of the anterior pouch is almost identical in the two forms, for in Balanoglossus its left-hand division becomes lined by cilia and opens to the exterior, whereas its right-hand half degenerates into connective tissue. And as regards the nervous system (which in Balanoglossus contains no mesenteric canal as that of Amphioxus does) "it is only necessary to imagine the invagination of the dorsal nerve-cord to have been extended along the back (instead of being confined to the region of the collar) in order to reproduce the condition which is found in Amphioxus." But however much we may be struck by these relations of Balanoglossus, its own isolated position and the extreme difficulty of allying it to any other Invertebrate groups prevent it from throwing much light upon the Vertebrate pedigree. The claims of the two theories discussed above may be unaffected, however close the correspondence between Amphioxus and Balanoglossus may be shown to be; and as yet Balanoglossus seems to do little more than remind us of how remote a relative of the Vertebrates Amphioxus itself is. Amphioxus occupies such an outlying branch, so far from the main stem of the genealogical tree of Vertebrates, that the demonstration of its likeness to an isolated Invertebrate like Balanoglossus may, like its obvious relationship with the Tunicates, be of little use to us.

It is perhaps premature to judge between these two theories detailed above, or to accept either of them definitely as an indication of the origin of Vertebrates. But we must point out that the Chætopod theory lies under the great disadvantage of assuming as far distant ancestor of Vertebrates a class of animals that seem really to occupy an apical position in a certain line of development. The Chætopods seem to be so highly specialised, that we must be suspicious of taking them to be the origin of another great group, but rather consider them as the ultimate result of evolution in a particular direction. In general it must always, *a priori*, be unsafe to attempt to make the apex of one group the base of the next; and in all cases it must be better, and more consonant with the principles of evolution, to search for the closest relations of one group among the simpler and less specialised members of another.

A. E. S.

THE ROYAL SOCIETY OF CANADA

THE annual meeting of this Society was held at Ottawa, May 21-24, under the presidency of the Hon. P. J. O. Chauveau, LL.D., D.-ès-L.

The following papers were read in Section III. (Mathematical, Physical, and Chemical Sciences):—Electrical induction in underground and aërial metallic conductors, by F. N. Gisborne, C.E. The author proposed, in order to get rid of induction phenomena in telephone circuits, to connect sending and receiving telephones by means of pairs of twisted and insulated wires. He described experiments made with a section of cable about 3000 feet in length and laid underground between two of the Departmental Buildings at Ottawa. The cable contained twenty indifferently insulated wires, which were divided into pairs, two wires being twisted together in each case, each pair constituting a metallic circuit, and one wire of each pair being used as a "return" instead of the earth plates usually employed. The experiments showed that if one of these pairs was used as a telephonic circuit, no induction effects could be observed in the others. The absence of induction effect he attributed to the equidistance of the two wires of a pair from any third wire and the equality and opposition of the currents flowing in them.—A particular case of the hydraulic ram or water hammer, by C. Baillargè, C.E.—On the form of the contracted liquid vein affecting the present theory of the science of hydraulics, by R. Steckel. Communicated by C. Baillargè, C.E.—The origin of crystalline rocks, by T. Sterry Hunt, LL.D., F.R.S. The author began by remarking that the problem of the origin of those rocks, both stratified and unstratified, which are made up chiefly of crystalline silicates, is essentially a chemical one. He then proceeded to review the history of the once famous dispute between the vulcanist and the neptunist schools in geology as to whether granite and other crystalline rocks were formed by igneous or by aqueous agencies, and showed from recent writers that the controversy is not yet settled. He noticed of the igneous school both the plutonic and the volcanic hypotheses of the origin of these rocks, and then considered the so-called metamorphic and metasomatic hypotheses, which would derive them by supposed chemical changes from materials either of igneous or of aqueous origin. The hypothesis of Werner was next discussed. This conceives all such rocks to have been successively deposited in a crystalline form from a chaotic watery liquid, which surrounded the primitive earth, and at an early time held in solution the whole of the materials of these rocks. The inadequacy of all of these hypotheses was pointed out, though it would appear that Werner's was the one nearest the truth. The author conceives that the crystalline rocks were formed by deposition from waters which successively dissolved and brought from subterranean sources the mineral elements. Their formation is illustrated by that of granitic veins, and that of zeolites—processes regarded as survivals of that which produced the earlier rocks. The true zeolites are but hydrated feldspars, while the minerals of the pectolitic group correspond to the protoxyd-silicates of the ancient rocks. The source of the elements in these rocks, according to the new hypothesis here proposed, was in the superficial layer which was the last-congealed portion of an igneous globe consolidating from the centre. In this primitive stratum, porous from contraction and impregnated with water, resting upon a heated anhydrous nucleus, and cooled by radiation, an aqueous circulation would be set up, giving rise to mineral springs. The waters of these dissolved and brought to the surface, there to be deposited, the quartz, the feldspars, and other mineral silicates, which, through successive ages, built up the great groups of crystalline stratified rocks, often so markedly concretionary in aspect. Exposed portions of the primitive silicated material would be subject to atmospheric decay and disintegration, giving rise to sediments of superficial origin, which would become intercalated with the deposits from subterranean sources. The reactions between the mineral solutions from below and the superficial materials were important in this connection, probably giving rise to certain common micaceous minerals; while dissolved silicates allied to pectolite, by their reaction with the magnesian salts, which then passed into the ocean waters, generated species like serpentine and pyroxene. This process of continued upward lixiviation of the primitive chaotic stratum would result in the production of a great overlying body of stratified acidic rocks, leaving below a basic residual and much diminished portion, the natural contraction of which would cause corrugations of the superincumbent stratified mass, such as are everywhere seen in these ancient rocks. The source of volcanic rocks is partly in this lower and more or less exhausted stratum of comparatively insoluble and basic ferriferous silicates, whence come melaphyres and basalts; partly in the secondary or acidic mass, which, softened by the combined agency of water and heat, may give rise to granitic and trachytic rocks; and partly also, it is conceived, in later aqueous deposits of superficial origin, which also may be brought within the influence of the central heat. This attempt to explain the genesis of crystalline rocks by the continued solvent action of subterranean waters on a primitive stratum of igneous origin the author designates the crenitic hypothesis, from the Greek *κρήνη, font*. A preliminary statement of it was made by him to the National Academy of Sciences at Washington, April 15, 1884, and appears in the *American Naturalist* for June.—On the density and thermal expansion of aqueous solutions of copper sulphate, by Prof. J. G. MacGregor, D.Sc. The author gave the results of extended observations of the density of solutions of different concentration and at different temperatures. They show that the rate of variation of density with temperature increases with the temperature and with the percentage of salt in solution; that the density of any solution at low temperatures (below 20° C.) diminishes, as the temperature increases at a greater rate than that of water; that the ratio of the density of a solution to the density of water at the same temperature diminishes as the temperature increases; and certainly for many solutions, probably for all, attains a constant value within the temperature limits of the experiments (below 35°-50°); that, therefore, at about 40° C. the thermal expansion of solutions is the same as that of water at the same temperature. The experiments also substantiated a result formerly reached by Prