Branch to Grand Falls, is marked by the very " frequent occurrence of certain North-Western plants. And " the district comprised by the curved northern limit of Maine, " and a line drawn from Grand Falls to a point between Baker " Lake and Boundary Branch, will be found to be nearly the " range of these plants in our State. This district is so entirely " *distinct botanically from any other portion of Maine, that its* " limits can be said with confidence to be clearly defined. The " following list of plants may be considered as comprising the " most characteristic species of the St. Johns district:—

" Anemone parviflora.
" Astragalus alpinus.

" Astragalus sp. ign.
" Oxytropis " "
" Artemisia borealis.
" ——— Canadensis.
" Tanacetum Huronense.
" Vilfa Cuspidata."

He also instances *Astragalus Robbinsii*, *Hedysarum boreale*, *Nabalus racemosus*, *Primula Mistassinica*, *Solidago Virgaurea* var. *Alpina*, and *Tofieldia glutinosa*, as plants of the same district.

" The whole region through which these plants are distributed is covered by a thick growth of coniferous trees."

So little is known of the flora of the northern counties of New Brunswick, with the single exception of Kent, that we know of the occurrence of but a limited number of these species on the streams flowing to the Gulf, but nevertheless feel satisfied that the majority of them will yet be gathered there. The late Dr. Robb met with Anemone Multifida on the Restigouche, and Shepherdia Canadensis at Grand Falls, on the St. John River. The last named species has also been gathered near Dalhousie. Mr. Fowler has collected in the Gulf Counties *Vaccinium Canadense* and *Nardosmia palmata* (common), the rare *Juncus Stygius*, *Carex lenticularis*, *Cinna arundinacea* var. *pendula*, *Triticum caninum*, and *Elymus Mollis*. Prof. Bailey observed Allium Schænoprasum during his descent of the Nepissiquit.

Some of these, as well as the remaining species of the list (except about half a dozen species still known only on the Upper St. John,) have been gathered in the southern highlands.

Near the outlet of the St. John River is a sheet of water, known as the Kennebackasis Bay, which is as deep as Behrings Straits, and deeper than those which divide France from England. Here the yachtsman may sail for 20 miles without starting sheet, and the lover of the picturesque will see several cliffs and bold hills 400—600 feet high rising from the water's edge. Here also he will find the presence of man indicated by sawmills, factories, shipyards, broad cultivated fields, and scattered villages, whither the citizens of St. John resort in summer, not to avoid the heat, but to escape the fog.

In this basin the spring floods of the St. John River, unable to find free egress to the ocean, are pent up until the middle of

June, exerting their chilling influence on the surrounding air. Even in midsummer, should a bather more venturesome than his fellows swim out of the shallow coves which line the shore, he will soon find his limbs stiffened by the refrigerating power of these profound waters.

As there are here the conditions favorable to the growth of northern forms of vegetation, it will not excite surprise that the boreal type of Northern Acadia should re-appear around this Bay. Its shores have as yet received only an occasional summer glance from the botanist, and therefore the discovery of many more northern forms will probably reward the search of a diligent explorer. Among the species thus far recognized I may instance a stone-crop or live-for-ever (*Sedum Rhodiola*), a Saxifrage (*Saxifraga Aizoon*), and the fern *Woodsia hyperborea R. Br.*, which Mr. D. A. P. Watt regards as a northern variety of *Woodsia Ilvensis*,* as common on the perpendicular cliffs near Rothsay. The first-named species was gathered many years ago on Cape Blomiden, N.S., by Dr. Robb, and, strange to say, has recently been found on the cliffs of Delaware River, Pennsylvania. On the rocky ledges and gravelly beaches around Kennebackasis Bay flourish the American primroses (*Primula farinosa* and *Primula Mistassinica*). the first named in great abundance; also the Wild Chive (*Allium Schœnoprasum*), a small *Aster graminifolius*, and Hooker's *Nabalus racemosus*. The Northern Green Orchis (*Habenaria Hyperborea*) is also sparingly met with. But the most conspicuous plant is the Northern Scrub Pine (*Pinus Banksiana*), which here attains gigantic dimensions, one individual noticed rising to the height of more than 45 feet, with a girth of 6½ feet. This tree, in its elm-like habit of growth, is in striking contrast with all the other evergreens around. At the end of May the numerous pyramidal erect spikes of flowers give it the aspect of a chandelier studded with yellow wax-lights. In Acadia it has an extensive range, for it is not only abundant throughout the Gulf districts, whence it spreads over to Grand Lake and the Petticodiac River, but Goodale also met with it in Northern Maine, where, however, it is scarce.

Around the shores on the upper part of Kennebeckasis Bay, where the waters are shallow, species of a more southern type grow, such as the Nodding Wake Robin (*Trillium cernuum*),

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* Woodsia Ilvensis var. Alpina, Watt.

the Yellow Violet (*Viola pubescens*,) and the two Anemones (*A. nemorosa* and *A. Pennsylvanica*.) The shrubby cinquefoil (*Potentilla fruticosa*) also is very abundant.

There are two other positions in which the species of this type are found in Southern New Brunswick. One, beneath the cool shade of evergreen trees which cover the abrupt hills between this Bay and the sea coast. On the mossy slopes under these trees the sweet Coltsfoot (*Nardosmia palmata*) opens its flowers in early spring; and the Round-leaved Orchis (*Habenaria rotundifolia*) may be found in bloom at a later period. Kalm's Lobelia (*L. Kalmii*) and the spurred gentian (*Halenia deflexa*) intermingled with other Sub-Arctic forms, abound in the open pastures. Other species, such as the swamp chickweed (*Stellaria uliginosa*), for which, like *Sedum Rhodiola*, a station in Pennsylvania is known; the large-leaved Geum (*G. macrophyllum*), and the willow-leaved dock, (*Rumex salicifolius*) have been found at the sea-side, on the borders of salt marshes, near St. John.

Looking at the known range of this type throughout Acadia, we may fairly suppose that the whole of its northern continental portion will be characterized by the presence of the foregoing and other boreal forms; and that these may also be looked for around the whole southern height of the Gulf of St. Lawrence. In Insular Acadia it probably usurps Prince Edward's Island, mantles over the hills of northern Nova Scotia, and in Cape Breton blends with the Sub-Arctic flora of the Atlantic coast.

In the interior of Continental Acadia there is a large area overspread by a group of plants of a more southern type than those we have been considering. West of the Alleghanies they range as far south as New York, Ohio, and the south-west part of the Province of Ontario. Many of them, however, cross the Appalachian range, and are found more or less abundantly in West New England. The valley of the Connecticut River generally limits their range eastward.

This is essentially the type which G. L. Goodale looks upon as characteristic of the Aroostook country. He says:—

"This second region, which we can distinguish as the 'Aroos-" took district,' is characterized by the occurrence of a different " flora. Instead of conifers, we find a prevalence of hard-" wood trees. Maples, Beeches, Oaks and Amentaceæ form the " forests. Under such trees we see flourishing Dicentras,

" Claytonias, Adlumia, *Aralia Quinquefolia*, *Solidago odora;*
" on the shores of the rivers and their tributaries *Lobelia*
" *Kalmii*, *Anemone Pennsylvanica*, and two species of Vitis,
" *Vitis labrusca* and *V. cordifolia*."

In the following list of Western or Continental species will be found some of those above mentioned; but the range of others is such as to exclude them from this eastern fragment of a flora, which finds its home west of the Green Mountains of New England:—

No. 3.—LIST OF CONTINENTAL SPECIES.

SPECIES.	Upper Plain.	Lower Plain.	Valleys of the Southern Hills.
Dicentra Canadensis - - -	S*	....	....
Adlumia cirrhosa - - -	S*	....	....
Nasturtium palustre var. hispidum	....	....	*
Lathyrus palustris var. myrtifolius	....	....	*
Œnothera chrysantha - - -	....	E*	....
Hippuris vulgaris - - -	....	....	*
Artemisia biennis - - - -	....	E*	....
Blitum capitatum - - -	....	W*	....
Listera convallarioides - - -	....	E*	*
Carex Richardsonii - - -	....	E*	*
——— cylindrica - - - -	....	E*	....
Anemone Pennsylvanica - -	S*	W*	*
Claytonia Caroliniana - - -	....	W*	*
Conioselinum Canadense - -	S*	....	....
Aralia quinquefolia - - - -	S*	W*	*
Pogonia verticillata - - -	S*	....	....

Goodale's remarks on the vegetation of the Arostook country apply signally well to the valley of the main St. John River from Eel River to the southern hills; and represent with almost equal fidelity the aspect of the western and central part of the Acadian Plain, where the soil is deep and drainage good. In approaching the Gulf this type of vegetation gives place to a collection of species having a more northerly range. In the valleys of the southern highlands, in King's County, it mingles with the New England flora prevalent to the S.W., of which several species appear to be rare or wanting along that part of the Acadian Plain facing the Gulf of St. Lawrence.

V. *Maritime Type.*—The extensive and varied sea coast pertaining to the Lower Provinces affords ample scope for the growth of maritime plants. On the North Shore, Mr. Fowler has met with more than 30 species, as may be seen by the following list, and most of them, with a few additional forms, occur also on the shore of the Bay of Fundy.

No examination, so far as I am aware, has yet been made of the salt springs in this and the neighboring province of Nova Scotia, for maritime plants. Perhaps a few of the species which once grew around these springs, when they were at the margin of the sea, may yet linger there. *Ranunculus Cymbalaria* was collected at Fredericton by the late Dr. Robb, as appears from a specimen in the Herbarium of the University of that city, which is now distant 80 miles from the salt water.

No. 4.—LIST OF MARITIME SPECIES.

SPECIES.	Gulf of St. Lawrence.	Bay of Fundy.
Ranunculus Cymbalaria	*	*
Hudsonia tomentosa	*	....
Lechea thymifolia	*	....
Honkenya peploides	....	*
Spergularia rubra var. marina	*	*
Lathyrus maritimus	*	*
Ligusticum Scoticum	*	....
Aster Radula	*	*
Solidago sempervirens	*	*
Plantago maritima	*	*
Statice Limonium var. Carolinianum	*	*
Glaux maritima	*	*
Mertensia maritima	*	*
Atriplex hastata	*	*
Salicornia herbacea	*	*
——— mucronata	....	*
Obione arenaria	*	....
Chenopodina maritima	*	*
Salsola Kali	*	*
Polygonum aviculare var. littorale	*	
Myrica cerifera	*	....
Triglochin Palustre	*	*
——— maritimum	*	*
Ruppia maritima	*	....
Juncus bulbosus	*	*
——— Balticus	*	....
——— Greenii	*	
Eleocharis pygmœa	*	*
Scirpus maritimus	*	*
Carex maritimus	*	*
——— salina	*	*
Calamagrostis arenaria	*	*
Spartina juncea	*	*
——— stricta var. glabra	*	....
Glyceria maritima	*	*
Hordeum jubatum	*	*
Asplenium marinum*	......	......

* This species is accredited to New Brunswick in Hooker's Flor. Bor. Am.

Ranunculus Cymbalaria, as above stated, has been gathered at Fredericton. But I am not aware of the existence of any others of the list inland, except the sub-maritime *Aster Radula* and *Atriplex hastata*.

In concluding this division of the subject, it may be added, that our present knowledge of Acadian botany would lead us to suppose that the *Continental* type, besides occupying the southern half of the Plateau of Continental Acadia, also spreads throughout the valley of the St. John, and its tributaries, to the heart of the Southern Hills, and reappears in the valley of the S. W. Miramichi. That the *Boreal* type lies around it to the north-east, and to the south-east, as far as the outlet of the St. John River. Here it mingles with the few sub-Arctic species which still hold their ground along this coast, and in like manner flourishes in company with these same species, on the low points of land jutting into the Gulf of St. Lawrence. The *sub-Arctic* species form, as it were, a fringe to the general vegetation of the country skirting the shores of the Gulf of St. Lawrence and the Bay of Fundy. The occurrence of an Alpine group in the northern highlands seems as yet scarcely established, since, on the highest of those hills, Prof. Bailey met with but one species which could be referred to this type, viz., *Vaccinium uliginosum*. The *New England* type is widely spread throughout Acadia, but appears to be more especially prevalent in the south-western counties. Several species, such as the Blue-bell (*Campanula rotundifolia*), and Hemlock (*Abies Canadensis*), are reported by Mr. Fowler as scarce or wanting on the "North Shore;" and the Cedar (*Thuja Occidentalis*) appears to be a rare tree in Nova Scotia, and even entirely wanting in most parts of that Province.

Special Causes which have Operated upon the Distribution of Plants in Acadia.

Beside two agents, Winds and Migratory Birds, which have had a world-wide influence in spreading vegetation from one region to another, there is a third which, from the important part it has played in modifying the flora of Acadia, deserves special attention. This is the floating ice, and drift-wood of the Polar Current, and of the St. John River.

To form any conception of the vegetation which covered Acadia in early times, we must fall back upon the researches of Geology. As regards its modern botanical aspect, the history of Acadia begins with the Champlain epoch. The clay beds of this period, which cover wide areas in Southern New Brunswick, have yielded no determinable remains of plants, except sea-weeds, which appear to belong chiefly to the Rhodosperms and Chlorosperms, and are of common occurrence in connection with fine clays near the coast. Thus we are left to infer the character of the vegetation from the climatic conditions indicated by the presence of Arctic and sub-Arctic animals in the Acadian seas at the Champlain epoch, and to the known flora of this period in Canada. At Green's Creek, on the Ottawa River, the deposits of this age contain concretions which have gathered around organic remains, such as sea-shells. fishes and bones of the seal. Many of them also contain the remains of land-plants. Dr. Dawson, to whom these relics were submitted for examination, detected the following species of plants: the Norway Cinquefoil (*Potentilla Norvegica*), the Mountain Cinquefoil (*P. tridentata*), the Balm of Gilead (*Populus balsamifera*), the Bear Berry (*Arctostaphylos Uva ursi*), the White Clover (*Trifolium repens*), the Round-Leaved Sundew (*Drosera rotundifolia*), and two kinds of Pondweed (*Potamogeton natans*), and (*P. perfoliatum.*) Such a group of plants would find a congenial home in that part of Acadia now occupied by the sub-Alpine type of vegetation. Indeed, with the exception of the Bear Berry, they are all known denizens of that part of Acadia laved by the Arctic current. It may be perceived, then, that to reproduce the climatic conditions of the Champlain epoch, it is only necessary to submerge the St. Lawrence valley, and the plains east of the Appalachian range, and admit the Arctic current to sweep freely over these submerged lands. That such was the state of the southern half of Continental Acadia during a great part of the age in question there can be no doubt, the Southern Hills alone standing above the icy current, which swept by on either side. With such physical conditions universally prevalent in this region, the Arctic and sub-Arctic must have been the predominant type of vegetation. As the plains began to emerge during the succeeding Terrace Period, which was one of upheaval, no doubt many Boreal forms were added to those already present in the country.

These additions were largely influenced by the constant play of the Arctic current upon our shores. It acted as a circumpolar distributor of species, and to it the wide range of many Arctic and Boreal plants is evidently due. Entering the Polar Sea between Norway and Spitzbergen, it sweeps round the ice-bound shores of the Old World by Russia and Siberia. An insignificant branch escapes into the Pacific by Behring's Straits, but the main body of the current continues its course through the Georgian Archipelago, and passes into the Atlantic again between Greenland and Labrador. The retarded rotation of the earth throws this current, when entering the Polar Sea, upon the coast of the Old World; the accelerated rotation felt by the same moving mass of water on its southward course causes it to cling to the shores of America from Labrador to Florida, and envelope the eastern part of the British Possessions, which are fully exposed to its chilling influence. The principal body of the current passes southward around Newfoundland, but a branch goes westward between this island and Labrador, through the Straits of Belleisle, and courses around the Gulf of St. Lawrence, as has been already stated.

It is the transporting power of this current as a whole, and of this branch, in particular, which has more directly influenced the vegetation of our country.

Three of the largest rivers in the Old World, and an equal number of those in the New, help to freshen the waters of this great oceanic stream. The Spring floods of the great Siberian water-courses sweep down into it vast quantities of drift-wood and debris filled with the seeds of plants. Many of these are carried onward in the floe-ice toward the American coast, where they receive accessions from the McKenzie River, and in the course of years work their way through the group of islands between North America and Greenland. The Saskatchewan River also contributes its quota of organic relics to the burden borne on the bosom of the Polar current from the Arctic regions of the three continents. The peculiarity of all these great water courses is, that their sources are in temperate latitudes, while their embouchures are in Arctic or Sub-Arctic regions, and thus the waste of vegetation which they bear downward toward the sea, when they are swollen by melting snows, is cast upon the ice about their mouths. The seeds of plants flourishing in the regions from which these rivers flow might thus very readily be transported in the course of time, upon floe-ice and drift-wood, to the north-eastern parts of America.

Accordingly we find little difficulty in tracing back the course of the Boreal and Arctic types north-westward across the Continent of America, toward Asia. Attached to the table of Boreal forms are three columns shewing the range of the species to the N.W., compiled from the late Sir W. J. Hooker's Flora Boreali Americana, Dr. Gray's Flora of the Northern United States (1859), and a list of the plants collected at Anticosti by Prof. A. E Verrill. Labrador and Newfoundland are bleak, inhospitable countries, whose flora is but imperfectly known; yet of the three score species of this list, more than one-half have been gathered there. In the St. Lawrence Valley, chiefly in that part of it below the great Lakes and around Lakes Huron and Superior, more than two-thirds of the list of Boreal species occur;—many of these being only known in the far western parts of the Valley about Lakes Superior and Huron, or on the mountain tops of New England and New York. The presence of these species in Acadia is easily accounted for when it is considered that there is a continuous water communication from the great lakes of the interior to the northern confines of Acadia. But it is more remarkable, if we fail to give due weight to the transporting powers of the Polar Current, that all the high Northern forms, with half a dozen exceptions, should be already known as indigenous to the North West Territory, between Red River, the Arctic Sea, and the Rocky Mountains. Moreover, there are three species which, if one may judge from the authorities above quoted, are not known to occur in the interspace between this region and Acadia, or to the N.E. of the latter. These are *Collomia linearis*, discovered by Mr. Fowler on the Gulf coast; *Vilfa cuspidata*, found by Mr. Goodale on the Upper St. John, and *Oxytropis campestris*, gathered by Prof. Baily on the Main St. John. This list of adventurous emigrants from the N.W. would be largely increased were we to include species which occur in the intervening country only on the mountain tops of New England and New York.

The River St. John appears also to have played an important part in distributing plants throughout Acadia, and a few remarks on its peculiarites may, therefore, not be out of place. This is one of the most considerable of the numerous rivers which take their rise in the Appalachian range, and about one-half of

Continental Acadia is included within the limits of its basin. A connection with the sea, as singular as that of the St. John, is to be found in few rivers (if any) of equal size, on the globe.

The outlet of this river at the "Falls" (or, more correctly speaking, Rapids), is a narrow and tortuous channel, bordered by cliffs and obstructed by rocky ledges. Over this barrier, as is well known, there is a flux and reflux of the tide twice a day; but as the tidal wave must rise fifteen feet or more before it can overcome this impediment, its influence on the river above is comparatively trifling, the water within the barrier not rising more than 2½ feet, while at high tide the level of the water in the harbour is about 13 feet above that of the river at its summer level.

It is not so generally known, however, that during the spring floods the quantity of water poured into the St. John's River, through its various tributaries, is such as to exclude any influx from the sea. At this season of the year the contracted entrance to the river, which at other seasons excludes the rushing tides of the Bay of Fundy (preventing the formation of mud flats, a striking feature in the estuaries of rivers further up the Bay), also impedes the discharge of the spring floods.

These pent up waters are then compelled to spread themselves over the lowlands of the valley of the river, and such affluents as the Kennebeckasis, Nerepis, Washademoack, Belleisle, Grand Lake and the Oromocto. Two extensive, though very irregularly shaped, lakes are thus formed,—the lower one extending, in the form of an oxbow, down the valley of the Kennebeckasis, around Grand Bay, and up the "Long Reach" and Belleisle Bay; the upper one embracing a large area, beginning at the lower end of Long Island, and extending upwards over the low lands lying around the Washadmeoack River, Grand Maquapit, and French Lakes, and all the interval lands between Gagetown and the Oromocto—submerging also the lands on each side of this river for many miles up. The area of the lake-like expansions of the St. John River, which lie partly among the southern hills, and partly to the northward of them, cannot fall far short of 600 square miles.

During the summer and autumn these extensive sheets of water, which ramify through the southern part of the Province at the opening of navigation on the river, have shrunken to very limited proportions, being represented chiefly by the waters of

Grand Lake, on the one hand, and those of Grand and Kennebeckasis Bay, on the other.

As the excess of water in the southern tributaries, viz., the Kennebeckasis, Nerepis and Belleisle Rivers, has, to a great extent, been discharged before the "freshet" of the main river rises, the great rush of water down from it causes a reflux into the above mentioned rivers, which second overflow is known on the Kennebeckasis as the "back freshet." This large body of cold water, which does not subside before the first week in June, undoubtedly retards very much the development of vegetation on the lower part of the St. John River. About two weeks after the ice in this part of the river has been discharged into the Bay, that from the upper part (above the Grand Falls) makes its appearance in the harbor, and is distinguished not only by the great quantity of drift-wood and freshet debris which accompany it, but also by its clearness and solidity (hence called the "block ice.") It frequently happens that this second run of ice does not pass the falls, but southerly winds hold it in the still waters above until it becomes liquified by the increasing heat of spring. When this happens the debris and vegetable matter, brought down from the head waters of the St. John, are thus scattered over the shores of Kennebeckasis Bay and the "Long Reach," and the seeds of species once peculiar to the upper part, have by this means been distributed along the lower part of the river.

These annual freshets and their concomitants have undoubtedly effected much in the distribution of species over areas in Central and Southern New Brunswick, which they could only have reached otherwise by slow degrees. It is in this way that I would account for the abundance of many species below the freshet mark on Kennebeckasis Bay, which have not been met with on the surrounding hills, but are common in the interior of the Province. Moreover, there are several species, which are noted by Mr. Goodale, as being very abundant on the Upper St. John (above Grand Falls), which are also met with on the shores of the Kennebeckasis, such as *Nabalus racemosus*, a plant decidedly north-western in its range, the two Primroses, *Primula farinosa*, and *P. mistassinica*, which grow in several places along the shore; the latter with its beds of beautiful pale rose-colored flowers tinting the gravelly beaches of Drury's Cove. To these we may perhaps add the Northern Green Orchis (*Platanthera hyperborea*), and the wild Chive (*Allium schœno-*

prasum), the latter being frequently met with on rocky and gravelly shores; also *Aster graminifolius*, *Anemone Pennsylvanica*, a very showy plant, with large white flowers, *Nasturtium palustre*, var. hispidum, *Parnassia palustris*, the White Silver Maple (*Acer dasycarpum*), the Dwarf Cherry (*Prunus pumila*), the Black Alder (*Ilex verticillata*), one of the Loosestrifes (*Lysimachia ciliata*), the Bracted Bindweed (*Calystegia sepium*), more commonly called Convolvulus, whose delicate white flowers, tinged with pink, present a beautiful contrast to the labyrinth of foliage with which they are entwined; also the Water Persicaria (*Polygonum amphibium*), the Canadian Wood Nettle (*Laportea Canadensis*), *Sparganium racemosum*, and the Canadian Lily (*Lilium Canadense*). Another plant, the "Sweet Coltsfoot," (*Nardosmia Palmata*), if not introduced by birds, probably immigrated at a much earlier period (the Post-Pliocene), as it grows far above the present level of the river.

While many North-Western and Western species have, by the spring floods of the river, or other means, been thrust into the group of species which characterize the coastal zone, others have been held at bay on the St. John River by the cool temperature and damp atmosphere, which prevail near its mouth during the summer months.

From the observations presented in the foregoing pages, the following conclusions may be drawn:—1st, One of the most peculiar features in the flora of the region to which these remarks relate, is the arrangement of several of the types mentioned, in zones around a central tract, due to the refrigerating influence of cold waters on the adjacent seas. 2d, That although there are highlands of considerable elevation in Acadia, they do not appear to exercise a very marked influence on the vegetation, except in so far as they act as a barrier to the oceanic winds. 3rd, That on account of its semi-insular position, and its full exposure to the chilling effect of the Arctic current, the maritime parts of this country have become the home of northern species not found within the limits of New England, and of many others which grow only on mountain tops, or cold, sheltered places, in that part of the United States. 4th, That although the sea-coast of Acadia is thus inhospitable, the interior has a summer climate so warm as to encourage the growth of a group of plants, which the damps and chill winds of the same season exclude from New England; such species being either entirely absent from that region, or found only sparingly in its warmer western and southern parts.

Judging from what is known of the flora of our country, as compared with that of the Upper Provinces, we may look upon the narrow girdle of sub-Arctic vegetation, which borders our shores, as paralleled by that which extends up the St. Lawrence River as far as the Island of Orleans, and reappears on the north shore of Lake Superior. The Boreal type, which is supposed to cover much of the northern part of Acadia, reappears on the St. Lawrence at and above Quebec, and is also met with around the shores of Lake Huron, and in the northern peninsula of Michigan. The group of plants which has been referred to as a Continental type, characterizes the country around Lake Ontario. Hence, we may look upon the central parts of Acadia as represented in climate and productions by that part of Ontario which lies around the eastern and northern shore of the lake of that name, and extends thence to Lake Huron.

There is an assemblage of plants in the S. W. part of Ontario, which Mr. Drummond designates as the Erie type, and which is said to characterize the region around that most southerly of the great Lakes. Of this type we have, so far as known, no representatives in Acadia. We may assume, therefore, that there is no portion of Continental Acadia, possessing a summer as warm and dry as prevails in the more southerly part of Canada, around Lake Erie. But while a comparison of the climate of Acadia with that of the Upper Provinces may thus be instituted, through the indigenous plants which grow in different parts of the Dominion, it is to be borne in mind that such a comparison relates only to the temperature and other climatic conditions of the summer. In the winter the climate of the maritime Provinces is very much milder; so that, while the valley of the St. Lawrence may be filled with snows to the depth of six feet or more, the southern shores of Nova Scotia may be but sparsely covered, or entirely bare.

Finally, from the known climatic conditions of Insular Acadia, the character of the vegetation, in its different parts, may be roughly predicated. Thus, the fog-wrapt shores along the Atlantic coast are known to support a vegetation similar to that of the southern shores of New Brunswick and Eastern Maine. Further, the Boreal type probably extends along the northern shore of Nova Scotia into the Island of Cape Breton, and may be expected to mingle to some extent with the sub-Arctic type along the Atlantic coast. The Boreal type may be looked for in force on Prince Edward's Island, fringed, as in New Brunswick, by sub-Arctic forms near the shores. In the central and north-western part of Nova Scotia, a partial recurrence of the Continental type may be looked for; but owing to the moister summers, and nearer proximity to the sea, it is probably more largely mingled with New England forms than it is in the valley of the St. John.

ON THE PROBABLE SEAT OF VOLCANIC ACTION.

By T. Sterry Hunt, LL.D., F.R.S.

The igneous theory of the earth's crust, which supposes it to have been at one time a fused mass, and to still retain in its interior a great degree of heat, is now generally admitted. In order to explain the origin of eruptive rocks, the phenomena of volcanos, and the movements of the earth's crust, all of which are conceived by geologists to depend upon the internal heat of the earth, three principal hypotheses have been put forward. Of these the first supposes that in the cooling of the globe a solid crust of no great thickness was formed, which rests upon the still uncongealed nucleus. The second hypothesis, maintained by Hopkins and by Poulett Scrope, supposes solidification to have commenced at the centre of the liquid globe, and to have advanced towards the circumference. Before the last portions became solidified, there was produced, it is conceived, a condition of imperfect liquidity, preventing the sinking of the cooled and heavier particles, and giving rise to a superficial crust, from which solidification would proceed downwards. There would thus be enclosed, between the inner and outer solid parts, a portion of uncongealed matter, which, according to Hopkins, may be supposed still to retain its liquid condition, and to be the seat of volcanic action, whether existing in isolated reservoirs or subterranean lakes; or whether, as suggested by Scrope, forming a continuous sheet surrounding the solid nucleus, whose existence is thus conciliated with the evident facts of a flexible crust, and of liquid ignited matters beneath.

Hopkins, in the discussion of this question, insisted upon the fact, established by his experiments, that pressure favors the solidification of matters which, like rocks, pass in melting to a less dense condition, and hence concludes that the pressure existing at great depths must have induced solidification of the molten mass at a temperature at which, under a less pressure, it would have remained liquid. Mr. Scrope has followed this up by the ingenious suggestion that the great pressure upon parts of the solid igneous mass may become relaxed from the effect of local movements of the earth's crust, causing portions of the solidified matter to pass immediately into the liquid state, thus giving rise to eruptive rocks in regions where all before was solid.*

Similar views have been put forward in a note by Rev. O. Fisher, and in an essay on the formation of mountain chains, by Mr. N. S. Shaler, in the proceedings of the Boston Society of Natural History, both of which appear in the *Geological Magazine* for November last. As summed up by Mr. Shaler, the second hypothesis supposes that the earth "consists of an immense solid nucleus, a hardened outer crust, and an intermediate region of comparatively slight depth, in an imperfect state of igneous fusion." In this connection it is curious to remark that, as pointed out by Mr. J. Clifton Ward, in the same Magazine for December (page 581), Halley was led, from the study of terrestrial magnetism, to a similar hypothesis. He supposed the existence of two magnetic poles situated in the earth's outer crust, and two others in an interior mass, separated from the solid envelope by a fluid medium, and revolving, by a very small degree, slower than the outer crust.† The same conclusion was subsequently adopted by Hansteen.

The formation of a solid layer at the surface of the viscid and nearly congealed mass of the cooling globe, as supposed by the advocates of the second hypothesis, is readily admissible. That this process should commence when the remaining envelope of

* See Scrope on Volcanos, and his communication to the *Geological Magazine* for Dec., 1868.

† The elevated temperature of the interior of the globe would probably offer no obstacle to the development of magnetism. In a recent experiment of M. Trève, communicated by M. Faye to the French Academy of Sciences, it was found that molten cast iron when poured into a mould, surrounded by a helix which was traversed by an electric current, became a strong magnet when liquid at a temperature of 1300° C., and retained its magnetism while cooling (Comptes Rendus de l'Acad. des Sciences, Feb., 1869.)

liquid was yet so deep that the refrigeration from that time to the present has not been sufficient for its entire solidification, is, however, not so probable. Such a crust on the cooling superficial layer would, from the contraction consequent on the further refrigeration of the liquid stratum beneath, become more or less depressed and corrugated, so that there would probably result, as I have elsewhere said, "an irregular diversified surface from the contraction of the congealing mass, which at last formed a liquid bath of no great depth, surrounding the solid nucleus." Geological phenomena do not, however, in my opinion, afford any evidence of the existence of yet unsolidified portions of the originally liquid material, but are more simply explained by the third hypothesis. This, like the last, supposes the existence of a solid nucleus, and of an outer crust, with an interposed layer of partially fluid matter, which is not, however, a still unsolidified portion of the once liquid globe, but consists of the outer part of the congealed primitive mass, disintegrated and modified by chemical and mechanical agencies, impregnated with water, and in a state of igneo-aqueous fusion.

The history of this view forms an interesting chapter in geology. As remarked by Humboldt, a notion that volcanic phenomena have their seat in the sedimentary formations, and are dependent on the combustion of organic substances, belongs to the infancy of geology. To this period belong the theories of Lémery and Breislak (*Cosmos*, v. 443; Otte's translation). Keferstein in his *Naturgeschichte des Erdkörpers*, published in 1834, maintained that all crystalline non-stratified rocks, from granite to lava, are products of the transformation of sedimentary strata, in part very recent, and that there is no well-defined line to be drawn between Neptunian and volcanic rocks, since they pass into each other. Volcanic phenomena, according to him, have their origin not in an igneous fluid centre, nor in an oxydizing metallic nucleus (Davy, Daubeny), but in known sedimentary formations, where they are the result of a peculiar kind of fermentation, which crystallizes and arranges in new forms the elements of the sedimentary strata, with an evolution of heat as a result of the chemical process (*Naturgeschichte*, vol. i. p. 109; also *Bull. Soc. Geol. de France* [1], vol. vii. p. 197). In commenting upon these views (*Am. Jour. Science*, July, 1860), I have remarked that, by ignoring the incandescent nucleus as a source of heat, Keferstein has excluded the true exciting cause of the chemical changes which take place in the buried sediments. The notion of a subterranean combustion or fermentation, as a source of heat, is to be rejected as irrational.

A view identical with that of Keferstein, as to the seat of volcanic phenomena, was soon after put forth by Sir John Herschel, in a letter to Sir Charles Lyell, in 1836 (*Proc. Geol. Soc. London*, ii. 548.) Starting from the suggestion of Scrope and Babbage, that the isothermal horizons in the earth's crust must rise as a consequence of the accumulation of sediments, he insisted that deeply buried strata will thus become crystallized by heat, and may eventually, with their included water, be raised to the melting point, by which process gases would be generated, and earthquakes and volcanic eruptions follow. At the same time the mechanical disturbance of the equilibrium of pressure, consequent upon a transfer of sediments, while the yielding surface reposes on matters partly liquified, will explain the movements of elevation and subsidence of the earth's crust. Herschel was probably ignorant of the extent to which his views had been anticipated by Keferstein; and the suggestions of the one and the other seemed to have passed unnoticed by geologists until, in March, 1858, I reproduced them in a paper read before the Canadian Institute (Toronto,) being at that time acquainted with Herschel's letter, but not having met with the writings of Keferstein. I there considered the reaction which would take place under the influence of a high temperature in sediments permeated with water, and containing, besides silicious and aluminous matter, carbonates, sulphates, chlorids, and carbonaceous substances. From these, it was shown, might be produced all the gaseous emanations of volcanic districts, while from aqueo-igneous fusion of the various admixtures might result the great variety of eruptive rocks. To quote the words of my paper just referred to: "We conceive that the earth's solid crust of anhydrous and primitive igneous rock is everywhere deeply concealed beneath its own ruins, which form a great mass of sedimentary strata, permeated by water. As heat from beneath invades these sediments, it produces in them that change which constitutes normal metamorphism. These rocks, at a sufficient depth, are necessarily in a state of igneo-aqueous fusion; and in the event of fracture in the overlying strata, may rise among them, taking the form of to eruptive rocks. When the nature of the sediments is such as generate great amounts of elastic fluids by their fusion, earthquakes and volcanic eruptions may result, and these—other things being equal—will be most likely to occur under the more recent formations." (*Canadian Journal*, May, 1858, vol. iii. p. 207.)

The same views are insisted upon in a paper "On some Points in Chemical Geology" (Quart. Jour. Geol. Soc., London, Nov. 1859, vol. xv. page 594,) and have since been repeatedly put forward by me, with farther explanations as to what I have designated above, *the ruins of the crust of anhydrous and primitive igneous rock.* This, it is conceived, must, by contraction in cooling, have become porous and permeable, for a considerable depth, to the waters afterwards precipitated upon its surface. In this way it was prepared alike for mechanical disintegration, and for the chemical action of the acids, which, as shown in the two papers just referred to, must have been present in the air and the waters of the time. It is, moreover, not improbable that a yet unsolidified sheet of molten matter may then have existed beneath the earth's crust, and may have intervened in the volcanic phenomena of that early period, contributing, by its extravasation, to swell the vast amount of mineral matter then brought within aqueous and atmospheric influences. The earth, air, and water thus made to react upon each other, constitute the first matter from which, by mechanical and chemical transformations, the whole mineral world known to us has been produced.

It is the lower portions of this great disintegrated and water-impregnated mass which form, according to the present hypothesis, the semi-liquid layer supposed to intervene between the outer solid crust and the inner solid and anhydrous nucleus. In order to obtain a correct notion of the condition of this mass, both in earlier and later times, two points must be especially considered, the relation of temperature to depth, and that of solubility to pressure. It being conceded that the increase of temperature in descending in the earth's crust is due to the transmission and escape of heat from the interior, Mr. Hopkins showed mathematically that there exists a constant proportion between the effect of internal heat at the surface and the rate at which the temperature increases in descending. Thus, at the present time, while the mean temperature at the earth's surface is augmented only about one-twentieth of a degree Fahrenheit, by the escape of heat from below, the increase is to be found to be equal to about one degree for each sixty feet in depth. If, however, we go back to a period in the history of our globe when the heat passing upwards through its crust was sufficient to raise the superficial temperature twenty times as much as at present, that is to say, one degree of Fahrenheit, the augmentation of heat in descending would be twenty times as great as now, or one degree for each three feet in depth (Geol. Journal, viii. 59.) The conclusion is inevitable that a condition of things must have existed during long periods in the history of the cooling globe when the accumulation of comparatively thin layers of sediment would have been sufficient to give rise to all the phenomena of metamorphism, vulcanicity, and movements of the crust, whose origin Herschel has so well explained.

Coming, in the next place, to consider the influence of pressure upon the buried materials derived from the mechanical and chemical disintegration of the primitive crust, we find that by the presence of heated water throughout them, they are placed under conditions very unlike those of the original cooling mass. While pressure raises the fusing point of such bodies as expand in passing into the liquid state. it depresses that point for those which, like ice, contract in becoming liquid. The same principle extends to that liquefaction which constitutes solution; where, as is with few exceptions the case, the process is attended with condensation or diminution of volume, pressure will, as shewn by the experiments of Sorby, augment the solvent power of the liquid.* Under the influence of the elevated temperature, and the great pressure which prevail at considerable depths, sediments should, therefore, by the effect of the water which they contain, acquire a certain degree of liquidity, rendering not improbable the suggestion of Scheerer, that the presence of five or ten per cent. of water may suffice, at temperatures approaching redness, to give to a granitic mass a liquidity partaking at once of the character of an igneous and an aqueous fusion. The studies by Mr. Sorby of the cavities in crystals have led him to conclude that the constituents of granitic and trachytic rocks have crystallized in the presence of liquid water, under great pressure, at temperatures not above redness, and consequently very far below that required for simple igneous fusion. The intervention of water in giving liquidity to lavas, has,

* Sorby, Bakerian Lecture, Royal Society, 1863.

in fact, long been taught by Scrope, and notwithstanding the opposition of Plutonists, like Durocher, Fournet, and Rivière, is now very generally admitted. In this connection, the reader is referred to the *Geological Magazine* for February, 1868, page 57, where the history of this question is discussed.

It may here be remarked that if we regard the liquefaction of heated rocks under great pressure, and in presence of water, as a process of solution rather than of fusion, it would follow that diminution of pressure, as supposed by Mr. Scrope, would cause not liquefaction, but the reverse. The mechanical pressure of great accumulations of sediment is to be regarded as co-operating with heat to augment the solvent action of the water, and as being thus one of the efficient causes of the liquefaction of deeply buried sedimentary rocks.

That water intervenes not only in the phenomena of volcanic eruptions, but in the crystallization of the minerals of eruptive rocks, which have been formed at temperatures far below that of igneous fusion, is a fact not easily reconciled with either the first or the second hypothesis of volcanic action, but is in perfect accordance with the one here maintained, which is also strongly supported by the study of the chemical composition of igneous rocks. These are generally referred to two great divisions, corresponding to what have been designated the trachytic and pyroxenic types, and to account for their origin, a separation of a liquid igneous mass beneath the earth's crust into two layers of acid and basic silicates, was imagined by Phillips, Durocher, and Bunsen. The latter, as is well known, has calculated the normal composition of these supposed trachytic and pyroxenic magmas, and conceives that from them, either separately, or by admixture, the various eruptive rocks are derived; so that the amounts of alumina, lime, magnesia, and alkalies, sustain a constant relation to the silica in the rock. If, however, we examine the analyses of the eruptive rocks in Hungary and Armenia, made by Streng, and put forward in support of this view, there will be found such discrepancies between the actual and the calculated results as to throw grave doubts on Bunsen's hypothesis.

Two things become apparent from a study of the chemical nature of eruptive rocks; first, that their composition presents such variations as are irreconcilable with the simple origin generally assigned to them, and second, that it is similar to that of sedimentary rocks whose history and origin it is, in most cases, not difficult to trace. I have elsewhere pointed out how the natural operation of mechanical and chemical agencies tends to produce among sediments, a separation into two classes, corresponding to the two great divisions above noticed. From the mode of their accumulation, however, great variations must exist in the composition of the sediments, corresponding to many of the varieties presented by eruptive rocks. The careful study of stratified rocks of aqueous origin discloses, in addition to these, the existence of deposits of basic silicates of peculiar types. Some of these are in great part magnesian, others consist of compounds like anorthite and labradorite, highly aluminous basic silicates, in which lime and soda enter to the almost complete exclusion of magnesia and other bases; while in the masses of pinite or agalmatolite rock we have a similar aluminous silicate, in which lime and magnesia are wanting, and potash is the predominant alkali. In such sediments as these just enumerated we find the representatives of eruptive rocks like peridotite, phonolite, leucitophyre, and similar rocks, which are so many exceptions in the basic group of Bunsen. As, however, they are represented in the sediments of the earth's crust, their appearance as exotic rocks, consequent upon a softening and extravasation of the more easily liquefiable strata of deeply buried formations, is readily and simply explained.*

The object of the present communication has been to call the attention of geologists to the neglected views of Keferstein and Herschel, which I have endeavoured to extend and to adapt to the present state of our knowledge. It is proposed in another paper to consider the question of the agencies which have regulated the geographical distribution of volcanic phenomena both in ancient and in modern times.

Montreal, Canada, March, 1869.

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* See in this connection the *Canadian Journal* for 1858, p. 203; Quart. Geo. Society for 1859, p. 494; Amer. Jour. Science [2] xxxvii., 255, xxxviii. 182; also Geology of Canada, 1863, pp. 643, 669, and Rep. Geol. Canada, 1866, p. 230.

THE TOAD AS AN ENTOMOLOGIST.

By A. S. Ritchie.

The principal object of the following notes on the toad as a collector of beetles, is to show how useful some of the lower animals are to man in his search after knowledge.

Before entering on the subject, a few remarks on the habits of the toad may not be uninteresting.

From the earliest accounts relating to this creature it has always been looked upon by the people as ugly, hideous, and venomous, while even supernatural powers have been attributed to it. Thus an old author says: "If the toad burrowed near the root of a tree, every one who ate a leaf of that tree would die, and if he only handled it, would be struck with sudden cramps." Some of the antidotes recommended for toad venom are the following: Black hellebore, powdered crabs, the blood of the sea tortoise mixed with wine, the stalks of dogs' tongues, the powder of the right horn of a hart, cummin, the vernet of a hare, the quintessence of treacle and the oil of a scorpion, mixed and taken *ad libitum.*

Even in those days when these elaborate prescriptions were invented some good was acknowledged to exist in the toad. The "toad-stone" is alluded to by Shakespere in the passage:

> "Sweet are the uses of adversity,
> Which like a toad, ugly and venomous,
> Wears yet a precious jewel in its head."

During the middle ages the stone found in the head of this reptile was popularly believed to be possessed of the power of giving warning of the presence of poisons. Fenton, writing in the year 1569, says: "There is to be found in the heads of old and great toads a stone they call borax or stelon. This worn in a ring gives a forewarning against venom." Another recommendation the toad had in those days was "its power as a styptic." Supposing any one to fall down and knock his nose against a stone, he could instantly stop the bleeding if he only had in his pocket a toad that had been pierced through with a piece of wood and dried in the shade or smoke. All he had to do was to hold the dried toad in his hand and the bleeding would immediately cease. The reason for this effect is, "that horror and fear constrained the blood to run into its proper place, for fear of a beast so contrary to nature."

In our day, however, the properties of this animal are better understood, although to a great extent it is still held to be venomous by the people, and generally killed wherever it is found.

Recent investigations go to prove that an acrid secretion covers the body of the toad, which is the cause of sore mouths in dogs attacking it. One of the great uses of the toad is its propensity for destroying insects injurious to vegetation. Our gardeners ought to introduce them into their gardens and cultivate the acquaintance of these creatures; their little trouble in so doing would be amply compensated.

The toad is of a retiring disposition, loving dark corners and shady places. It has a slow, crawling motion, and is of a very timid disposition. Numerous instances might be cited of pet toads, and of their becoming quite tame.

The toad differs in some respects from the nearly related frog. The structure of the mouth is, however, nearly the same; the tongue is attached by the root, as it were, to the base and front of the mouth, the tip being reversed and pointing down the throat when the animal is at rest.

The moment it sees an insect its eyes brighten and sparkle, the toes twitch, and quicker than the eye can follow, the tongue is thrown out, the insect transfixed, and withdrawn into the mouth.

Unlike the frog, the toad does not spring after its prey, but remains seated. Having kept frogs in the Aquarium, I have noticed that they will spring two or three times their own length from the moss to catch a fly on the glass, using their tongue, as it were, on the jump. They seldom miss their mark. As far as my experience goes, neither of these animals will eat anything without life or motion. I have, however, often deceived a frog by moving a dead fly in the sight of the creature, which it always took readily. Many stories have been told of toads in rocks, and reasons have been given by authors as to the way in which they became so embedded. My subject has, however, nothing to do with these "old great toads," but to one of our own day and generation. After this digression, I shall now introduce my friend, the toad, in his capacity as a collector of beetles.

The true naturalist, in the pursuit of his study, is a very teachable individual; he never refuses assistance from any one, whatever his station in life is, or however meagre his knowledge of the science may be. The many ways he uses the animal creation to advance his knowledge, in the particular branch of study, may be illustrated as follows:—

The Conchologist wearies for the pleasant days of summer, to take a trip to the sea-side, with his dredges and lines, his bottles and store boxes, where he adds to his collection many interesting and perhaps new forms of molluscan life.

A trip to the sea-side is not always easily obtained; but the naturalist may be seen in the markets buying the several species of flat fish, such as flounders and other species which live and feed at the bottom of the sea. Knowing them to be good collectors, he takes advantage of this fact to procure many and sometimes rare species, and thus adds to his cabinet, without the trouble of dredging for them.

The Entomologist, likewise, has recourse to different methods to obtain the objects of his interesting study. The following is one of many:

Starting at six o'clock one morning, in the summer of 1864, for a walk to our beautiful mountain, to collect insects, provided with the requisite apparatus, a wide-mouthed bottle, with spirits, for beetles, and a small flat box, lined with cork, for butterflies, &c., my success was particularly good. The first captures were eleven specimens of carrion beetles, comprising three species, viz., *Silpha peltata*, *Silpha marginalis*, and *Silpha inæqualis*. These were obtained from the body of a dead hawk owl (*Surnia ulula*). Having secured them in the bottle, and walking leisurely along, I noticed a toad (*Bufo Americanus*) sitting contentedly at the root of a basswood tree (*Tilia Americana*). Having never made use of my dingy friend as an insect collector, although aware of his propensity that way, my mind was made up to press him into the service—but how? He must be dead first. As he sat looking at me with his beautiful eyes (for although his appearance is not very prepossessing, still those beautiful, bright, yet languid eyes go a great way to improve his appearance), I had certain qualms of conscience about taking his life; still it was in the cause of entomology, and for the furtherance of science his life was sacrificed. Now he was dead; how was I to proceed? I had cut up and dissected many insects as well as birds; but to cut up a toad, and before breakfast—"there's the rub"—that grey, warty toad, no beautiful eyes now. One slash of the knife through the skin, another through the walls of the stomach, and the poor creature's breakfast was exposed.

I was a little disappointed at first, as one or two common forms of beetles presented themselves, that might have been obtained without sacrificing the poor animal; still, I reasoned as he had been up nearly, or perhaps all night, collecting, and I had not, he must have taken some species not in my collection. Having scraped the contents of his stomach into my bottle of spirits, I started home, resolved to see what the insects were before breakfast.

I spread them out on a sheet of blotting-paper and counted them, the result being as follows, naming them for the benefit of my entomological friends, who have not made use of the toad as a collector of insects:—

There were thirteen perfect specimens, viz.,—

	No. of Specimens.
Cymindis pilosa, rare, ...	one.
Platynus cupripennis, common, . . .	two.
Bembidium quadrimaculatum, uncommon, .	one.
Cercyon, undetermined, ...	three.
Tachyporus jocosus, common, . . .	one.
Pæderus littorarius, rare, ...	one.
Ips faciatus, common, ...	three.
Ips sanguinolentus, common, . . .	one.

Besides these, there were one elytron each of Hippodamia and of Brachycantha; also vestiges of legs and wings of other insects.

I have killed several toads since, with similar results; one, I may mention, had the stomach filled with a species of *Chrysomelidæ*, *Doryphora trimaculata*, amounting to eleven specimens. He had evidently come across a colony of that insect, and made a hearty breakfast. I may state that this insect was in great abundance, during 1864, on the Island of Montreal. The same may be said of last summer, 1868; taking them by the score on the Mountain, also along the river at Hochelaga.

The earlier you go out in the morning the better; before sunrise, if possible, ere the process of digestion has gone too far.

Birds are also very useful as collectors of insects, as may be seen by the following from one of the daily papers, being only one of many thousand examples:—

BIRDS THE FARMER'S FRIENDS.—An intelligent farmer boy in Illinois observed a small flock of quails, commencing at one side of a cornfield, taking about five rows regularly through the field, scratching and picking around every hill, then returning and taking another five rows, until thinking they were pulling up the corn, he shot one and then examined the field. On the ground they had been over, he found but one stalk of corn disturbed, but in the quail's crop he found one cut worm, twenty-one striped vine bugs, over a hundred chintz bugs that he could distinctly count, and a mass apparently consisting of hundreds of chintz bugs, but not one kernel of corn. During the past five years the quails in that vicinity have been decreasing, and the chintz bug increasing.

It will thus be seen, from what has been said regarding the habits of those humble animals, toads and birds, what great services they render to man in the economy of nature, and will, it is hoped, tend to show that it is the duty of all, especially of agriculturists, to preserve such valuable animals.

ON TRICHINA SPIRALIS.

By J. Baker Edwards, Ph. D., F. C. S.,

(Late Lecturer on Chemistry and Medical Jurisprudence at the Royal Infirmary School of Medicine, Liverpool, England.

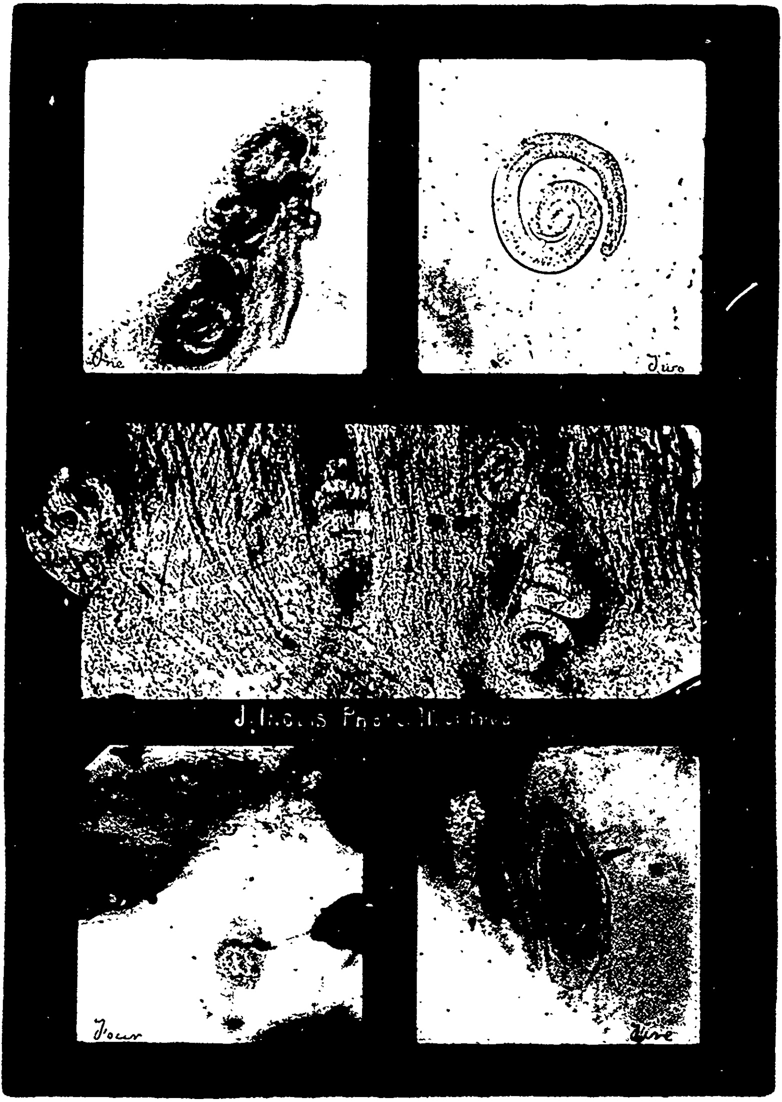
The occurrence of two fatal cases of Trichiniasis at Hamilton, Ont., and the successful treatment of several cases in Montreal, have drawn fresh attention to the parasite causing this disease; and as the researches into its natural history are somewhat scattered, it is thought a short *resumé* may not be uninteresting to our readers.

The cysts containing this parasite, and forming its sarcophagus in the flesh, were observed and examined microscopically by Tiedman in 1822. These were found in human muscle after death, and occasioned much speculation as to their real nature. In 1835 they were minutely examined by Mr. James Paget, and described and named by Professor Owen;* but as there then existed no clue to their natural history, they for some years possessed no interest beyond the fact of their existence in human muscle, and their classification as a genus of Entozoa; belonging to the order, Cœlelmintha; family, Nematoidea. Herbst found, in 1841, that dogs, when fed upon parts of a badger containing these worms, became infested with them in their muscles. But it remained for Zenker, in 1860, to show that the human body becomes infected with these parasites in

* Trans. Linnean Socy., LXXX., LXXXIV.

MICRO-PHOTOGRAPHS OF TRICHINA,

TAKEN FROM PORK AND FROM HUMAN MUSCLE.



One—Free Trichina, from Pork —100 diameters.

Two—Single Trichina, from Human Muscle.—150 diameters.

Three—Trichina embedded in Human Muscle.—150 diameters.

Four—Trichina encysting, from Pork.—50 diameters.

Five—Trichina fully encysted but not calcareous; from Pork.—50 diameters.

consequence of eating pork already containing them. Since this time, thousands of deaths have been traced to this cause, which would previously have been attributed to typhoid, gastric, or rheumatic fever, paralysis, poisoning, or atrophy. Further researches by Virchow of Berlin and Leuckart of Giessen, added greatly to our knowledge of the natural history of the species, and Prof. Dalton has elaborately studied cases of the disease in New York.

Trichiniasis is now fully established as one of the "ills which flesh is heir to." In several hospital examinations of human bodies after death from various causes, from 2 to 3 per cent. of adults are found to contain old encrusted capsules containing these worms, thus bearing evidence of the existence of this disease at some former period. In the Chicago market a medical commission found in the pork offered for sale 2 per cent. of flesh thus infected.

From these facts it may be inferred that the disease occurs much more frequently than has heretofore been supposed, but that it is only under peculiar circumstances that the worm breeds with such excessive rapidity as to cause fatal or even serious results.

The cases of the disease which have recently occurred on this Continent have caused still further investigations to be made as to its character, the probability of its detection, and the means of cure. Of these cases, those which occurred in the west were fatal, but those in Montreal, being of a slight nature and speedily diagnosed, were treated successfully. The whole literature of the question has been searched for an explanation of the facts which presented themselves in the Montreal cases, and whilst they are found to be in general accordance with cases on record, in some respects they may be considered unique. The history of the Montreal cases may be concisely stated thus:

On Wednesday, the 24th of March, a family in a boarding-house partook of some hastily-fried ham. Within an hour afterwards two of the adults felt nauseated and had some pain in the stomach. One took a large dose of brandy, and vomited his dinner; the other felt only abdominal pain, spasms, and faintness. He returned from his work and went to bed. During the night his wife and wife's mother felt ill, and suffered from pains in the bowels, together with great feverishness and thirst. During the following day, five other persons, who had partaken of the same meal, suffered more or less from similar symptoms, and in the evening of Thursday called in a physician, who, after careful enquiry, diagnosed Trichiniasis, and called in a second opinion on the case. On Good Friday a slice of ham was submitted to me for microscopic examination, in which I discovered, after some hours' investigation, several characteristic specimens of Trichina spiralis. By Monday morning, with the assistance of my friend Mr Ritchie, I had found several groups of Trichina, both in the free state and partially, as well as fully, encysted. These were during the same day shown to a considerable number of medical friends.

Mr. C. Baillie kindly placed his micro-photographic apparatus at my disposal, and during the week produced some excellent negatives of the worms "*in situ*" in the pork muscle.

No. 1.—This photograph (reproduced by Mr. Inglis) shows a group of Trichinæ in very close proximity, travelling up a line of muscular tissue, or rather between the muscular bundles.

No. 4 shows an individual worm surrounded by a gelatinous cyst, protruding his head therefrom, apparently in search of food, for his head and mouth can be distinguished under the microscope in the dark mass of muscle to the right of the field. Above, around and below are the worms not encysted, but curled up in the band of muscle, so that thirteen may be counted on a field of view not exceeding the tenth of an inch in diameter.

No. 5 shows what appears to be a lateral section of the worm fully encysted, but the worm is really whole, and the section only optical, the cyst being so transparent as to allow focusing through it. The cyst, although perfect, is not calcareous, and in no case did any calcareous cysts present themselves. The above were found in the slice of ham in question, and, indeed, in one particular muscle of that ham, of which the horizontal section did not exceed one-quarter inch in thickness. It is evident, therefore, that the disease was recent in the young pig from which the ham was taken, and that, being in the free and semi-encysted condition, the worms were in a condition to be aroused into action and activity in a much shorter time than had they been fully and calcareously encysted. According to Virchow*

* Virchow's archives, 1850, vol. xxxiii, page 535.

and Zenker the period of incubation of the cyst in the stomach is from six to eight days. This has been erroneously interpreted to mean that such a period must elapse before any marked symptoms can be recognized. Such a period of time however, is meant to be inclusive of the reproducing power of each individual, from whose body successive broods of young, numbering from *100* to *200*, are discharged. Dr. T. S. Cobbold* has found a period of sixty-nine hours amply sufficient for the development of the young muscle flesh worms of the human subject into the sexually mature adult Trichina of the dog. If all the worms were calcareously encysted a delay of from three to six days might be expected before intestinal irritation was a marked symptom. But in cases where the worms are young and free in the muscle, development may take place in a few hours, and rapid multiplication take place before other encysted worms were released from their capsules.

Thus a succession of fresh irritations to the muscular and nervous system may be expected from the first few hours to a period of eight or ten weeks. In the fatal cases examined in Chicago and Hamilton no single case of encysted Trichina was found in the flesh, but in the Montreal cases one or two distinct and complete cysts were extracted from the man's leg. This was eight weeks after eating the pork, and when the symptoms had somewhat abated, but considerable pain still felt in the muscles. The great shock to the system, which frequently terminates fatally, appears to result from excessive generation of the worms at any one period;—thus young and *healthy persons are frequently killed sooner than older and* more feeble individuals, the reason being that in the former case probably more food is eaten, digestion is more rapid, nausea more readily overcome by active exertion, and the breeding of the worms becomes excessive and continuous. In the Hamilton cases the young woman died in three weeks, whilst her mother survived six weeks, after eating the fatal repast. Nos. 2 and 3 in the photograph show examples of the worms in the latter case. In No. 2 the worm is carefully picked out from the muscle. No. 3 shows the muscle containing the worms in various postures on a line of muscle, it also

* Journal Linnean Society, vol. ix, page 209.

shows two generations on or near the same line of muscle. The faint curve near the edge of the margin being a larger and older worm than the other three, it is but partially in focus, and only about one half is, therefore, seen.

These worms have been generally figured in works on Physiology in two conditions, viz., encysted in the muscle, and sexually developed in the intestinal canal. The appearance of the young sexless worm *in transitu* in the flesh has not been carefully described. Some observers have, therefore, mistaken it for another species, whilst others have overlooked it altogether. The photographs Nos. 1, 3, 4 and 5 show fairly the varied forms in which the worm may be expected to be found in flesh during periods of from one to six weeks after ingestion. After a period of from six to twelve months the cysts become covered with a phosphatic opaque deposit, and the worm can only be seen by dissection or by solution of the coating in weak acid. These old cysts are sometimes found empty.

The best medium which I have found for mounting recent muscle for the examination and extraction of specimens, under the microscope, is a mixture of one part glycerine and one part aqueous carbolic acid. The muscle may be conveniently examined by a two-third object glass, and a B. or C. eye piece with the smallest aperture in the diaphragm. The extracted worm is best seen under a $\frac{1}{4}$-inch objective, with a small pencil of light, or by polarised light. No. 1 is magnified 100 diameters; Nos. 2 and 3, 150 diameters; Nos. 4 and 5, 50 diameters.

In 1866 some valuable experiments were conducted, in reference to the propagation of these worms, by Dr. T. Spencer Cobbold,* whose researches on Cestoid Entozoa place him at the head of English authorities on such subjects.

After feeding animals with trichinous food, seven experiments on birds all proved negative. Three sheep, two dogs, one pig and one mouse gave also negative results.

Nine cases were successful, viz., four dogs, two cats, one pig, one Guinea pig and one hedgehog.

While we may, therefore, conclude that birds and herbivorous mammals are very unlikely subjects for infection by this

* Journal of the Linnean Society, Zoology, vol. 9, p. 205.

means; it is also found that other animals, as the dog and pig, for instance, may partake of the food and yet escape infection. This helps to explain the recorded facts that large parties have eaten of trichinous food in company, and some have been killed, others suffered slightly, and again some escaped altogether.

Moreover, in the human subjects examined *post-mortem*, where the disease has not proved fatal, in some cases, the cysts were by no means numerous, whilst in others they have been estimated at from forty to one hundred millions. The excessive alarm which is apt to seize the public mind by the discovery of a case here and there is not, therefore, justified by the facts when properly understood. At the same time, whatever means can be adopted by the public authorities to prevent its becoming a familiar disease in our new Dominion should be forthwith adopted.

REMARKABLE LUNAR PHENOMENON.

By C. Smallwood, M.D., LL.D., D.C.L.

A somewhat rare and singularly beautiful phenomenon occurred between the hours of 9 and 10.20 p.m. of the 25th January, 1869, at this place (Montreal.)

It has been said that *haloes* and *coronæ* are very seldom or ever seen around either the Sun or Moon at the same time, and that their existence is very rare, and has been seen but by very few observers; but such was the case in the present instance, and deserves to be placed on record.

"The moon of the winter's night had hid the stars,
A bow of beauty, rich in shades of light,
Had circled in a crown of golden rays;
The snow lay stretched in beds of silvery white."

The sky at 8 p.m. was quite free from visible clouds; the moon shone with a brightness peculiar to our Canadian climate; but few of the stars were visible. The Moon's age at noon was 12.9 days. The Barometer at 9 p.m. stood at 29.710 inches, Thermometer at 0° (zero) with light breezes from the West. At 8.30 p.m. very light and indistinct *cirrus* clouds began to form in the Zenith, very minute, and at a very high altitude. They somewhat rapidly increased in size and density, mingling with a slight *cumulus* which had formed in the West, and were carried by the wind eastward. These together formed round the moon a corona of golden light 5° in diameter, encircled by a concentric ring or halo of bright prismatic rays of about 1° in breadth. The red ray was nearest the moon, then the orange,—and next respectively the yellow, green, blue, indigo and violet shades. A second but much larger circle or halo was also visible during part of the time, about 15° in diameter, and tinted with faint prismatic colours. *Cirrus* and *cumulus* clouds were seen floating from the west eastward, and were very visible and well defined within the concentric rings.

These appearances lasted for nearly an hour. The formation of *cumulus* clouds became more dense, and at a less altitude began to obscure the distinct outlines, and seemed to co-mingle and to obliterate these appearances from view.

At 9h. 40m. p.m. heavy *cumulus* clouds spread rapidly and covered the whole horizon. A very high wind prevailed during the whole of the night.

At 7 a.m. the next day (the 26th) the barometer had fallen to 29.646 inches, with a slight rise in temperature. The thermometer at the same hour stood at 1°. A small amount of snow fell at 8h. 20m. a.m.

It might be stated that a partial eclipse of the moon occurred on the evening of the 27th. Its appearance was unsatisfactory, owing to the presence of clouds and to the hazy state of the atmosphere.

ON THE DISTRIBUTION OF RAIN.

By C. Smallwood, M.D., L.L.D., D.C.L.

The geographical distribution of rain over the surface of the globe may be said to be proportioned to temperature, its humidity to the tides or fluctuation in the atmosphere, as indicated by the barometric variations, to changes of temperature, and to the configuration of the earth's surface.

The conditions necessary to the formation of rain are the presence of clouds, (although some observers have recorded rain falling from a cloudless sky,) to that of the cirrus (or snow cloud) at a high elevation, and at a low temperature (some 40° degrees below zero), together with the cumulus (or vapour cloud). These co-mingling by moist air-currents being forced into the higher region of the atmosphere by colder, less humid and consequently heavier currents from beneath, form together the nimbus (or rain-cloud). These induce a change in temperature and electrical action, conditions necessary to produce rain. This is carried by clouds and currents of wind and distributed over the lands of our continents, thus watering the earth, supplying vegetation, and the various wants of mankind and returning again by the rivers to the sea. From the surface of the ocean pure aqueous vapours are constantly ascending to supply the unceasing requirements of the organic and inorganic world.

Rain-clouds are attracted to certain localities more than to others, for it was shewn that at Ulleswater (England) the great heat of 1866 caused a great increase in the amount of rain, owing to its condensation by the mountains in that district. But beyond the formation of the surface of our globe, there are other conditions which supply natural conductors, such as the pointed extremities of the leaves of trees and of plants. May not our primæval forests have given rise to a different meteorological condition of a former world? The great coal formations may be taken as an example in illustration of this.

Many countries have been made sterile by cutting down indiscriminately the whole of the trees. Such, indeed, is actually the case in the recent deserts of Syria, Chaldea and Barbary. The "*Oases*" of the desert are nothing more than a few trees purposely left as a shade for the weary traveller.

The value of several estates in the West Indies has been greatly diminished by the cutting down of the trees upon them, and the rain fall over large regions of our own continent is much diminishing, owing, no doubt, to the large and extensive clearances of our forest; while on the other hand, the rain fall in the Upper Province of Egypt has been increased tenfold by the planting of twenty millions of trees by Mehemet Ali.

Until two years ago rain in that Province was unknown; but in twelve months ending April last there were actually 14 days on which rain fell, and later there fell a heavy shower—a phenomenon which the oldest Arab had never witnessed. Here we see rain returning to the desert on restoring the trees.

In Spanish America, lakes have had their area diminished and their shores dried from the general removal of the trees by the Spaniards; but now that cultivation has been resumed by the enterprising Americans, these lakes are being again filled up with water, and the shores are once more plentifully supplied with rain.

Extensive drainage, although beneficial to the rapid growth of plants and to the profit of the agriculturist, may also tend to diminish the rain fall by robbing the springs of their supply and by conducting the surface water more rapidly to the rivers and to the ocean.

Those lands near the sea over which the wind transports the aqueous vapour there acquired are, as a general rule, the most plentifully watered, while those distant from this source receive less in amount; these facts are fully borne out by actual observations. And may not the diminished rain fall in England be attributed in a great measure to the extensive surface draining by drain-tiles and other methods which are resorted to to promote the rapid growth and excessive yield of grain and some of the other agricultural products?

It will be seen that rain increases with the temperature, from the fact that hot air holds more water suspended than cold. The humidity of the atmosphere attains its maximum at the sea shore, and there tends to produce the greatest amount of precipitation. These causes are always present, but in a modified degree, and frequent, though small, showers are the necessary consequence; heavy and violent rain storms are of rare occurrence there.

In proportion as the mercurial column in the barometer falls, there is more chance of rain being formed, inversely in countries with a high Barometric pressure, such as on the 30th degree of latitude, where there is very little rain. Such regions have a tendency to become deserts.

Variations of temperature and irregularities of climate increase the showers of rain; and the formation of the soil plays also an important part in the production of rain, for ascending concave surfaces of soil receive a maximum, more especially when exposed to rainy winds, and more rain falls in *wooded* than in *bare* districts.

It rarely or never rains on the coast of Peru, in the great Valley of the River Columbia, in that of the Colorado in North America, the Sahara in Africa, and the Desert of Gobi in Asia, while in Patagonia and Chiloe it rains almost every day.

Days of rain are more numerous in high than in low latitudes.

In the region of Calmus it rains during a part of every day, the fall amounting to 225 inches in the year.

The heaviest fall of rain on our globe takes place on the Khasia Hills to the north-west of Calcutta, and amounts to 600 inches annually.

The greatest amount which has fallen in the vicinity of Montreal in one hour was 1.110 inches.

These observations extend over a period of upwards of 20 years.

Below is a table shewing the annual mean amount of Rain fall at some of the principal stations on our globe. The amount is in inches and tenths:—

	Inches.		*Inches.*
Madras	55.10	Dublin	24.00
Bombay	75.00	Glasgow	21.33
Canton	78.00	Aberdeen	28.87
Sierra Leone	87.00	Manchester	36.00
Rio Janeiro	89.00	Liverpool	34.00
Barbadoes	72.00	New York	28.63
Vera Cruz	183.00	Cambridge	44.48
Bergen	89.90	Albany	40.67
Stockholm	19.67	Baltimore	40.98
Copenhagen	18 55	New Orleans	52.31
Brussels	29.96	Cincinnati	48.63
Naples	29.94	San Francisco	22.00
Rome	30.86	Washington	41.20
Paris	22.64	Halifax	43.44
St. Petersburgh	17.65	St. John, N.B.	42.10
London	22.00	Toronto	31.50
Oxford	27.10	Montreal	36.00
Cork	40.00	Quebec	39.10

ON SOME OF THE CAUSES OF THE EXCESSIVE MORTALITY OF YOUNG CHILDREN IN THE CITY OF MONTREAL.

By PHILIP P. CARPENTER, B.A., Ph. D.,
Hon. Secretary of the Montreal Sanitary Association.

The object of the present paper is (1) to continue and enlarge upon the data given in the *Canadian Naturalist*, New Series, Vol. 3, pp. 134–156, under the head of "Vital Statistics of Montreal;" and (2) to enquire into some of the causes of the most unusual disproportion between the deaths of young children and adults.

The lettering and numbering is so given as to correspond with the previous article, to which the reader would do well to refer back. The figures for 1866 are repeated, along with the general average of 12 years, in order to make a suitable comparison with the succeeding years. It should be remembered that in each of the years beginning with 1866 the official directors and executors of public hygiene have stated that the city was never before in so cleanly a condition.

A.—THE CENSUS RETURNS.

In advance of the approaching Census, it is most important to remember how inaccurate the last was proved to be; the double entry of "uncooked" figures for Quebec deaths presenting a discrepancy of 296 (see p. 134), and the Montreal deaths presenting a known deficiency of 1,143 (see Table 8, p. 147). It behoves all members of the governments therefore, both federal, provincial and municipal, and all who can bring influence to bear upon these governments, to see to it that the appointments are not given to incompetent political favourites, but to the best men that can be found for so important a public work. The citizens of the largest (and the most unhealthy) city in the Dominion should especially see to this.

B.—THE PROTONOTARY'S RETURNS.

These continue to be the only accessible data for the Births in Montreal, as well as for both Births and Deaths in the surrounding counties. Yet they only record religious ceremonies. The births among Baptists (a very small sect, however, in this city and province) are not publicly registered. An imperative Registration of Births and Deaths (with the *proximate* and *remote* causes of the latter under medical certificate) is among the first duties of our government. It should not be left to the peculiar views of the leaders in either Province, but should be *uniform for the whole Dominion*, and enforced by sufficient penalties.

In the following tables, Vaudreuil and Soulanges, having been permanently removed to another registration district, are no longer represented by averages. The population of the six counties was 81,291 in 1861, to which the average increase, viz., 2,938, is added year by year. This alteration somewhat affects the averages as previously given:—

4. *Montreal City: Returns of Baptisms and Funeral Services.*

Year.	Supposed Population.	Births.	Deaths.	Excess of Births over Deaths.	Deaths per 1,000 Living.	Deaths per 100 Births.
Average of 7 years	93,583	4,545	3,390	1,155	36·2	74
Montreal City in 1865.......	103,363	5,543	3,761	1,782	36·4	68
" 1866.......	111,374	5,158	3,381	1,777	30·3	65
" 1867.......	116,608	5,598	4,247	1,351	37·7	76
" 1868.......	122,088	5,060	4,567	493	37·4	90
Average of 4 years	113,358	5,339	3,989	1,350	35·4	75

5. *Six adjacent Counties: Returns of Baptisms and Funeral Services.*

Year.	Supposed Population.	Births.	Deaths.	Excess of Births over Deaths.	Deaths per 1,000 Living.	Deaths per 100 Births.
Average of 8 Counties for 7 years	109,611	3,923	1,911	2,012	17·4	48
Six Counties in 1865	93,043	2,763	1,651	1,112	17·7	59
" 1866	95,981	2,591	1,415	1,176	14·8	59
" 1867	98,919	2,686	1,603	1,083	16·2	59
" 1868	101,857	2,588	1,532	1,056	15·4	59
Average of 4 years	97,450	2,657	1,550	1,107	16·0	59
Ditto, corrected to the Population of Montreal	113,358	3,091	1,803	1,288	16·0	59
Ditto, Montreal City	113,358	5,339	3,989	1,350	35·4	75
Balance for and against the City	0	2,248	2,186	62	19·4	16

It appears, therefore, that though our mothers give birth to more than 2,000 infants yearly, in addition to the infants born among the same number of country people, the city only gains 62 lives, as the fruit of all this suffering and loss!

The deaths registered by the Clergy, in the city of Montreal, as compared with those registered at the Cemeteries, present the following results.

8. *Comparison of Mortality-Records in Montreal City,* 1866—1868.

Year.	Cemetery Returns.	Clergy Returns.	Not Entered in Clergy Returns.	Or, per 100 Deaths.	Or, per 1,000 Living.
1866	3,610	3,381	229	6.3	2.0
1867	4,465	4,247	218	4.9	1.9
1868	4,842	4,567	275	5.7	2.2
Total	12,917	12,195	722	5.6	2.0

C.—Interments at the Cemeteries.

The allowances to be made in estimating the accuracy of these returns are stated at p. 147; for the comparison of years, of seasons and of ages *with each other*, they are invaluable. During the last year, the descriptive columns in the weekly sheets have been filled up with much more accuracy than heretofore, in consequence of urgent representations from the Sanitary and Medical Associations; but they are not yet accurate enough for the requirements either of medical, sanitary or statistical science. This is greatly to be regretted and deprecated; because in a large city, where all the interments are made at two cemeteries, a very little determination on the part of the officials would produce nearly all that can be desired.

7. *Rate of Mortality for the City of Montreal, from the Cemetery Returns.*

Year.	Supposed Population.	Deaths of Adults.	Or, per 1000 of all ages living.	Deaths of *Children.*	Or per 1000 of all ages living	Deaths of Children to every 100 d'ths of adults.	*Total* Deaths.	Or per 1000 of all ages living.	Or one Death in every	Yearly excess of Deaths of all ages as compared with adjacent c'unties.	Or, per 1000 living.
Average of 12 yrs.	89,860	947	10.5	2,224	25.0	238	3,191	35.5	28 living	1,696	18.9
1866	111,374	1,226	11.0	2,384	21.4	194	3,610	32.2	30 "	1,970	17.7
1867	116,608	1,274	10.9	3,191	27.3	254	4,465	38.3	26 "	2,576	22.0
1868	122,088	1,318	10.8	3,524	28.8	267	4,842	39.6	25 "	3,006	24.6
Average of 3 yrs.	116,690	1,273	10.9	3,033	25.8	238	4,229	36.7	27 "	2,516	21.4
Supposed present Population.	127,826.										

The deaths in the city, according to the country rate of dying in the same year, ought to have been in 1866 1640
" " " " " " in 1867 1889
" " " " " " in 1868 1836

9. *Total Deaths in Montreal, of all ages, for each month.*

Month.	Total for each month, for 12 years.	1866.	1867.	1868.
January	2,792	227	260	230
February	2,539	234	281	363
March	2,920	297	381	346
April	3,068	293	321	387
May	3,051	258	324	481
June	3,381	284	469	416
July	4,858	415	667	631
August	4,321	387	696	713
September	3,245	394	363	406
October	2,741	245	234	329
November	2,567	260	274	284
December	2,814	296	195	256
Total of each year.	38,297	3,610	4,465	4,842

10. *Deaths of Children under 12 in Montreal, for each month.*

Month.	Total for each month, for 12 years.	1866.	1867.	1868.
January	1,897	150	164	160
February	1,679	146	175	230
March	1,980	183	241	234*
April	2.040	183	202	264
May	2,074	152	223	356
June	2,440	181	362	311
July	3,927	341	578	508
August	3,358	289	547	573
September	2.320	280	277	324
October	1.777	157	147	202
November	1,630	156	175	193
December	1,810	166	107	169
Total of each year.	26,932	2,384	3.191	3.524

* At the beginning of this month, after an unusually severe winter, there came a rapid thaw, with special stenches in the drains and on the surface of the low levels. This was succeeded by a sudden frost, with peculiarly severe N. E. storms. The children's deaths *rose* from 17 at the opening of the month *to 79 in the thaw*; and fell again in the week of cold storms to 16. The deaths of adults were scarcely affected by either change.

11. *Deaths of Adults (and childen above 12) in Montreal, for each month.*

Month.	Total for each month, for 12 years.	1866.	1867.	1868.
January	895	77	96	70
February	860	88	106	133
March	940	114	137	112
April	1,028	110	119	123
May	977	106	101	125
June	941	103	107	105
July	931	74	89	123*
August	963	98	149	140
September	925	114	86	82
October	964	108	87	127
November	937	104	99	91
December	1,004	130	88	87
Total of each year.	11,365	1,226	1,274	1,318

* This *includes* 3 *deaths from sunstroke* in a single week, in consequence of the excessive heat. Yet the average deaths of adults did not exceed that of April; these 30 extra deaths being compensated by unusual healthiness in other respects. At the same time, the children, none of whom died from sunstroke, *had nearly doubled* their April rate of dying.

Months.	12. *Average Weekly Mortality, of all ages, for each Month.* Average of 12 Years.	1866.	1867.	1868.	13. *Average Weekly Mortality of Children under 12, for each Month.* Average of 12 Years.	1866.	1867.	1868.	14. *Average Weekly Mortality of Adults (and Children above 12,) for each Month.* Average of 12 Years.	1866.	1867.	1868.
January	52·7	56·7	65·0	57·5	35·8	37·5	41·0	40·0	16·9	19·2	24·0	17·5
February	52·9	58·5	70·2	72·6	34·9	36·5	43·7	46·0	17·9	22·0	26·5	26·6
March	54·1	59·4	76·2	85·5	36·6	36·6	48·8	58·5	17·4	22·8	27·4	28·0
April	60·1	73·2	80·2	96·7	40·0	45·7	50·5	66·0	20·1	27·5	29·7	30·7
May	57·6	64·5	81·0	96·2	38·9	38·0	55·7	71·2	18·5	26·5	25·2	25·0
June	65·0	56·8	93·8	103·9	46·9	36·2	72·4	77·7	18·1	20·6	21·4	26·2
July	93·4	103·7	166·8	157·7	75·5	85·2	144·5	127·0	17·9	18·5	22·2	30·7*
August	82·1	96·7	139·2	142·6	63·3	72·2	109·4	114·6	18·1	24·5	29·8	28·0
September	62·4	78·8	90·7	101·5	44·6	56·0	69·2	81·0	17·8	22·8	21·5	20·5
October	51·7	66·2	58·5	65·8	33·5	39·2	36·7	40·4	18·2	27·0	21·7	25·4
November	50·3	65·0	54·8	70·9	31·9	39·0	35·0	48·2	18·3	26·0	19·8	22·7
December	52·1	59·2	48·7	63·9	33·5	33·2	27·7	42·2	18·6	26·0	22·0	21·7
Average Week of Year	61·2	69·4	85·4	93·1	43·0	45·9	61·2	67·7	18·1	23·6	24·3	25·3

* Without the 30 deaths from sunstroke, the Adult average for July would have been only 23·2, (or a little more than that of November,) in spite of the unusually oppressive heat. Probably persons were afraid to drink so much liquor. In Lancashire, it has been found that the *health of the people is improved* in times of special privation, as during the cotton famine, simply because they cannot afford to swallow so much drink-poison.

18. *Weeks of Maximum and Minimum Mortality, for all ages, in Montreal.*

Year.	Highest Mortality, in week ending	Lowest Mortality, in week ending	Which is at the yearly rate, per 1,000 living, of Maximum	Minimum	Range of variation, at yearly rate per 1,000.	Actual Range of variation, between max. and min. weeks	General Average of the year, per 1000
1866	July 21..121	June 9.44 / Dec. 1.45	54	19	35	77	32.2
1867	" 27..185	Nov. 2.39	82	17	65	146	38.3*
1868	" 18..209	Jan. 18.48	89	20	69	161	39.6
Or, for Children under 12 years of age only:—							
1864	July 2..116	Oct. 22...25	58	12	46	91	34.1
1865	" 1..103	" 28...24	50	10	40	79	26.8
1866	" 21..102	Jan. 6...25	48	11	37	77	21.4
1867	" 27..157	Dec. 28...19	70	9	61	138	27.4
1868	" 18..152	Jan. 18 / Oct. 24 } 32	64	14	50	120	28.8
Or, for Adults only:—							
1864	Apr. 30..36	Sept. 3..... 7	18	3	15	29	11.2
1865	Aug. 5..33	" 23.....10	16	5	11	23	11.0
1866	May 19..37	July 14.....14	18	7	11	23	11.0
1867	" 11..35	June 22.....10	16	5	11	25	10.9
1868	July 18..57†	Sep. 12.....12	24	5	19	45	10.8

* If the mortality (corrected for increase of population) had been calculated from September 1st, 1866, to September 1st, 1867, it would have given the death-rate of the year as 40.6 per 1000.

† Thirty of these were from sunstroke: see note to Table 11. It appears that, with this exception, the range of variation for adults is remarkably uniform.

These tables, compiled with the greatest attainable accuracy for the space of 14 years, prove to an absolute demonstration, after making all reasonable deductions for possibilities of error, not merely on the average of years, but in each single successive year, (1) that the mortality of Montreal is excessive as compared with the immediately adjacent country districts, under the same climatal conditions, but less favoured as regards wealth and intelligence; (2), that this excess is utterly disproportionate in the ratio of the deaths of children and adults; (3), that this excessive mortality of children uniformly attains its greatest height during the heats of summer. It is possible to bring out these facts with even greater distinctness.

The mortality of July, 1867, having reached a higher point than that of any previous year without special epidemics or unusual heat, in spite of comforting assurances from the city authorities that the yards had never been so well cleansed, the Sanitary Association instituted enquiries into the condition, during the same season, of New York and Boston, and analyzed the returns on the cemetery sheets to ascertain during what period of life the special mortality prevailed. The following are the results.

21. *Analysis of Children's Deaths in Montreal, for the year* 1867.

Deaths.	Under 1 year, (including 201 blanks, or still-born.)	Above 1 year, and under 5.	Above 5 years, and under 12.	Total Children under 12.	Total, all ages above 12.
Interments of children	2,063	910	218	3,191	1,274
Or, per year of life	2,063	228	31	266	22
Condition, according to the prophecy of Isaiah.......	0	0	0	0	4,465
Proportion of total deaths per year of life; one in.......	2.1	19.6	144.0	16.7	203.0

	Under 1 year.	Total under 5.	....	Total under 12.	Total, all ages.
Total interments	2,063	2,973	....	3,191	4,465
Percentage of *total* deaths ...	46.2	66.6	....	71.5	100.0
Percentage of *children's* deaths	64.6	93.2	....	100.0	....
Supposed number of children living, corrected from the census of 1861	5,158	19,627	....	37,761	116,608
Deaths of children, per 1,000 living *at the same age* ...	399.9	151.4	....	84.5	38.3
Or, 1 in every .... (living at the same age.)	2.5	6.6	....	11.8	26
Ditto, average of 10 years	2.5	7 0	....	13.0	28
Ditto, average of Lower Canada, less principal cities .	....	....	....	27.0	96

	....	Between 5 and 12.	Total above 5.	Total above 12.	Total, all ages.
Supposed number of persons living in the city	....	18,144	96,981	78,837	116,608
Deaths per 1,000 living *at the same age*...............	....	12.0	15.4	16.1	38.3
Or, 1 in every .... (living at the same age.)	....	83	65	62	26

It is evident, therefore, that the children from 5 years upward are remarkably healthy in this city, the principal reason being that all the moribund children are killed off at an earlier age. It is *those children who are confined to the house* or to its immediate surroundings who are, in this city, so peculiarly unhealthy. The principal causes of the death-rate, therefore, must be looked-for in the condition of the dwellings.

But, as it is shewn that the special mortality of the city follows the months, not indeed for adults, but for children, let us examine whether it specially follows any particular period of childhood.

22. *Deaths of Children in Montreal,* 1867, *according to ages and months.*

	Under 1 year.		From 1 to 5 yrs.		From 5 to 12 yrs.		All ages under 12.	
	Total.	Weekly average.	Total.	Weekly average.	Total.	Weekly average.	Total.	Weekly average.
January	94	23.5	46	11.5	22	5.5	162	40.5
February	109	27.2	49	12.2	16	4.0	174	43.5
March	159	31.8	53	10.6	26	5.2	238	47.6
April	126	31.5	62	15.5	13	3.2	201	40.2
May	135	33.7	70	17.5	18	4.5	223	44.7
June	229	45.8	101	20.2	32	6.4	362	72.4
July	404	101.0	146	36.5	28	7.0	578	144.5
August	359	71.8	172	34 4	16	3.2	547	109.4
September	157	39.2	107	26.7	13	3.2	277	69.2
October	95	23.7	40	10.0	12	3.0	147	36.7
November	101	25.2	25	6.2	14	3.5	140	35.0
December	95	19.0	39	7.8	8	1.6	142	28.4
Total	2163	39.7	910	17.5	218	4.2	3191	61.3

The numbers are so few in the third column that they cannot be relied on for averages in a single year; but the very slight increase of June and July over the early months of the year is very noteworthy. In the second column, while the July death-rate is three times that of February, in the first column it is is nearly four times. It would appear, therefore, that the summer influences affect but slightly children above 5; and, most of all, those under 1 year. A single average year of life in each of the columns gives the following death-rate for an average week:—

23. *Average Weekly Death-rate of Children in Montreal, 1867, for each year of life.*

	Under 1 year.	From 1 to 5.	From 5 to 12.	Total.
December	19·0	1·9	0·2	2·4
July	101·0	9·1	1·0	12·0
June, July, August	72·9	7·6	0·8	9·1
April, May, September, October	32·0	4·3	0·5	4·4
Nov., Dec., Jan., Feb., March	25·3	2·4	0·6	3·3
Average for year	39·7	4·4	0·6	....

It appears, therefore, that a boy of 5 years has about 100 times the chance of life that can be hoped for an infant of months, both in December and July. But according to seasons, the older child has 42 chances of life, as compared with his baby-brother, in winter; 64 chances in spring and autumn; and 91 chances in summer.

So the child under 5, as compared with the baby, has 10 chances in December, 11 in July, 9½ in summer, 7½ in spring and autumn, 10½ in winter.

On the average of the year, the child under 5 has *nine* chances of life as compared with the baby; the child above 5, *sixty-six* chances. Against what fearful odds do the infants in this city struggle into life!

24. *Comparison of Montreal Children's Death-rate in air-poisoning, open, and frost-bound months.*

Average.	Air-poisoning Months: June, July, August.	Open Months: April, May, Sept., Oct.	Frost-bound Months: Nov., Dec., Jan., Feb., March.
Average weekly death-rate of children, under 1 year, ...1867..	72·9	32·0	25·3
Ditto, between 1 and 5 years ..1867..	30·4	17·4	9·7
Ditto, between 5 and 12 years..1867..	5·6	3·5	4·0
Ditto, all ages under 12 years ..1867..	108·8	53·0	39·2
Average week for 10 years, all ages, ..	61·9	39·2	34·5

That the excessive infantile mortality of July, 1867, was not due to exceptional climatal influences, will appear from the following statistics of Boston, obligingly furnished by Mr. Antonio, the

Registrar of that city. Boston is far more crowded than Montreal, with a much larger proportion of Irish lodging-houses, and with a raw, damp climate. But "the sanitary laws are good, and *faithfully executed.*"

. 25. *Comparative Sanitary Statistics of Boston,* 1867.

Average population of Boston for previous 10 years		178,500
Supposed " " for 1867		196,000
Total Yearly Deaths on the average of 10 years		2,474
Or, per 1,000 *of present population*		12.7
Deaths in *highest* month (*August*) on average of 10 years		461
Or, per 1,000 *of present population, at yearly rate of*		28.2
Deaths in *lowest* month (*June*) on average of 10 years		299
Or, per 1,000 *of present population, at yearly rate of*		18.3
Total Deaths during	July, 1866	482
"	July, 1867	365
"	August, 1867	452
Deaths of infants under	1 year, July, 1867	107
" children between	1 and 5 years, July, 1867	62
" "	5 and 10 years, July, 1867	18
" infants under	1 year, Aug., 1867	158
" children between	1 and 5 years, Aug., 1867	86
" "	5 and 10 years, Aug., 1867	22
Yearly rate of Deaths among 5,500 children under 1 year,	July, *1867*, per *1,000*	233.0
" " 24,000 " 5 years,	" "	84.5
" " 43,000 " 10 years,	" "	52.2
Deaths from *Cholera infantum,*	July, 1866	89.0
" "	July, 1867	49.0

By correcting these numbers according to the ratio of Montreal population, it appears that the July deaths were here *more than three times* those of Boston, although an unprecedented number of families had left our city; that of the total deaths in the year, only 39 per cent in Boston are of children under 5 years, instead of 65 per cent in Montreal; and that of these only 24 per cent in Boston were under one year, instead of 46 per cent in Montreal. *Of the children born in Montreal, two out of every five died within the year.*

These being the frightful facts of the case, so far as they can be at present ascertained, it becomes the duty of every thoughtful citizen to enquire into their causes.

The most evident of these is the fearful number of illegitimate children each year thrown away by their unnatural and most wicked parents, and placed under the fostering care of the Sœurs Grises at their Foundling Hospital. The condition in which they are received will be understood from the following table.

26. *Condition of Infants received at the Montreal Foundling Hospital.*

Condition.	1865.	1866.	1867.	1868.	Total.
Without covering	334	286	424	293	1,337
With only a cotton cloth	18	....	10	....	28
Almost frozen	6	....	7	20	33
Bleeding through want of the necessary offices at birth	15	11	13	25	64
Not washed after birth	31	29	18	30	108
Wounded by Instruments	8	4	8	7	27
Tainted with Syphilis	84	80	46	139	349
Sick	118	85	57	40	300
Dying	28	26	23	18	95
Dead	2	....	3	4	9
With bloody flux	....	15	13	....	28
With Hœmorrhage of the lungs	....	13	10	8	31
Not classed as above, but frequently covered with vermin	85	75	20	94	274
Total received	729	624	652	678	2,683

Whenever there appears a chance of life, these infants are sent into the country, in the care of nurses under surveillance. Even under favourable circumstances, there would be but poor chance of saving the lives of most of these abandoned ones; but it appears from a Report presented by the Medical officers to the City Council that the nurses are often unable to supply them with natural aliment. When they die, the corpses are sent to Montreal for interment, and are entered in our city bills of mortality, as their baptisms had been in the Protonotary's returns. The following statistics have been compiled from the Register of Deaths kept at the Hôpital Général.

27. *Mortality at the Montreal Foundling Hospital.*

Year.	1863	1864	1865	1866	1867	1868	Total.	Average of six years.
January	26	49	58	39	32	34	235	39
February	32	22	38	34	34	33	193	32
March	38	54	52	43	47	48	282	47
April	48	53	67	68	47	61	344	57
May	59	43	51	66	53	61	333	55
June	80	65	68	68	82	101	464	77
July	102	86	104	94	101	94	581	97
August	63	59	70	64	85	76	417	69
September	48	36	41	35	43	49	252	42
October	43	50	43	50	31	29	246	41
November	39	46	42	36	44	34	241	40
December	45	42	31	32	35	25	210	35
Total	623	605	665	629	634	642	3,798	†
Deduct *Adults*	8	16	20	15	15	†	74	†
Total *Children*	615	589	645	614	619	642	3,724	621
Of whom died, Under 7 days	11	18	24	23	36	22	134	22
" 1 month	427	404	401	402	368	348	2,350	362
Under 1 year	590	573	612	593	583	610	3,561	593
Between 1 and 5 years	24*	14	32*	21	34	31	156	26
Between 5 and 12 years	1	2	1	0	2	1	7	1

A more simple mode of keeping the register having been adopted at the suggestion of the writer, the following table has been eliminated for the past year. The numbers in the first column are included in the second, and both in the third.

* A large proportion of these deaths were from *rougeole*. It will be observed that the children, being in the country, escaped the fatal scarlatina which ravaged the city children in 1864, and also the unusual city mortality of July, 1867; also that last year June was in excess of July, which has never happened in the city. It is marvelous to observe that the coldest month is also the healthiest; even for these children who are so often received partially or entirely frozen, and so generally with insufficient clothing.

† In consequence of the mode in which the register was kept previously to 1868, some deaths of adults had been added-in with those of children; and for so small a number, distributed over the months, it was not thought needful to analyze the returns afresh.

28. *Death-rate, per months and ages, at the Montreal Foundling Hospital*, 1868.

	Under 1 week.	Under 1 month.	Under 1 year.	Between 1 and 5 Years.	Between 5 and 12 years.	Total Deaths.
January	2	16	26	5	0	31
February	1	16	26	7	0	33
March	2	16	44	4	0	48
April	2	33	59	2	0	61
May	1	31	60	0	1	61
June	2	58	100	1	0	101
July	4	42	93	1	0	94
August	1	47	72	4	0	76
September	3	33	46	3	0	49
October	0	19	29	0	0	29
November	2	23	31	3	0	34
December	2	14	24	1	0	25
Total	22	348	610	31	1	642

A comparison of figures in the second column fully bears out the common impression in the city that children born in winter have much greater chance of life than those born in summer. The following table exhibits the frightful loss of life to the community from paren[illegible] neglect.

29. *Balance of Life at the Montreal Foundling Hospital.*

Years.	Infants received.	Died at the Hospital.	Died at the Nurses' Houses.	Total Deaths.	Remaining alive.	Or, per cent.
1865	729	17	639	656	73	10.0
1866	624	15	566	581	43	6.9
1867	652	46	552	598	54	8.3
1868	678	14	623	637	41	6.1
Total	2,683	92	2,380	2,472	211	7.8

Many persons have attributed this excess of mortality to the existence of the Foundling Hospital; and one of the "religious" newspapers asserted (although the facts of the case were easily accessible) that "it was estimated that about 2,000 children die annually in it."* In order to correct these and other unfounded rumours, the Mère Supérieure of the Sœurs Grises has obligingly furnished the writer with the needful statistics, which, without any exaggeration, are appalling in the extreme. The Sisters are quite willing to allow that, with more knowledge, and with more means at their disposal to render available the knowledge already possessed, a much larger propor-

* See the *Echo* of June 19th, 1867.

tion of these "unwelcome children" could be saved, to become useful members of the community; but even this religious city cannot provide ladies more willing to do this most loathsome of works, and more devoted to the service which they thus offer to our common Saviour. Materials are not accessible to make an extended comparison of the mortality among Montreal foundlings with that of the same class elsewhere, but the following particulars are given in the "Fifth Annual Report of the Board of State Charities of Massachusetts," pp. 35, 37, 38, 45:—

30. *Comparative Mortality of Foundlings, under one year of age.*

	Per cent.
Supposed yearly death-rate at the Neapolitan *Hospital*	90
In some *Hospitals*, as high as	95
In some well-managed *Hospitals*, as low as from	40—60
In good *Asylums*, from	30—50
In good *single families*, from	20—35
Average death-rate of infants in the whole of *Massachusetts*	13.5
" " " in the country districts of ditto	12.6
" " " in Suffolk county, including Boston	17.4
Mortality at the *Foundling Hospital*, Ward Island, *New York*, 1868:—	
" Infants suckled by their own mothers	20.0
" " bottle-fed on milk by their own mothers	29.5
" Foundlings suckled by nurses	72.5
" " bottle-fed on milk by nurses	89.6
Montreal Foundlings, bottle-fed by nurses, 1868	89.9
Ordinary Montreal Infants, 1867	29.3
Total City mortality of infants under one year, (in Boston, 17.4;) in Montreal, 1867	36.8

It is an open question, which need not be here discussed, whether or not such institutions do more good, in the care of the forsaken, or harm, in the facility afforded to escape the shame of unlawful parentage. Two things are certain, viz., that while the passions of men remain uncontrolled by religion, especially when intensified by city life, these children will continue to be born; and that, where there are no such institutions, præ- and post-natal murder are common though often undiscovered crimes. Whether these children die scattered over the city, or collected into a hospital, or (as in our case) distributed through country homes, their deaths fairly belong to, as they have been thus far reckoned with, the city mortality.

One portion of the deaths, however, does *not* belong to us, viz., those who are sent into the city from other places; sometimes in a hamper or carpet-bag, by rail; and frequently, as may be supposed, in a moribund condition.

The following table embodies all that is known of their origin.

30. *Birth-place of Montreal Foundlings*, 1865-68.

Years.	Montreal City.	Canadian Cities. Quebec.	Ottawa.	St. Hyacinthe.	Three Rivers.	Country round Montreal.	Upper Canada.	United States.	Foreign Counties.	*Total* received from other places.	Total City and Country.
1865	443	147	20	26	8	44	15	25	1	286	729
1866	448	85	18	9	6	40	11	7	0	176	624
1867	413	98	20	21	12	42	15	29	2	239	652
1868	356	110	62	30	19	30	26	44	1	322	678
Total	1660	440	120	86	45	156	67	105	4	1023	2683
Yearly average.	415	110	30	21	11	39	17	26	1	256	671

A comparison may now be instituted between the mortality of ordinary children and those neglected by their parents.

31. *Comparative Mortality of Montreal Foundlings and Ordinary Infants.*

1867.	Baptized.	Interred.	Or, per 100 living at same age.
Total, Montreal Infants	5,598	2,063	36.8
Of whom were Foundlings	652	583	89.4
" Ordinary Children	4,946	1,480	29.9
Proportion of Foundlings to ditto	1 *in* 8	1 *in* 2,5	extra deaths) 59.5
Total, Boston Infants	.....	.....	17.4

In comparing Montreal with other cities, it would not be fair to make deductions for the peculiarities of our local institutions, because such peculiarities affect all large cities more or less; but, for the satisfaction of the inhabitants, the following table may be given. The strangers who are baptized in the city may be reckoned against those born here who are not baptized as infants.

32. *Corrected Death-rate for Montreal City.*

Year.	Total Deaths.	Proportion for Deaths of Imported Children.	Deaths of natives and ordinary inhabitants.	Corrected Death-rate per 1,000 living, at all ages.	Total Death-rate.
1865	4,025	258	3,767	36.3	37.8
1866	3,610	164	3,446	30.9	32.2
1867	4,465	219	4,246	36.4	38.3
1868	4,842	302	4,540	37.2	39.6
Average of 4 years	4,235	236	4,000	35.2	36.9

It follows that, although a portion of the lowered death-rate in 1866 was due to the unusually small number of infants received from the country, the balance, as compared with the average of the years before and after, viz., *no fewer than* 550 *lives, or* 5·4 *per* 1,000 *inhabitants*, may fairly be assigned to the anti-cholera cleansing. What a rebuke it gives to the members of the Council, and to the citizens who intrust to their care their own health and the very lives of their little ones, that in each succeeding year, notwithstanding the yearly boast that "the city was never so clean before," the death-rate has risen even above the previous number, humiliating as that is as compared with much larger and more crowded cities!

This table further rebukes those who attribute our excessive mortality to the strangers received at the Foundling Hospital, by showing that the average deduction to be made for this cause *only amounts to* 1·7 *deaths per* 1,000 *inhabitants*.

At the discussions which were held at the Natural History Society on this subject, a great variety of causes were assigned for the excessive mortality among our children. Probably all of these have more or less effect; but many of them apply with fully equal, if not greater force to other cities; and others again apply to the country districts just as much as to ourselves. Thus the frightful number of unwelcome children born among us, averaging 400 yearly, besides those who are provided-for by their parents, may be attributed in part to the large garrison which has been till lately stationed here; but it is the fruit of the same sin that curses humanity eslewhere. A large number of infantile deaths are undoubtedly caused by the drunkenness of their parents; but Montreal is not an unusually drunken city. The milk sold by many dealers is of inferior quality; but taking the city through, it is probably better and cheaper than in most English cities. Errors in diet, and deficiency of parental care are undoubtedly grievous causes of disease; but there is no reason to think that Montreal mothers are less careful and enlightened than in the country round: they ought to be more so. As to unripe fruit, &c., the country children get far more of it than we; and at the ages at which city children get most of it, it has been proved that they are *unusually healthy*. And as to the idea that catholic infants are predisposed to death from exposure to cold through the custom of early christening, it so happens that the coldest months, during which this cause ought to operate most, are by far the lowest in the death-rate.

It is only distracting attention from the main and solemn issue, thus to beat around the bush. Every thoughtful person who has observed and studied the simplest facts and first principles in sanitary science, must be aware that a *sufficient cause* for all our deaths is to be found in the filth and pollutions which are allowed to remain in our midst, and which poison the air, more or less, of the whole city, but most of all of the low and swampy districts. A large proportion of the inhabitants pour their slops daily on the spongy soil around their dwellings; house drains or even paved water-courses are little known; the contents of privies surcharge the porous earth around; and our back-yards, unusually large as compared with English cities, and which ought therefore to add greatly to our healthiness, are only so many more square feet soaked through and through with fœtid matter, forming (except during the merciful winter frost) an incesssant poison factory, wafting disease and death into our dwellings. A large number of our houses are built on stumps driven into this putrid soil or even marsh; the cellars are always charged with miasms, which find their way into the upper rooms; and too often the houses, even if not back to back, have no doors or windows except on one side. Very lately an M.D. of this city, with above the average of reputation, planted a group of cottages of this description on one of the worst undrained swamps in our midst. As if these evils, which may not meet the gaze of strangers, were not enough, the corporation persist in laying most of the streets in soft limestone, which in a very few days is ground to fine dust, and soon becomes charged with effete animal matter, in which form it enters our dwellings and lungs; or else it is in a state of mud, which emits so nauseous a stench that cottagers, who have shut their back windows to keep out the smell of the yards, are obliged to shut the front also to keep out the smell of the street. It is impossible faithfully to execute the contracts for street-cleaning, while this stone, long since reported against by the City Surveyor, and theoretically abandoned by the Road Committee, continues in full use: and as to the vaunted scavenging by-law, *the Council have refused the money to carry it out!* It may be said with very few exceptions, that in the more crowded parts of the city inhabited by all except the wealthy, there is scarcely a square yard of ground which is not charged with effete matter, ready to generate poisonous gases under the influence of every summer sun.

The foregoing may be regarded in great measure as errors of neglect or ignorance; but the very remedies applied at high cost are continual causes of disease. A large part of the older sewers in the city are made of absorbent and now putrid wood; and although the Council have determined to lay down no more, the brick sewers are often so badly constructed that the effete matter oozes through them, and deposits soon accumulate in their sluggish course. Moreover a large proportion of the house drains, even in high-rented dwellings, are still made of wood and untrapped. Only the new sewers are trapped at the gulley-holes; and at times, and in special places, the stench from these old poison-pits is insupportable. Thus our sewer and house drain system may be called (with few exceptions) an express contrivance for conveying the ordinary air-poisons, and the extraordinary infections of small-pox, scarlatina, &c., into every part of the city; and especially from the low into the higher levels, lest the rich should selfishly conclude that they were not affected by the evils which they allow to scourge the poor. The prevailing currents of air also, in the general direction of the river, while they serve somewhat to mitigate the unhealthiness of Griffintown, carry the air-poisons over the higher districts, where, being intercepted by the "Mountain," they impinge upon the fashionable streets and villas of our city.

Infants are more dependent on pure air even than children; they, more than adults; yet to all of us, unvitiated air is a necessary condition of health. Moreover, infants cannot escape from the air of their dwellings, nor from the poisons which fester there. The infantile death-rate is therefore the readiest thermometer, by which we estimate the virulence of poisonous emanations. How this thermometer rises and falls with the heat of the sun, has here been shewn. So far from wondering why so many children die in this city, we might rather wonder how so many manage to struggle into life, against such murderous forces. All these (as well as other) corrupting influences must be removed, if we hope to render up our account to the great Judge, free from the blood of these hundreds of children, to whom the Lord gave Life; who in their helplessness cry to us to nurture and guard it; but whom we, to save a few wretched dollars and a little toil and trouble, consign to a premature and therefore to a guilt-bearing Death.

MONTREAL, July 20th, 1865.

PROCEEDINGS

OF THE

NATURAL HISTORY SOCIETY.

(From March 1st to July 1st, 1869.)

MONTHLY MEETINGS.

Sixth monthly meeting, held March 29th, 1869, the President in the Chair.

The following donations were announced:

TO THE MUSEUM.

1,238 specimens (of 378 species) of Canadian insects, a small collection of fresh water shells, and a fasciculus of dried plants from Newfoundland: from Sir W. E. Logan, LL.D., F.R.S.

Pair of Barrow's Golden Eye (*Bucephala Islandica*) and female of the common Golden Eye (*Bucephala Americana*): from James Ferrier, Jr.

Pair of the Wood Thrush (*Turdus mustelinus*): from Mr. W. Hunter.

TO THE LIBRARY.

Annelides Chétepodes du Golfe de Naples, et Réponse à ses critiques, par M. de Quatrefages: from the author.

NEW MEMBERS.

James Shearer was elected an ordinary, and Cyril Graham a corresponding member of the Society.

PROCEEDINGS.

Mr. T. Macfarlane's paper "On the Geology and Silver Ore of Wood's Location, Thunder Cape, Lake Superior," was read by Dr. T. Sterry Hunt.

Dr. Girdwood read an essay "On the Application of Manures to Agriculture."

Dr. P. P. Carpenter made a communication "On Easy Methods for securing Effective Ventilation and Drainage in Dwellings."

Seventh monthly meeting, held April 26th, 1869.

DONATIONS TO THE MUSEUM.

A series of 25 named species of Graptolites from the Moffat

Shales: from W. Carruthers, F.L.S., &c. Seventy species of exotic shells, and a large series of European fossils: from A. Bell. One hundred and fifty species of European fossils, 4 rare minerals, 5 species of recent Echinoderms, 4 of crustaceans, and 2 of corals: from Bryce M. Wright. Seven skins of Jamaican birds, inner bark of the silk cotton tree (*Eriodendron*) and 4 species of exotic seeds: from F. A. B. Vinen. 6 English birds: from Mr. T. Cooke. Thirty-five skins of rare exotic birds, including three species of birds of Paradise; and 50 species of shells: from J. F. Whiteaves. Eleven species of exotic mammalia: from Mr. E. Gerrard, jr. Four species of foreign birds and 10 of reptiles: from the Liverpool Free Museum, per T. J. Moore. Japanese handkerchief case: from the St. George's Society. Russian soldier's sword, from Sebastopol: from J. T. Lacey.

TO THE LIBRARY.

Nature's Method of Controlling Noxious Insects, by Henry Shrimer, A.M., M.D.: from the Author.

NEW MEMBERS.

Hon. T. Ryan, Senator, Dr. W. Gardner, and Messrs. G. B. Burland, H. R. Ives, and R. Kellond, were elected ordinary members.

PROCEEDINGS.

Mr. J. F. Whiteaves then made some remarks upon some rare exotic birds recently added to the collection. In this communication the leading features of interest of a large series of birds recently acquired, partly by purchase and partly by donations, were briefly pointed out.

SOMERVILLE LECTURES.

The remaining two Lectures of this Course were delivered as follows:

5. March 4th, 1869. On the Recession of the Falls of Niagara: by C. Robb.

6. March 11th, 1869. *On the Adulteration of Food*: by G. P. Girdwood, M.D., &c.

ANNUAL MEETING.

The annual meeting was held on the 18th of May, 1869. the transaction of the usual business the Annual Address of the President was delivered by Principal Dawson; this will be found at page 121.

The report of the Council was then read by Dr. J. Baker Edwards, as follows:

REPORT OF THE COUNCIL.

Your Council, in reviewing the work of the past year, believe they may congratulate the members on the amount of progress attained.

The ordinary meetings have been fairly attended, and much interest has been evinced in the subjects brought forward; some of which have been of a highly practical and interesting social character, viz.:—

1. Oct. 26, 1868.—On some Specimens of Palæontological interest. By Principal Dawson.
2. " " On the remains of Mastodon found at Dunville, Ont. By E. Billings, F.G.S.
3. Nov. 30, 1868.—Notes on Beetles collected in the neighbourhood of Montreal. By A. S. Ritchie.
4. Dec. 28, 1868.—On some Recent Additions to the Society's Collection of Birds. By J. F. Whiteaves.
5. Jan. 25, 1869.—On the Prevention of Cruelty to Animals. By F. Mackenzie.
   " " " (On the) Vital Statistics of 1868. By Dr. P. P. Carpenter.
6. Feb. 22, 1869.—Notes on a Cruise in the Gulf of St. Lawrence. By John Bell, M.D.
7. " " Note~ on the Introduced Plants of Ontario and Quebec. By A. T. Drummond, B.A., LL.B.
8. March 29, 1869.—On the Geology and Silver Ore of Wood's Location, Thunder Bay, Lake Superior. By Thomas Macfarlane.
9. " " On the Application of Manures to Agriculture. By Dr. G. P. Girdwood.
10. " " On Easy Methods for Securing Ventilation and Drainage in Dwellings. By Dr. P. P. Carpenter.
11. April 26, 1869.—On some Rare Exotic Birds recently added to the Collection. By J. F. Whiteaves,
12. " " On Disinfectants. By Dr. J. Baker Edwards.

During the summer recess, the Society held a second field meeting at St. Ann's. Owing to unsettled weather, the party was a comparatively small one, but those who ventured were well repaid.

The excursionists were, by courtesy of the Grand Trunk authorities, conveyed by special train, which stopped first at Pointe Claire, allowing an interval, during which the party walked to the Quarries, and listened to an interesting address from Principal Dawson on the Geological features there exposed. Many fossils were obtained and the rocks closely examined.

The train then proceeded to St. Ann's, where the company separated into groups; the first, to collect fossils, under the guidance of Dr. Dawson; the second, to Fort La Berre, on the property of the Hon. J. Abbott, who gave a brief history of the old fort, and kindly entertained the party, which was conducted by Dr. Girdwood and Mr. Ritchie; and lastly, a botanical and microscopical party, in charge of Messrs. Whiteaves, McCord, and Edwards, who crossed over the river to Isle Perrot, where a large number of specimens in flower were obtained. After the return to the station, the prizes were announced as follows:

Largest number of named species of Flowering Plants, Mrs. Dr. Girdwood.
" " unnamed, Miss Dawson.
Juvenile Prize for Bouquet, Miss Edwards.

The Course of Somerville Lectures was of considerable and general interest, it embraced the following subjects:

1. On Palæozoic Land Animals. By Principal Dawson, F.R.S., &c.
2. On the Chemistry of Soap-making. By J. Baker Edwards, Ph. D., F.C.S.
3. On the Zoology of the Bible. By Rev. A. DeSola, LL.D.
4. On Primæval Chemistry. By Prof. T. Sterry Hunt, LL.D., F.R.S.
5. On the Recession of Niagara Falls. By Charles Robb.
6. On the Adulteration of Food. By G. P. Girdwood, M.D., &c.

The thanks of the Council and members are due to the gentlemen who have thus volunteered their exertions on the behalf of public instruction in Science.

The Conversazione, held on the 18th of February, was lively and interesting, and the Council believe was very acceptable to the members generally. The President gave an interesting address on the value of Scientific Education and Schools of Science for Adults. Prof. Johnson and Dr. Smallwood exhibited and explained a variety of philosophical apparatus, kindly lent by McGill College. Dr. J. B. Edwards exhibited and floated in the Museum, Plateau's Soap Bubbles charged with gas, which Mr. Charles Baillie illuminated with the Electric Light and maintained it steadily throughout the evening. A programme of excellent music was provided by Herr Mayerhoffer and his friends, the German Choral Society. A good display of Microscopes under the charge of members of the Montreal Microscopic Club, attracted great attention in the Library, which was also adorned with some valuable works of art, arranged by Mr. J. P. Clark.

On the 2nd February, an address was presented at the Court House, to the Governor General, Sir J. Young, who accepted the same with cordiality, and expressed his willingness to lend his aid to the Society, by becoming its Patron. The following day His Excellency visited the Museum, and was received by the Officers of the Society. He carefully examined the collections, and expressed his pleasure and interest therein.

We are indebted to the exertions of our esteemed Scientific Curator, Mr. Whiteaves, for very valuable additions to our Museum, partly presented and partly purchased, which will be enumerated in his report. These add greatly to the attractive character of the collection.

The membership of the Society during the year has somewhat diminished. The additions have been 14—losses 17; other sources of income are below the average; and in consideration of the loss of income by the presentation of Life membership to subscribers towards the debt, it becomes the duty of the friends of the Society to seek further additions to its ranks, and your Council would recommend an active canvass for new members and for subscribers to the *Quarterly Journal*, during the coming year. To the active officers of the Society, especially our industrious Curator, Mr. Whiteaves, our skilful bird-stuffer, Mr. Hunter, and our indefatigible Treasurer, James Ferrier, jun., Esq., the Society owes its best thanks for steady and hearty co-operation.

The Council have much pleasure in recommending to the Society that the silver Medal be presented to Dr. T. Sterry Hunt, F.R.S., for his valuable contributions to Science, in connection with the Geological Survey, and in the advancement of Chemical Geology in Canada.

The ventilation and lighting of the Lecture Room received the attention of your Council in the early part of the session, and some improvements in the admission of air were effected; it was found, however, absolutely necessary to provide means for carrying off the products of combustion, and by the kind assistance of Mr. M. H. Sanborn, the necessary amount was raised by voluntary contribution to complete the plan, by exchanging the open light for a Liverpool sunburner, which, being connected with a chimney, carries off all foul air, and will in future provide for the comfort and health of the audiences. One or two more improvements only require the necessary funds for their adoption, and your Council would appeal to some of the members to assist the future Council in carrying out these arrangements, viz., to provide a vestibule in the hall, and close in the lobby for a Curator's room, to fit double windows in the Lecture Room and Museum, and to colour and paint the premises.

In the Library a reading desk has been provided and the periodicals may there be found by members. The Library, however, requires urgently some clearances and additions, which duty we commend to the early attention of our successors.

During the year, the *Canadian Naturalist* has been put on a new and more popular basis, which your Council hope will make it more generally subscribed for among the members, and more acceptable to the public than heretofore. The Editing Committee has been re-organised, with a view to issue the Journal with greater regularity, and it will now appear Quarterly instead of Bi-monthly. It will contain a greater variety of matter, and be of a more popular scientific character. The Committee regret the delay in the appearance of the first number, which was partly due to the backward state of the two numbers of the last series, and partly to the printers' strike. The first number is now laid on the table and will be immediately in the hands of subscribers. Mr. Whiteaves, the Acting Editor and Recording Secretary, will be glad to receive the names of members who have not already subscribed for this Journal, and to receive communications or papers for publication therein, on subjects of natural or general science. The Society is responsible for 100 copies of the Journal which will be supplied to members at $2 per annum.

J. B. EDWARDS, Ph. D., F.C.S.,
Chairman of Council.

Mr. Whiteaves read his report as Curator and Recording Secretary, as under:

CURATOR'S REPORT.

During the past session, a large portion of the time has been spent in the active collection of new specimens. The additions to the Museum have been as follows:—

MAMMALIA.

Thirteen fine specimens of exotic mammals, new to the collection, have been added. These have been mounted, named, and placed temporarily in one of the large cases in the Museum. Two species have been added to our American series, a fine example each of the Water Mole (*Scalops aquaticus*), and of the Missouri pouched Rat (*Geomys bursarius*). Want of the necessary cases compels a temporary arrangement of many of the exotic mammals.

Several of the Canadian mammals are represented by very old and badly-preserved specimens, and these, as opportunity offers should be renewed.

BIRDS.

Efforts have been persistently made for some years past to make the series of Canadian birds as perfect as possible. Old specimens have been weeded out, and their places filled with fresh examples. During the past twelve months, twenty-two specimens have been added to our local collection. In the department of Foreign birds, great progress has been made. About 164 specimens have been added, all species of much interest, and some of considerable rarity. Among these latter may be noticed, three species of birds of Paradise, two species of the beautifully-coloured fruit pigeons (*Ptilinopus*), of the Indian Archipelago, Sonnerats' jungle fowl, three species of albatross, &c. The whole of the new birds have been skilfully mounted by Mr. Hunter, and are all named.

REPTILES AND FISHES.

Thirteen species of reptiles and three of fishes have been added during the past session. The space allotted to this part of the collection is altogether insufficient to exhibit even the whole of our present series. It is for this reason that we have not done anything towards completing our series of Canadian fishes, as at present we have nowhere to put them.

There are quite a number of reptiles and fishes in alcohol, which we are unable to exhibit from want of the proper bottles, and of suitable cases. The same reason has prevented the forming of a collection of the smaller and more critical Canadian fishes.

INVERTEBRATA.

In the kingdom mollusca rather over 100 species have been added. Large series of Canadian insects have been received from Sir W. E Logan, Mr. Billings, Mr. Ritchie, and Mr. Barnston. Over 500 species have been added, but many of these are duplicate specimens. Finally, five species of echinodermata, two of crustaceans, three cirrhipedes, two corals, and several sponges have been received.

GEOLOGY.

About 260 species of fossils, mostly from European formations, have been obtained. This has necessitated the re-grouping of the whole collection, which has been done, and the additions mounted, named, and incorporated with the general series. A few new minerals have also been received.

MISCELLANEA.

Several donations have been made to the ethnological and miscellaneous collections, but none of very special interest.

LIBRARY.

During the past year no new books have been purchased, and we still have to regret the absence of works of reference of recent date in every department of American natural history. Still, some improvements have been made in the library. By special application to the authorities we have succeeded in getting 35 volumes of the British Museum descriptive catalogues. During my stay in England efforts were made, with much success, to complete our series of English periodicals. Several of the numbers wanting to complete our American serials have also been procured, upon application to the editors; 20 volumes of serials have been bound since the last annual meeting; a reading-desk has been placed in the library, and the table re-covered.

Since the first of January considerable time has been spent in connection with the first number of the new volume of the Society's Journal, copies of which are now laid upon the table.

The most prominent wants in the Museum are additional cases for the series of mammalia, for fishes and reptiles, and for the formation of a collection to illustrate comparative anatomy and osteology. Further, special cases, with proper bottles, are urgently required to contain the collection of specimens preserved in alcohol, only a small portion of which can now be exhibited.

The additions to the collection during the session are the most important and numerous that have been received for years; and in conclusion, it is hoped that the work done has been in a satisfactory degree conducive towards the efficient carrying out of those objects, which it is the aim of this Society to foster and cherish.

J. F. WHITEAVES, F. G. S., &c.,
Curator and Rec. Secretary.

It was moved by W. Muir, seconded by L. A. H. Latour, and carried unanimously,

That the reports just submitted be accepted, printed, and distributed to the members.

On motion of Dr. Edwards, seconded by Dr. Smallwood, it was resolved:

"That the silver medal of the Society be voted to Dr. T. Sterry Hunt, F. R. S., to mark its appreciation of the value of his scientific labours, more especially in the department of Chemical Geology."

A vote of thanks to the President for his able and interesting address, having been moved by John Leeming, and seconded by Dr. Smallwood, was carried with acclamation.

The following resolution was also carried, having been moved by John Leeming, seconded by J. H. Joseph:

"That the thanks of the Society be voted to the officers for the past session, particularly to the Scientific Curator."

The following officers were then elected, Messrs. A. T. Drummond and Dr. John Bell acting as scrutineers:—

OFFICERS FOR 1869-70.

President.—Sir W. E. Logan, LL.D., F.R.S., &c.

Vice-Presidents.—Rev. Dr. De Sola: C. Smallwood, M.D., LL.D., D.C.L.; Principal Dawson, LL.D., F.R.S.; Dr. T. Sterry Hunt, F.R.S.; Dr. P. P. Carpenter; E. Billings, F.G.S. John Leeming; G. Barnston; C. Robb.

Treasurer.—James Ferrier, Jun.

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

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

Librarian.—A. T. Drummond, B.A., LL.B.

Council.—Dr. J. Baker Edwards, F.C.S.; A. S. Ritchie; D. A. P. Watt; D. R. McCord, M.A., B.C.L.; C. Baillie; G. L. Marler; J. H. Joseph; M. H. Sanborn; Dr. E. H. Trenholme.

Editing Committee of the "Canadian Naturalist."—General Editor, J. F. Whiteaves; Dr. J. B. Edwards (Chairman); Principal Dawson; Dr. T. Sterry Hunt; Dr. Smallwood; E. Billings; Dr. Carpenter; D. A. P. Watt; A. S. Ritchie.

Library and Membership Committee.—E. E. Shelton; R. McLachlan; R. J. Fowler; Dr. John Bell; D. A. P. Watt; and M. H. Sanborn.

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

TREASURER'S STATEMENT.

Dr. THE NATURAL HISTORY SOCIETY OF MONTREAL, in account with JAMES FERRIER, Jr., Treasurer. Cr.

1868.		Recapitulation.	
To Cash paid,		J. F. Whiteaves, salary	$400 00
"	"	Wm. Hunter, "	250 00
"	"	J. E. Poll, commission on collection	26 35
"	"	Interest	120 00
"	"	for Wood and Coal	163 25
"	"	Gas bills	71 40
"	"	Water "	40 60
"	"	City Assessments	45 40
"	"	Insurance	39 00
"	"	Repairs, and petty expenses	119 85
"	"	Books, Printing, and Advertising	124 54
"	"	Fixtures	171 76
"	"	Specimens	90 53
1869.			
"	"	Excursion	64 99
May 1st, 1869.—Balance in Treasurer's hands			60 99
			$1788 66

1868.		Recapitulation.	
By Cash received,		Government Grant	$750 00
"	"	Donations towards liquidation of debt	50 00
"	"	" " Glass Cases	50 00
"	"	Members' yearly subscriptions	552 00
"	"	Museum entrance fees	38 00
"	"	Rent of Lecture Room, &c	55 00
"	"	Sale of Old Cases	8 00
"	"	Excursion tickets sold	56 50
"	"	Proceeds of Conversazione	9 57
			$1788 66

Montreal, May 1st, 1869.

E. & O. E.

(Signed,) J. Ferrier, jun., *Treasurer*.

STATEMENT OF LIABILITIES, MAY 1st, 1869.

Mortgage on Society's Building, favour Royal Institution	$2000 00
Dawson Bros.' account	128 75
Total	$2128 75

We, the undersigned, have examined the vouchers and compared them with the entries, and find them correct.

(Signed,) G. L. MARLER.
(Signed,) ALEX. S. RITCHIE.

18 May, 1869.

FIELD DAY AT BELŒIL.

The third of these pleasant social gatherings was held on Wednesday, June 9th—the place selected being Belœil Mountain.

By the courtesy of Mr. C. J. Brydges, a special train was provided to convey the party as far as St. Hilaire. A little after 9 o'clock a.m., some 150 or more of the members and friends of the Society, took their seats in the train at the Bonaventure street station. At about 11 o'clock the excursionists arrived at St. Hilaire. Here vehicles of various descriptions were in readiness to convey the visitors part of the way up the mountain. The more zealous naturalists, however, preferred walking, knowing that many objects of interest would be found at the base of the mountain. Nor were they doomed to disappointment, for not only were several scarce plants found that were not met with further up, but rocks of the Utica shale and Hudson river group were seen in situ, with their characteristic fossils. By noon the whole party had assembled at the lake, when Dr. J. B. Edwards explained the programme for the day, and stated that letters had been received from Major Campbell, C. J. Brydges, Rev. Dr. De Sola and Drs. Smallwood and Girdwood, in which they expressed their regret at not being able to be present. Half an hour was then given for the consumption of creature comforts, and after lunch, Dr. T. Sterry Hunt gave a short account of the history of the mountain.

He stated that he had expected Major Campbell would deliver an address, but that gentleman had said there was little of historical importance to relate. The mountain was known by three or four different names, Belœil, Rouville, Chambly, and St. Hilaire. It was called Rouville, from the seigniory of that name, and Belœil, from Belœil seigniory opposite. There was a grand religious demonstration here in 1841, when Monseigneur Forbin-Janson, Bishop of Nancy, came out to the country, and by his marvellous eloquence caused a great religious awakening among the French Canadians. The Bishops of the province determined to commemorate his visit by erecting a cross for pilgrimage upon this mountain. Accompanied by their clergy, and an enormous concourse of the faithful, they came here on the 6th October, 1841, and erected a cross on the top of the mountain, to represent the Cross of Calvary, previously making fourteen little stages up the mountain side, to mark the fourteen stages of our Lord's Passion. The people then gathered upon the shores of the lake, to the number of 10,000 or 20,000, as variously stated, filling even the trees, and the eloquent Bishop preached to them from a little boat on the lake. In 1844, or 1845, the support of the cross gave way, and it became a ruin. He feared that since that time, the faithful had almost forgotten this famous pilgrimage. The mountain had also been called *le pain de sucre*, or sugar loaf, but he trusted it would prove easier of ascent, than might be supposed from the name.

Two parties were then formed, one for the study of the geology of the mountain, under the guidance of Principal Dawson and Dr. T. Sterry Hunt; the other to collect botanical and zoological specimens, with Dr. Bell and Messrs. McCord, Ritchie and Whiteaves as leaders. The ascent was then made in a leisurely and excursive way, until in due course the summit was gained. The clink of the hammer during the ascent, and the fair faces around one, brought vividly before the mind's eye the scene described in the well-known lines from "The Princess":—

> Many a little hand
> Glanced like a touch of sunshine on the rocks,
> Many a light foot shone like a jewel set
> In the dark crag; and then we turn'd, we wound
> About the cliffs, the copses, out and in,
> Hammering and clinking, chattering stony names
> Of shale and hornblende, rag and trap and tuff,
> Amygdaloid and trachyte, till the sun
> Grew broader towards his death and fell, and all
> The rosy heights came out above the lawns."

The extensive panorama visible from the summit, was the theme of much admiration. To the south and east the mountains of Monnoir, or Mount Johnson, Montarville, Brome and Shefford met the eye, and in the haze, the Green Mountains were dimly perceptible. Nor was the charm of water lacking to complete the landscape; the St. Lawrence and the Richelieu Rivers, the mountain tarn at our feet, and a portion of Lake Champlain helped to make up the picture, which may be described as a flat, enormous plain of stratified rocks, here and there broken through by isolated trappean hills.

The gathering was then called to order, and Principal Dawson, standing upon the most convenient rock, said he had anticipated

Sir William Logan would have been present, but he had been unable to come. The duty of speaking about the geological features of this remarkable mountain would devolve upon Dr. Sterry Hunt, who knew so much more about it than any other person present. They might consider themselves standing upon the capital of one of the great pillars which support the earth; for the mountain was one of those solid masses of igneous rock which might be traced down into the far depths of the bowels of the earth. They were little mountains, it was true, but they were far older than some more pretentious ones, and deserved to be respected because of their venerable antiquity. These mountains give us a striking illustration of the condition of the country immediately preceding the time when it first became inhabited by man. The plains now spotted with farm-houses were, when visited by Jacques Cartier, one unbroken forest. But ages before that they were merely an extension of the Gulf of St. Lawrence, and the mountain upon which we now stand was a little island, around which great quantities of ice floated, just as they do now in the Strait of Belle Isle. On the companion mountain of Montreal, at a height of over 400 feet above the present sea level, might be found deposits containing sea shells and other marine animals, of the same species, for the most part, as those now living in the Gulf of St. Lawrence. The processes were then explained by which the present contour of the landscape was effected, and the country made as we now see it, fit for the habitation of mankind.

Dr. Hunt then gave a short account of the features of geological interest of the mountain, and of the surrounding country, as follows: He stated that he would prefer to give a dozen lectures respecting the mountain rather than condense what he would like to say into a speech of a few minutes. A fine view was offered of the geographical divisions of the country. The valley of the St. Lawrence, with the fine champaign country now in view, was bounded on the north by the Laurentide Hills, which stretched from Ottawa and the rear of Kingston to the Gulf of the St. Lawrence. In the south might be seen the Green Mountains, a continuation of which range, called by the early French settlers the Notre Dame Mountains, stretched along the south shore of the St. Lawrence to the sea. These southern mountains were a portion or spur of the great Appalachian chain. The Doctor then called attention to the trappean hills, including the one upon which the party was standing, which occur in the area between the two great mountain ranges just described. It had been stated that Belœil was a granitic mountain and belonged to the Appalachian chain; but this was a mistake. In the first place, these rocks are not granitic; in the second place, they do not belong to the Appalachians, to which they had been referred; and thirdly, they differ from the Appalachian hills, which are all stratified rocks. These mountains around us are all volcanic in their origin and are composed of unstratified rocks. There are marks of a great rupture of the earth at intervals, which might be traced in the valley. Along this fissure or line poured, in olden times, a great quantity of volcanic rock. This valley of the St. Lawrence was then in a state of great volcanic activity; and there were burning mountains, earthquakes, and disturbances such as now occur on the Pacific coast and along the Mediterranean; and some mountains poured out masses of lava. These hills are the bases or roots of so many volcanic cones. These cones were probably much higher than the present mountains, and their roots were altogether buried in the soft rock which then filled the whole valley to a level above some of these mountains.

At a very early period, much of this filling was removed by water, and subsequently, in the Post-pliocene period, the great polar current swept down this valley, carrying with it icebergs, and grinding and wearing away all the soft parts, until finally this harder mass resisting its action, remained in bold relief. This rock is of a harder, denser texture and is less liable to wear down than Montarville and most of the other mountains, and, for this reason, it is higher. These rocks have a distinct character: Rigaud and Montreal differs from this; Boucherville differs very widely from it, and Yamaska differs somewhat from either. Brome and Shefford are unlike anything else you find in these. You have in these mountain peaks some of the most remarkable and varied types of eruptive rocks. The erosion just mentioned will account for the very singular and level aspect of the scenery around these hills. It is extremely difficult to fix the precise age of these rocks, even geologically. But these mountains were old when the first sands of the Alps and the Himalayas were at the bottom of the deep. There was another curious story: from the evidence of the existence of Devonian limestone on the other side of the lake, it appeared that after the earlier erosion there was again a filling up of the valley with Upper Silurian and Devonian rocks, and this filling up was again swept away by water.

With reference to the lake, Dr. Hunt explained that the water shed and r .fall were quite sufficient to supply a little lake like that. The mountain was 1287 feet above the Richelieu and about 1300 feet above the sea.

After spending some time on the top, to enjoy the prospect and to collect specimens of the peculiar micaceous diorite of the mountain, together with other objects of Natural History, the company returned to the lake. Here the judges examined the collections made, and awarded three prizes, as follows:—

1. For the largest number of named species of flowering plants: Miss Isabella McIntosh, 37 species.

2 and 3. Best juvenile collection of flowers, not named: Masters G. T. Robinson and Rankin Dawson, equal, each 33 species.

Honourable Mention: Masters Robert Lewis, 21 species, and E. G. Penny, 17.

During the day the following results were obtained by the Zoological and Botanical parties. In the department of Zoology no unusual birds were noticed. Several examples of the wood frog (*Rana temporaria var-sylvatica*), a geographical variety of the common English species, were met with, as were also examples of a land salamander of the genus Plethodon. The only ophidian observed was the "small brown" snake (*Storeria Dekayi*). No scarce land snails were taken, though the beautiful *Helix Sayii* of Binney is not unfrequent here, and a rigorous search might have resulted in the capture of the still rarer *Helix dentifera*. Among the butterflies we noticed the yellow "swallow-tail" (*Papilio turnus*), the destructive small cabbage butterfly (*Pieris rapæ*), recently introduced into this country from Europe, the "Camberwell beauty" (*Vanessa antiopa*) and several "skippers." At the top of the mountain, upon beech trees, were found several specimens of the fine and scarce lunar moth (*Saturnia luna*), the crumpled wings of the specimens shewing plainly how recently they had emerged from the chrysalis. Ten species of beetles were taken, a list of which, kindly prepared by Mr. A. S. Ritchie, we subjoin:—

Cicindela repanda, Dej.	Aphodius fimetarius, Linn.
Platynus sinuatus, Dej.	Lachnosterna fusca, Frohl.
Pterostichus caudicalis, Say.	Corymbites æripennis, Kirby.

Staphylinus cingulatus, Grav.
Geotrupes excrementi, Say.
Meloe angusticollis, Say.
Chrysomela scalaris, Leconte.

In Botany about 60 species of flowering plants were collected. We give a list of the most interesting, omitting only extremely common species: *

Clematis Americana	American Clematis.
Ranunculus abortivus	Small-flowered Crowfoot.
" sceleratus	Cursed Crowfoot.
Aquilegia Canadensis	Wild Columbine.
Actœa spicata	Bane Berry.
Chelidonium majus	Celandine.
Turritis stricta	Tower Mustard.
Viola blanda	Sweet White Violet.
" cucullata	Common Blue "
" rostrata	Long-spurred "
" Canadensis	Canadian "
" pubescens	Downy Yellow "
Cerastium viscosum	Larger Mouse-ear Chickweed.
Claytonia Caroliniana	Spring Beauty.
Acer Pennsylvanicum	Striped Maple.
Prunus Pennsylvanica	Wild Red Cherry.
" Virginiana	Choke Cherry.
Potentilla tridentata	Mountain Cinquefoil.
Pyrus arbutifolia	Choke Berry.
Amelanchier Canadensis	June Berry.
Ribes Cynosbati	Wild Gooseberry.
" prostratum	Fetid Currant.
Saxifraga Virginiensis	Virginian Saxifrage.
Mitella diphylla	Two-leaved Mitrewort.
" nuda	Naked Stemmed do.
Tiarella Cordifolia	False Mitrewort.
Hamamelis Virginica	Witch Hazel.
Aralia racemosa	"Spikenard."
" nudicaulis	Wild Sarsaparilla.
Lonicera ciliata	Fly Honeysuckle.
Viburnum opulus	Cranberry Tree.
" accrifolium	Maple-leaved Arrow-wood.
" lantanoides	American Wayfaring Tree.
Oldenlandia cœrulea	"Bluets."
Antennaria plantaginifolia	Plantain-leaved Everlasting.
Vaccinium Canadense	Canadian Blueberry.
Trientalis Americana	Star-flower.
Scrophularia nodosa	Knotted Fig-wort.
Pedicularis Canadensis	Wood Betony.

* We are indebted to Dr. John Bell for the identification of several species in this list.

Cynoglossum officinale	Common Hound's Tongue.
" Virginicum	Wild Comfrey.
Hydrophyllum Virginicum	Water Leaf.
Asarum Canadense	Canadian Wild Ginger.
Dirca palustris	Leather-wood.
Juglans Cinerea	Butternut.
Fagus ferruginea	American Beech.
Corylus rostrata	Beaked Hazel.
Ostrya Virginica	Iron-wood
Arisæma triphyllum	Indian Turnip.
Platanthera bracteata	Bracted Green Orchis.
Corallorhiza innata	Coral-root.
Iris versicolor	Larger Blue Flag
Sisyrinchium Bermudianum	Blue-eyed Grass.
Trillium grandiflorum	Large White Trillium.
" erectum	Purple Trillium.
Polygonatum biflorum	Smaller Solomon's Seal.
Smilacina bifolia	Two-leaved False Solomon's Seal.
Streptopus roseus	Twisted Stalk.

The ferns gathered were all common species, and the most interesting cryptogam met with was the "apple" moss, *Bartramia pomiformis*, in fine fruit.

After the names of the successful candidates for prizes had been announced, Mr. Ritchie made a few remarks as to the number of species of insects taken during the day. An informal vote of thanks to the Committee who had organized the excursion, was proposed by Mr. Mackay, seconded by Mr. Champion Brown, and carried with acclamation.

About six o'clock tea was partaken of under the shade of the maples by the lake, and shortly afterwards the party returned to the Station. While waiting for the train several of the party were permitted, by the kindness of M. Valiquet, the Station-master, to examine his large collection of bees. The hives, amounting to from fifty to sixty in number, were placed each in a frame, out of one of which a portion of the comb was taken, which showed the workers in the act of making cells for three queens in a new swarm. M. Valiquet has devoted forty years to the study of bees, is President of an Apiarian Society, and received a medal at the late Paris Exhibition for improvements in bee culture.

The party arrived in Montreal a little after eight o'clock in the evening, apparently delighted with the pleasant day they had spent.

J. F. W.

MONTREAL MICROSCOPIC CLUB.

THIS Association was founded early in 1868 for the "promotion of microscopic knowledge amongst its members, by regular meetings for practical microscopic work, and for the interchange of ideas and experiences on microscopical subjects." The microscope is an eminently social instrument, for there is a natural craving in the mind of the observer of the beautiful, to share his pleasure with another. This Club is also of a highly social character, and its meetings are held fortnightly at the members' residences during the winter season. The "utile" is thus combined with the "dulce," and, without the reading of formal papers, valuable practical information is exchanged. From the pleasant and profitable working of this Club, we would strongly recommend the multiplication of such organizations in the cities of the Dominion—and look forward to a pleasant interchange of communication from such societies when formed. In England they have proved a remarkable success, and whilst in London such a Club formed the original nucleus of the Royal Microscopic Society, in the large county towns they have multiplied the number of microscopic observers an hundred fold. We hope to be able to chronicle a similar result in this country, where we have a glorious field for original investigation in every department of natural science. For the encouragement of similar efforts, we publish our plan of association, which we believe has been very successful, both here and at home, and therefore submit the following hints. It is desirable that such a Club should not be too numerous—from twelve to fifteen members is an amply sufficient number. It is better that these should be acquainted with each other, and that they should represent various professions. Here is a ground upon which clergy and laity, law and commerce, physician and patient, can meet on a common platform of intelligence and research; and no man's occupation or profession need prove the slightest barrier to his co-operation. Some may be proficient in the art, or be so favoured as to possess a valuable instrument; others may be disciples only, but rich in zeal; some may possess well-stored cabinets of choice objects, and others bring the

"Comely eels" from "the verdant mud."

All are welcome, and amongst the rich gifts of abundant nature comparisons are mute. Wherever six men can be found of the right sort, we would advocate the establishment of such a Club, even if only three microscopes could be raised amongst them to do the work—even one good instrument will do a great deal, with a good set of eyes. Our plan is very simple. The Club appoints a secretary, who arranges for the meetings, and suggests a special subject for illustration 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 investigation 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."

During the intervals of meeting the Monthly and Quarterly Microscopic Journals circulate amongst the members, and afford material for discussion and illustration.

The plan may be varied for different localities, but its general outline has borne good and useful fruit for nearly twenty years, at least such is the writer's own experience, and should further details be desired in furtherance of the establishment of similar organizations, the Honorary Secretary of the Montreal Microscopic Club will be glad to furnish them.

J. B. E.

REVIEWS AND NOTICES OF BOOKS.

* DISINFECTANTS AND DISINFECTION, BY ROBERT ANGUS SMITH, PH.D., F.R.S., F.C.S.—Dr. Angus Smith, the author of the treatise here noticed, is well known in Lancashire as an able, cautious and conscientious chemist, and in connection with the various chemical industries of which Manchester is the centre, he, more than any other man of his day, has had ample opportunities of forming opinions on this vital subject, both from an economical and from a scientific point of view. These opinions are entitled to the highest respect, although they are often more suggestive than positive, and indicate rather the candid and cautious than the convinced mind. The introductory chapter gives us a

* Published by EDMONSTONE & DOUGLAS, Edinburgh. 1869.

general history of Disinfection, from which it would appear that during past years mankind has been struggling against filth and disease, with various retrogressions, and with but partial success—with no rational conception of the evil to be avoided, or of the nature of the remedy to be sought.

From the East, however, he traces practices of public cleanliness, which were strictly adopted by the Romans, such as the use of drainage, of disinfectants applied to sewers, and of the daily removal of all refuse or decomposing animal matter from the roads. Pitch, and the substances derived from its distillation, appears to have been highly prized, and to the same products modern science turns with the greatest confidence.

The idea that epidemic disease was produced or encouraged by the decay of animal or vegetable matters, was deeply rooted in the minds of the ancient Greeks and Romans; and after a general laxity of such belief and carelessness of such consequence, modern science reverts to this idea, assisted by the researches of Dusch, Schroeder, Liebig and Pasteur. On this subject our author says:—

"The two great theories may be called Liebig's and Pasteur's—the first, (Liebig's), dealing with organic decomposing matter ready to communicate its action by its own activity. That idea has a sound scientific basis, and I am disposed to think it quite undeniable at present.

"The second, that of Pasteur's, leads to organized bodies or germs, and although he also has not originated the idea, its clearest proof and expression is due to him. He does not seem to have retained firm hold of a part of the battle ground gained from chemistry. There is probably a point where the 'organic' and 'organised' touch so nearly as to be difficult to distinguish, but here the distinction between the two is very real, and the point of contact is still to be sought."

Cases of disease our author says are caused:—

"1st. By gases.

"2nd. By vapours.

"3rd. By putrid or decomposing substances.

"4th. By organized bodies in various stages and ferments."

To meet these, disinfectants are employed of various natures, viz.:—

1st. To attack the gases and vapours – Oxygen, chlorine.

Thus nitrous oxide from saltpetre or nitric acid—chloric acid from chlorate of potash—chlorine from hypo-chlorite of lime—Ozone from permanganate of potash—(Condy's fluid.)

These are true disinfectants—that is, removers of smell, de-odorizers, and destroyers of decaying matter, but not antiseptics, that is preservers of organic substances.

De-oxidizers have a similar office, and sulphur fumigation is *one of the most ancient forms of purification.* In Cowper's translation of Homer's Odyssey, book xxii., line 492, we have:—

"Bright blast-averting sulphur, nurse, bring fire!
That I may fumigate my walls; then bid
Penelope with her attendants down,
And summon all the women of her train.
But Euryclea thus his nurse replied.
My son! thou hast well said; yet will I first
* * * * *
Not so. Bring fire for fumigation first.
He said: Nor Euryclea, his loved nurse,
Longer delayed, but sulphur brought, and fire,
While he, with purifying streams, himself
Visited every part, the banquet room,
The vestibule, the court."

Glauber, in 1689, part 3, p. 2, says:—"Whoever shall attempt to describe sulphur in a most accurate manner, will have need of abundance of paper. But he that knows nothing of sulphur, knows nothing at all."

The gas (sulphurous acid gas) is very valuable in arresting fermentation and cryptoganic growth. It de-odorizes putrid matter, while it disinfects. Chlorine may act either as an oxidizing agent. It destroys putrid smells as if by magic, and thoroughly destroys animal matter.

Heat and cold are nature's own disinfectants, acting by des-sication and condensation. The tar acids are among the most valuable disinfectants, chiefly because they retain their power under circumstances of extreme dilution. The available forms of these compounds—viz., carbonic acid and carbonate of lime—are highly recommended as antiseptics as well as disinfectants. But the subject of comparative values of these disinfectants we will reserve for a subsequent notice, as our space is exhausted.

J. B. E.

(*To be continued.*)

GEOLOGY AND MINERALOGY.

Gold Deposits of Nova Scotia.—Prof. Hind has recently issued a detailed report on the Gold Veins of Waverley, which, however, he regards as beds rather than veins. He notices the occurrence, in a bed of quartzite, of fossils or concretions, which he compares to *Palæotrochis* of Emmons, from the so-called "Taconic" Rocks of North Carolina. Such supposed fossils have, we believe, been previously found by Dr. Honeyman, but Prof. Hind has, for the first time, published them as probable organic remains, and, if this view be sustained, will have been the first to announce the discovery of fossils in the gold rocks of Nova Scotia. The following extracts exhibit some of the most important parts of this report:—

"Among the most remarkable peculiarities of the leads are the markings on the quartz and on the enclosing rock, whether Whin or hard compact slate. These markings vary from slickensides to huge rolls, several feet apart, and sometimes a foot in the swell. They are found in the slates, remote from leads, and often resemble ripple marks. To Mr. Campbell the credit is due of first calling particular attention to these markings, and Dr. Hunt, likewise impressed with their importance in regard to the structural geology of the Gold Districts, says:—

'Mr. Campbell has called special attention to what he has called the grain or reed-like marking often impressed on the surface of the beds in a direction parallel to the east and west axes of folding, and he points out that the angle of dip, eastward or westward, of these markings on the crown of the great anticlinals, enables us to detect the transverse or north and south lines of undulation, which have at a subsequent period disturbed the horizontality of the east and west anticlinal folds. The markings in question often appear as rib-like ridges or flutings, which are most conspicuous on the surface of the auriferous quartz layers and the enclosing beds. On the summit of the anticlinal folds they are sometimes so large, and so well defined, as to give to the layers a wrinkled or corrugated form, producing what is designated in the region as barrel quartz, and has, by some observers, been compared to the ripples on water, and by others to that parallel arrangement of logs which is seen on what is called a corduroy road. The best known samples of this is at Waverley, but it is also seen at Montague, Oldham, and at Upper Stewiacke.'

"A few yards west of the West main dislocation at Waverley a fine illustration of these corrugations is visible in the slates. The resemblance to ripple marks at the first glance is very striking, but a closer examination shows that the corrugation is not on the same plane as the bedding, and consequently the force which produced it must have been other than water.

"The direction of the axis of the small undulations is such that they might well have been produced during the folding of the greater or east and west anticlinal, but the occurrence of similar corrugations in other districts, at angles nearly approaching forty-five degrees, where there is no evidence of a cross anticlinal of such magnitude, gives color to the supposition that these markings were not necessarily associated with the first folding, and that they are untrustworthy guides in relation to that movement.

"At Montague, and at Mount Uniacke, there are small and large undulations and markings, which do not appear to have had any connection with the east and west folding, but it is very probable that they were connected with local disturbances in those districts, and may form valuable assistants in discovering the displacements. Under all circumstances they are well worthy of study, and such distinguishing characteristics may eventually be found as will enable them to be separated, and referred to the force which produced them, whether occasioning a fold or a dislocation.

"They have, however, an especial bearing on the structure of numerous leads, which give indisputable evidence of motion, either in their body or at one wall. The coincidence between the direction of the ripples on the slates at Waverley and the dip of the rocks resulting from the cross anticlinal, is so marked that in this instance they may with propriety be referred to the first folding; and the force which occasioned the ripples caused also a bodily sliding to a small extent of one bed of strata over another, and the production of a fissure which was subsequently filled with quartz and carbonate of lime constituting a segregated vein. Sometimes the fracture took place in or near the middle of a bed of quartz. At Mount Uniacke, for instance, there is a four-foot lead, which has a fracture near the centre, partially filled (subsequently) with arsenical iron pyrites, and in the cavities the crystals of quartz are seen with their apices pointing towards each other. The same peculiarity is not unfrequently observed in large leads. At Waverley the movement has occurred between the quartz and the Whin, or between the quartz and hard slate, or in bands of slate, and in all cases slickensides, reed-like markings, ripples and small undulations have been produced. In the Barrel Quartz no sliding motion is distinguishable, for the corrugations extend far into the overlying Whin rock until they assume the form of a series of connected arches five, six, and even seven feet in width. The corrugations are by no means confined to the quartz lead, but spread out, fan-like, into the overlying rock. At Montague the ripples or swells are at an angle of 45°, and are frequently from five to eight feet apart, and the swell rises as much as six inches above the plane of the bedding, the laminæ of the wall rock conforming to it. At Lawrencetown there are similar large ripples, but at an angle of about 30°. The leads in question, both at Montague and Lawrencetown, are synclinal forms. It is a popular belief that in the vicinity of these swells the lead is more productive than between them. It appears to be well established at Montague that the nodules of arsenical iron pyrites containing free gold, are more numerous and of larger proportions close to the swell than at a distance from it. But lenticular masses of arsenical iron pyrites are found in the Whin, remote from any visible vein, unconnected with one another, and sometimes lying at right angles to the bedding.

At Hammond Plains there are immense beds of feebly auriferous quartz, as much as 20 feet thick, and in these crystals of oxide of zinc are numerous, besides numerous cavities lined with crystals of calcareous spar; the surfaces of the crystals are spangled with cubical iron pyrites. At Renfrew, where the strata have evidently slid over one another, crystals of calcareous spar are common, and sometimes form as much of the lead as the rich gold-bearing quartz itself; these occur on the Free Claim, where a considerable twisting of the strata has taken place, and short unconnected, bnt thick auriferous veins, fill the cavities formed by the movement, which are newer than, and wholly distinct, from the bedded leads, contemporaneous with the strata. While the gold which the bedded leads contain, in common with the other metals, was most probably derived from the oceanic waters from which the quarty was deposited, the gold in the short segregated veins of subsequent origin was transferred from the bedded leads or auriferous interstratified slates.

"In every district in Nova Scotia it is remarked that the gold frequently "runs in streaks;" that is to say a zone of rich auriferous quartz occupies a certains breadth in the lead, while to the east and west of that zone the quartz is comparatively poor in the precious metal. It is also found that in different districts the "Gold Streak" has a different angle with the horizon, and that sometimes the course of the rich zone is coincident with the ripples or swells in the leads,—also that the Gold Streak varies in direction in different leads.

"At Montague the Gold Streak dips at an angle of 45 degrees to the west, so also do the corrugations in the lead.

"At Sherbrooke in some mines the Gold Streak on the south side of the anticlinal dips to the east at a high angle, and on the north side to the west at about the same angle.

"At Lawrencetown the dip is westerly at a low angle. The dip of the corrugations is the same.

"It is probable that in each lead the Gold Streak has a course peculiar to itself, with an easterly and westerly trend. Known facts respecting the Gold Streak are too few and too indefinite to permit of any conclusion being drawn for any number of leads, but where one lead is taken into consideration, much useful information may be obtained by studying the structure of the lead and the direction of the "Streak."

"In the shallow synclinal at Lawrencetown for instance, the dip of the Gold Streak being westerly at a low angle on the south side of the synclinal, its dip will probably be easterly at the same angle on the north side. On an anticlinal if the streak or zone dip easterly on the south side, it will be found dipping westerly on the north side, in the continuation of the same lead or sheet of auriferous quartz. At Montague there are two very rich zones on the same lead about 520 feet apart, dipping west at an angle of 45 degrees. The breadth of one zone is about 300 feet of the other 250 feet; the yield of gold in each has been tolerably uniform, and averaged 3½ ounces to the ton. On the west side of these zones the yield diminishes abruptly to 5 dwts. per ton; on the other side it shades off to 3 dwts. per ton.

"The distribution of the zones at Sherbrooke leads to the inference that the gold was originally deposited in belts from the oceanic waters, whether influenced by accumulations of organic matter or otherwise. It would be a simple matter to explain the structure of the Gold Streak, on the supposition that organic matter determined the deposition of the metal, in belts or zones, for it is easy to conceive accumulations of stranded organisms on subaqueous beaches, in a shallow sea, in the form of long, narrow bands. Organic matter determines the deposition of most metals from solutions, and whatever intermediate combinations and decompositions took place, accumulations of organic matter may have been the proximate cause which determined the distribution of the gold in zones or belts. According to this view the direction of Gold Streak will probably differ slightly in each lead, but there will be a general parallelism in a considerable number of adjacent leads, and the direction of one zone will be a clue to several.

"But other and more important deductions may be drawn when attention is given to one particular lead. The course of the Gold Streak being once known, it can be traced through all the deviations produced by anticlinals, synclinals, dislocations, and in general almost all varieties of disturbance.

"From Mr. Burkner's table, on page 36, it appears that the average yield of the Tudor Lead, between the depths of 55 feet and 100 feet from the surface, was as follows, from east to west:—

"Breadth of Zone, 55 feet.

Mean yield on areas 165, 164, 163.	450 feet.	22 dwts.
" " area 162	150 "	36 "
161 And one-third of 160	200 "	24 "
Mean yield of two-thirds of area 160	100 "	$3\frac{2}{3}$ "

"The falling off in the west 100 feet of area, 160 is not only sudden but extreme. But it must be remembered that on this area the work was stopped at a depth of 110 feet. It is worth while to consider what probabilities exist of discovering the rich zone at a greater depth.

"An inspection of the section showing the form of the east and west anticlinal, points out the remarkable coincidence that in area 160 (or more properly area 201, where Mr. Burkner's shafts are really situated, as shown on the large plan, in the Mines' Department), the strata dip suddenly to the west at an angle of about

50 degrees. At Mr. Burkner's last shaft they dip N. 50 W., and are already to the west of the crown of the arch, produced by the lateral crush or squeeze between the walls of the great dislocations.

" Hence the zone of rich auriferous quartz, dipping with the strata, has already begun to plunge to the west at an angle of about forty or fifty degrees, and must be sought for below the depth of 110 feet, at which depth the work was stopped.

" The course of the rich zone, west of area 201, will be nearly parallel to the axis of the anticlinal, through areas 202, 203, south part of 157, 156, 155, &c., but descending westerly at an angle of about 45°, in a word, being roughly parallel to the intersection of the Tudor vein, as shown in the east and west section.

" Mr. Clarke states that no visible Gold treak was met with in that part of the Tudor Lead which passes through some of the properties east of Mr. Burkner's areas. But the " Streak" on the North Lead dipped from west to east, and the " Streak" on the North Taylor, South Taylor and No. 6 Leads, dipped from east to west. It is much to be regretted that no reliable data exists from which diagrams, showing the auriferous zones on these leads, can be constructed. The circumstance of the quartz, from all being mixed before crushing, makes it impossible to collate the necessary observations. The general fact is stated as the result of observations during the time the work was going on.

* * * * *

"A section, in detail, across three thousand feet of the strata at Mount Uniacke, made last summer, enables me to institute a comparison with the Waverley beds, and to draw some general conclusions, which show a remarkable similarity between the structure of these districts.

" The east and west anticlinal, at Mount Uniacke, is similar in form to that of Waverley, and may be described as a sharp fold, with an overturn dip on the south side. The summit has not been flattened or compressed, and it is probable that the overturn is greater than at the last-named district,—and bends over to the south instead of to the north.

" The rocks are generally similar in composition, and are arranged in alternating bed of whin and slate, with a bed of gritty quartzite not less than 380 feet thick, where the section was made, and without visible partings of slate. Succeeding this enormous band of quartzite are alternating beds of whin and slate, the first-named greatly preponderating.

"The strata at Mount Uniacke, from the axis of the anticlinal, in which direction the section was made southwards, may be represented as given below.

"The cross anticlinal appears to be very gentle, so that the outcrop of the band of quartzite, and consequently of most of the leads, if no great dislocations have taken place, will be that of a very long and narrow ellipse, much flattened on the south side and bulging out on the north side.

SECTION AT MOUNT UNIACKE.

	Feet.	Rocks.
Axis of anticlinal to arsenical group of leads......	475	Alternating beds of whin and slate with leads.
Arsenical group to centre of twisted slates......	200	Alternating beds af whin and slate with leads.—Twisted slates about 50 feet thick, and micaceous.
Centre of twisted slates to base of great quartzite band................	110	Whin and slate.
GREAT QUARTZITE BAND.	380	Very coarse at base, in fact, a grit, with grains generally as large as a mustard seed, then gradually becoming finer as it approaches the summit, where it is a very fine light-coloured rock.
Dark coloured slates with plumbaginous surfaces interstratified with bands of "whin."............	20	Leads.
Whin with thin bands of slate—in the centre the slates are twisted......	775	Leads.

	Feet.	Rocks.
Dark coloured slates, with plumbaginous surfaces, with thin bands of whin.	60	Leads.
Heavy bedded "whin," with a few thin bands of slate.................	750	Leads.
Total thickness measured..	2770 feet.	

A coarse grit, or quartzite, much resembling the coarse grit at Mount Uniacke, has been already described as occurring at Waverley, where it is especially distinguished by concretionary forms and fossils, supposed to be the Palæotrochis of Emmons. Hence it has been marked on the map as Concretionary Quartzite.

In the following section, made by Mr. Clarke in the spring of last year, the concretionary quartzite occurs in that part of the section enclosed within brackets, and it is the 431 feet of strata at Waverley, composed of 421 feet of "whin," and 9 feet 3 inches of slate, which I propose provisionally to place as the equivalent of the 380 feet belt at Mount Uniacke.

Mr. Clarke's Section on Areas 370, 315, 304, 249, 238, *and* 183, *on North and South Course.*

NORTH.

	Feet.	Inches.		
Whin...............	51		....	
	1	0	.... Lead	
Slate...............	6	5	....	
	1	4	.... Lead.	
Slate...............	5	6	....	
	1	0	.... Lead.	
Whin...............	30	6	....	
Slate	26		....	
*Whin............	178		....	Probable equivalent of the great band of quartzite at Mt. Uniacke.
Slate...............	1	3	....	
		6	..... Lead.	
Whin...............	161		....	
Slate...............	8		....	
Whin...............	83		....	
	0	3	.... Lead.	

	Feet.	Inches.		
Slate	1	3	....	
Whin	15	6	....	
Slate	2	2	....	
Whin	36		....	
Slate	35		....	
Whin	80	6	....	
		1	....	Lead.
Whin	5		....	
		2	....	Lead.
Whin	5	3	....	
		10	....	Lead.
Whin	77		....	
		2	....	Lead.
Slate	1	3	....	
Whin	64		....	
		3	....	Lead.
Whin	99		....	
	45		....	Concealed.
Whin	34		....	
Slate	41		....	

* * * * *

"Should the identity between these strata, in the two districts, be established, the following conclusions will be reasonable:—

"1st. That a large number of gold-bearing quartz leads lie underneath the lowest lead known at Waverley.

"2nd. That on the assumption that no very considerable differences in the aggregate thickness exist between the strata at Mount Uniacke and Waverley, there is a belt of auriferous strata, about six hundred feet thick, concealed beneath the barrel quartz at Waverley, which is exposed at Mount Uniacke.

"3rd. That the Taylor group may be identified at Mount Uniacke, associated with the "dark colored slates, with plumbaginous surfaces."

"4th. That the equivalent of the rich Tudor group may be found at Mount Uniacke.

"5th. That the majority of worked mines are on leads, which will be found below the barrel quartz at Waverley.

"There is no reason to suppose that the great quartzite belt, at Mount Uniacke, is destitute of leads or slate partings in other parts of the district. It has been already observed, that both slate and leads not unfrequently "thin out" and "take up" again; that they often form thin lenticular sheets, where whin occurs in massive beds. When leads are found in slate they are generally persistent.

"It is this intermittent form of some leads which has led to the opinion that they are segregated veins filling longitudinal cracks produced by the folding of the strata. It must be borne in mind that independently of the slaty structure of many leads, as described by Dr. Hunt, the pressure to which the strata were subjected during the folding, could not have been less than that of a mass of nine thousand feet in thickness, and, possibly, an incumbent ocean superadded. Under such pressure the formation of fissures would be problematical.

* * * * *

Several of the facts referred to in the above extracts, are supposed to indicate that the gold quartz is an original bedded deposit, formed under the same conditions as the containing beds. We are inclined to believe, however, that they admit of a very different interpretation, and that Prof. Hind, as well as other observers, have been misled by the supposed analogy of the bedded ores of the Quebec group of Lower Canada, which are very different from the veins parallel to the bedding so abundant in the metamorphic districts of Acadia.

The following observations are of a more practical character:

"The practice of mixing quartz from different leads, and crushing the whole together is to be condemned. It is impossible, by the adoption of this method, to ascertain whether a lead is paying or not. A poor lead worked at the same cost as a rich lead may neutralize all the benefits which would be obtained if the rich lead were worked alone. Each lead ought to be crushed by itself, and a statement of the result, with the cost of mining the quartz, recorded. This can be done without any difficulty in mills with from ten to twenty stamps, without retarding work, if system is adopted. Plans of all the workings are also essential, showing at least monthly progress. In case a fault is discovered in one lead, and difficulties should arise in ascertaining the effect of the disturbance, it can be speedily reached in a neighboring lead, and the question whether it is an upthrow or downthrow, or throw to the north or south, or two or more of these movements combined, settled generally without difficulty; but if no monthly plan of workings is kept on record, all is confusion. With the single exception of a plan and section, made some years ago by Mr. Bell, of the works on a few areas, together with a lithographed plan of the whole district, showing the position of the several properties, I was unable to obtain any plan of surface workings, much less any plan of underground workings, and the agents of the different companies uniformly informed me that none, to their knowledge, were in existence.

"The absorption of all returns to pay large dividends is, as a rule, as fatal an error in gold mining as in most other enterprises. When the different mines were yielding very handsome returns, it was most unwise to suppose that such unlooked-for prosperity would continue for any length of time. Nevertheless, it appears that nearly all profits were at once divided amongst the shareholders, and no reserve fund permitted to accumulate. Hence, when the returns grew less, the necessary means to provide machinery for deeper workings were not forthcoming, and, as a consequence, most of the establishments were closed.

"The narrowness of the properties is a great objection to permanent operations. Several companies at Waverley have only 450 feet on the leads. If, owing to the absence of appropriate pumping and hoisting machinery, the works are stopped at a depth of 300 feet, it is very easy to calculate the duration of a company with such a small quantity of available lead. The absence of any regulations defining the space which different companies shall leave between the workings on the same or adjacent lead, is likely to become a fruitful source of trouble. In one instance, at Waverley, the agents of two companies decided not to touch the quartz within four feet of their boundary on either side, with a view to prevent, by means of an eight foot dividing wall, the water from one mine draining into the other. This agreement, I was informed, was faithfully kept on one side and as grossly abused on the other, the whole of the four feet of quartz being removed. The consequence is that the works on one mine being stopped, the proprietors of the other have been vainly endeavoring to drain both, on account of leakage through the dividing wall, which unfortunately has hitherto defied all their attempts to arrest.

It is an error to suppose that because a lead diminishes in average, so as to be worked at a loss, that it will necessarily continue poor. All experience in gold mining tends to prove that all leads or veins are more or less intermittent in yield. If we may be guided by Montague, the nearest district to Waverley, and a synclinal fold of the same auriferous belt, the rich auriferous zones follow one another within a few hundred feet. It has already been stated that many of the leads in California have a bedded structure, and they are profitably worked at a depth of 800 feet with intermittent degrees of richness. At the same time proper machinery for hoisting and drainage must be adopted in order to arrive at this result, which, it need scarcely be observed, cannot be obtained if shareholders insist on a division of all profits, without leaving any reserve for contingencies, and subsequently refuse to raise additional funds when the period for their application arrives.

It is to be feared that this system is too commonly pursued in Nova Scotia, and there is reason for supposing that other districts will soon be in the same condition as Waverley. But there is no present cause for apprehension, that with systematic mining, conducted on proper business principles, the leads will be less profitably worked in the future, or that there is any danger whatever of the yield of gold diminishing under the judicious management of mining properties. On the other hand, the remarkable uniformity and continuity of the leads, their great number in a small vertical space, their bedded structure, which implies indefinite prolongation, and the high percentage of gold they contain, are convincing proofs that when capital, skill, and forethought are combined, a very large proportion of both West and East Waverley will yet be profitably mined for many years to come.

BOTANY AND ZOOLOGY.

SHEPHERDIA CANADENSIS.—Most microscopists are aware of the extreme beauty of the scales of Elœagnus when viewed under a low power, and with polarized light. It may not however be so generally known that precisely the same kind of scale are to be found on the leaves of the *Shepherdia Canadensis*, the only Canadian example of the Elœagnus or Oleaster family.

The Shepherdia is a small shrub common in Lower Canada, and was named after Mr. John Shepherd, a former curator of the Liverpool Botanic Garden. J. F. W.

THE COLOURS OF FOLIAGE.—The green colour of leaves, one element of which must be a vegetable blue, has led an American experimentalist to the conclusion that leaves turn red at the end of the season through the action of an acid, and that the green colour could be restored by the action of an alkali. The conclusion has been verified, the *Athenæum* declares, by experiment. Autumnal leaves placed under a receiver with vapour of ammonia in nearly every instance lost the red colour and renewed their green. In some, such as the sassafras, blackberry, and maple, the change was rapid, and could be watched by the eye, while others, particularly certain oaks, turned gradually brown, without showing any appearance of green.

BIRDS OF THE GUANO ISLANDS.—We copy the following extract, descriptive of "Life on a Guano Island," from a late number of the New York Times. "Among the chief objects of interest to a visitor on Baker's Island are the birds, and they are well worthy of study. During the first night of my stay on this forlorn spot it seemed at times as if the houses were besieged by innumerable tom-cats; then the tumult resembled the suppressed bleating of goats, and I heard noises as of bats grinding their teeth in rage; again it was the querulous cooing of doves; and soon the chorus was strengthened by unearthly screams, as of ghouls and demons in mortal agony. But on going forth into the darkness to learn the cause of this infernal serenade, all was apparently calm and serene, and the radiant constellation of the Southern Cross, with the neighbouring clouds of Magellan, looked me peacefully in the face, while from another quarter of the heavens the Pleiads shed their "sweet influence" over the scene. The most quiet time of night with the birds is about daybreak, when they seem to subside into "cat-naps," preparatory to the labours of the day. By day many of the birds range on tireless wing over leagues of ocean in quest of fish. But still the number of those that remain about the island is so great as to defy computation; and as you pass through their haunts, in some places they rise in such clouds as actually to darken the air above you. The eggs of some of the birds are of fine quality, and are much esteemed by the Americans, as well as by the Hawaiians on the island, Those of a bird called the nu-e-ko are the most valued. This name is an imitative word, derived from the cry of this restless creature, and is applied to it by the Hawaiians, who have quick intuitions in onomatopoetic matters. In regard to moral character, the birds of Baker's Island may be divided into two classes—those which make an honest living, and those which are robbers. The gannet stands at the head of the respectable birds, and is a thrifty and honest citizen of the air. The representative of the thievish class is the frigate-pelican, or man-of-war bird (*Tachypetes aquilus*). This species has a dense plumage of gloomy black, a light, wiry body, that seems made for fleetness, and wings of even greater spread than the gannet's. Its tail is deeply forked, its bill is long, sharp, and viciously hooked. Audubon regards the frigate-bird as superior, perhaps, in power of flight to any other. It never dives into the ocean after fish, but will sometimes catch them while they are leaping out of the water to escape pursuit. It is often content to glut itself with the dead fish that float on the water, but it depends mostly for a subsistence upon robbing other birds. The smaller ones they easily overtake, and compel them to disgorge their spoils; but to waylay and levy blackmail upon those powerful galleons, the gannets, is an achievement requiring strategy and address. As the richly-laden gannet approaches the coast of his island home, he lifts himself to a great height, and steadily oars himself along with his mighty pinions, until he sees his native sands extending to dazzling whiteness below. Now sloping downward in his flight, he descends with incredible velocity. In a moment more he will be safe with his affectionate mate, who is awaiting his return to the nest. But all this time he is watched by the keen eye of the man-of-war bird, who has stationed himself so as to intercept the gannet in his swift course. With the quickness of thought, the frigate-bird darts upon him, and, not daring to attack boldly in front, he plucks him by the tail and threatens to upset him, or he seizes him at the back of the neck and lashes him with his long wings. When the poor gannet, who cannot manœuvre so quickly as his opponent, finds himself pursued, he tries to buy his ransom by surrendering a portion of his fishy cargo, which the other swooping down, catches before it has time to reach the earth. If there is but one frigate-bird, this may be a sufficient toll; but if the unwieldly gannet is set upon by a number of these pirates, he utters a cry of real terror and woe, and, rushing through the air with a sound like a rocket, in his rapid descent, he seeks to alight on the nearest point of land, well knowing that when once he has a footing on *terra firma* not even the man-of-war bird dare come near him. The man-of-war bird is provided about its neck and chest with a dilatable sack, of a blood-red colour, which it seems to be able to inflate at pleasure. On calm days, about noon, when the trade-wind lulls, giving place to a sea breeze that gently fans the torrid island, these light, feathery birds may sometimes be seen at an immense height balancing themselves for whole hours without apparent motion on their outstretched fans. Whether they are able to increase their specific levity by inflating their pouches with a gas lighter than the atmosphere, or whether they are sustained by the uprising column of heated air that comes in on all sides from the ocean, is a question I am unable to answer. While floating thus, this bird has its pouch puffed out about its neck, giving it the same appearance as though it had its throat muffled in flannel."

A Chicken-Dance.—To see a chicken-dance requires a long journey. The performers are the sharp-tailed grouse dwelling in the north-western plains of America, and replacing on the west of the Rocky Mountains the well-known prairie-hen of the eastern districts. This beautiful bird is alike estimable for the admirable sport which it affords, and for its delicacy as an article of food; and it is very desirable that, if possible, it should be acclimatized in this country. Mr. Lord, the naturalist to the British North American Boundary Commission, is sanguine on this point, and believes it to be most admirably fitted for our hill and moorland districts. "It is very hardy," he observes, "capable of bearing a temperature of 30° below zero; feeds on seeds, berries, and vegetable matter, in every particular analogous to what it could find in our own hill country; a good breeder, having usually from twelve to fourteen at a brood; nests early and would come to shoot [Query, to be shot?] about the same period as our own grouse." He adds, that the young birds in May could be caught at any point up the Columbia river, and once on board the steamer, could be fed as readily as fowls. The fur-hunters term these birds spotted chickens. They pair very early in the spring, and their love meetings are celebrated by remarkable festivities called Chicken Dances. Their ball-room is a high round-topped mound, and the dancing begins either at sunrise, or in the evening, and by the time that the matrimonial arrangements are concluded, and the happy pairs set off for their respective homes, the mound is trampled down as bare as a road, Mr. Lord saw several of these dances, and gives a very graphic report of the first which he witnessed. Riding up into the hills early one spring morning, he heard the peculiar chuck-chuck which indicated that a dance was in progress. Tying up his horse and dog, he crept towards the knoll from whence the sound proceeded, and finally gained the shelter of a stump, from whence, unperceived, he had an excellent view. Like a true lover of Nature, he frankly admits the "joyous delight which the sight afforded him. There were," he observes, "about eighteen or twenty birds present on this occasion, and it was almost impossible to distinguish the males from the females, the plumage being so nearly alike; but I imagined the females were the passive ones. The four birds nearest to me were head to head, like game cocks in fighting attitude—the neck-feathers ruffled up, the little sharp tail elevated straight on end, the wings dropped close to the ground, but keeping up by vibration a continued throbbing or drumming sound. "They circled round and round each other in slow waltzing-time, always maintaining the same attitude, but never striking at or grappling with each other; then the pace increased, and one hotly pursued the other until he faced about, and *tête à-tête* went waltzing round again; then they did a sort of 'cure' performance, jumping about two feet into the air until they were winded; and then they strutted about and struck an attitude, like an acrobat after a successful tumble. There were others marching about, with their tails and heads as high as they could stick them up, evidently doing the heavy swell; others. again, did not appear to have any well-defined ideas what they ought to do, and kept flying up and pitching down again, and were manifestly restless and excited—perhaps rejected suitors contemplating something desperate. The music to this eccentric dance was the loud chuck-chuck continuously repeated, and the strange throbbing sound produced by the vibrating wings." Mr. Lord subsequently watched several other balls, in all of which the same series of strange evolutions was carried out.—*Once a Week.*

CHEMISTRY AND PHYSICS.

ON NEW EXPLOSIVE POWDERS, BY M. DESIGNOLLE.—Many improvements having lately been made in the art of war, and particularly in the adoption of breech-loading arms, the want has been felt of new powders to meet the requirements of the present artillery. This want has been supplied by M. Designolle, who has invented a new system of powders of which carbazotate or picrate of potash is the base. These powders are of four kinds, viz, a musket powder, gunpowder for short bore cannons, slow gunpowder for cannons with long bores, and an explosive powder for torpedoes and projectiles destined for the undermining of fortifications. The principal advantages of these new powders are the following:—Increase of balistic power without increase of explosive power; the base remaining the same, possibility of regulating and varying the effects between the limits of one to ten; also of regulating, at will, the rapidity of combustion of this powder, and of increasing the balistic power without changing the mode of manufacture. Other advantages are—regularity in the manner of action; suppression of sulphur, and consequently of the vapours of sulphide of potassium and sulphuretted hydrogen; absence of action on metals and almost entire suppression of smoke. Into the explosive powders only two components enter—picrate of potash and nitrate of potash; the musket and gun powders contain carbon in addition to the above-named ingredients. To prepare these powders, the ingredients are beaten from three to six hours with a proportion of water varying from 6 to 14 per cent., according to the nature of the mixture; the powder is condensed by means of the hydraulic press, with a pressure of from 30,000 to 100,000 kilos., graining of the powder, and pressing and drying it according to the methods employed for the black powder. In order to increase the balistic power, the relative proportion of picrate of potash in the mixture must be increased. For musket powder it has been proved that no more than 20 per cent. of picrate of potash is required, while for gunpowders its proportion varies from 8 to 15 per cent. This component (picrate of potash) is of a beautiful golden-yellow colour, and crystallizes into prismatic needles possessing a brilliant reflection; it is insoluble in alcohol, but soluble in about 260 parts of water at 15° or 14 parts of boiling water. Heated with care, it becomes orange-red at a temperature of 300°, but on cooling, it assumes its original colour. Heated to 310°, it detonates with violence. The researches of M. John Casthellaz on the action of nitric acid on phenic acid improved the method of manufacturing picric acid, and produced chemically pure picrate of potash at such a reasonable price that the new powders are not more expensive than ordinary black powder.

MM. Designolle and Casthellaz give the following proportions for preparing deflagrating mixtures with coloured flames:—

Golden fire	Picrate of ammonia	50
	Picrate of iron	50
Green fire	Picrate of ammonia	48
	Nitrate of barytes	52
Red fire	Picrate of ammonia	54
	Nitrate of strontian	46

Chemical News; abstracted from the Bulletin de la Société d'encouragement.

MISCELLANEOUS.

MR. SORBY'S BLOW-PIPE BEAD CRYSTALS. — These exquisitely beautiful Miscroscopic objects are prepared by fusing borax in a circular loop of platinum wire, and adding various earths and minerals thereto, in such proportion that they are entirely dissolved at a high temperature, but partially deposited, when kept for some time, at a heat below dull redness. The beads should be about $\frac{1}{8}$th inch in diameter, and $\frac{1}{3}$rd that thickness. After having obtained crystals of a satisfactory character, the ring-shaped loop may be cut off, and the bead mounted in a cell with Canada Balsam. When thus mounted, they may be thoroughly examined with a $\frac{1}{2}$ inch or $\frac{1}{10}$ object glass and achromatic condenser. The full beauty of the specimen can only be seen with a binocular miscroscope; and few objects are better fitted to show the advantage of that kind of instrument. The crystals then stand out in perfect relief, and are seen to be equally complicated in all directions.

Fews objects of the kind are more easily prepared than the crystals of borate of magnesia deposited from borax saturated with magnesia, They first form as thin prisms, and smaller crystals are afterwards deposited, so as to give rise to objects very much like a handle with a brush at each end.

Zircon or zirconia fused with borax yields crystals of the borate. In their most rudimentary state they are small prisms with a simple cross at each end, which afterwards becomes complicated.

The crystals of molybdate of zirconia, formed by fusing zirconia in borax with molybdic acid, are extremely elegant and beautiful objects. They are so delicate that their own weight would probably break them, if they were in an aqueous solution; but being supported in solid borax, like the insects enclosed in amber, they are secure from all enjury.

Scheelite — native tungstate of lime — fused in borax, is deposited in crystals of great beauty, and is an object easily prepared.

The molybdate of strontia, produced by fusing strontia and molybdic acid in borax, crystallizes in long spindle-shaped crystals; whereas the molybdate of lime yields very different crystals, of an intermediate form.

Apatite—native phosphate of lime—fused with borax, deposits in crystals which vary much in shape. Six-sided stars are often formed on the surface, and needle-shaped crystals grow from their centres into the interior of the borax, so that they look like nails with highly ornamented heads driven down into the bead. When formed with their axis parallel to the surface, the crystals are sometimes much like *diatomaceæ.* The addition of phosphate of soda to a borax bead containing lime, in almost any state of combination, gives rise to similar crystals.

On adding a certain amount of carbonate of soda to quartz or various silicates dissolved in borax, crystals are deposited, which vary much according to circumstances: but they all seem to be due to the variable growth of many small six-sided prisms with expanded ends. Another form shows a curious dice-box, resulting from a bundle of such crystals. Probably they are some silicate of soda, modified by the presence of other bases.

Columbic acid is deposited from borax in crystals which often have similar forms; whereas titanic acid gives hair-like prisms, variously grouped. Molybdic acid is sometimes set free as liquid globules, which coalesce, rise to the surface, and afterwards solidify as small spheres.

THE SOLAR HEAT.—M. Mouchat, who has been experimenting on the utilization of the solar heat, has sent in a paper on this subject to the Academy of Sciences. He states that, according to his experiments, upwards of three-sixths of the solar heat might be gathered at a small cost. At Paris, a surface of one square mètre normally exposed to the rays of the sun receives, on an average, at any time of the year, on a fine day, ten units of caloric per minute. Such a quantity of heat would make a litre of water at freezing-point boil in ten minutes, and is equivalent to the theoretical action of a one horse-power. He further states that he had proved the possibily of keeping hot-air machines going by means of solar rays, and had succeeded in making a few litres of water boil by exposure to the same agent; and in June, 1866, he had made a small steam-engine work by converting water into vapour with the assistance of a reflector one mètre square.

The American Association for the Advancement of Science will hold its eighteenth meeting at Salem, on Wednesday, August 18th. It is intended to give great prominence to microscopy, and the committee have issued a special prospectus calling on microscopists to aid in sending instruments and specimens. Communications should be addressed to Mr. F. W. Putnam, the Local Secretary, Salem, Massachusetts. The titles of papers should be handed in as early as possible, in order to secure their presentation to the Association. Each title should be written on a separate slip of paper, with the author's name and address, and an estimate of the number of minutes required to read the communication. As soon as practicable after entering the titles, the paper itself, or an abstract, must be handed to the Secretary, and until all these conditions are complied with, no title can appear in the programmes.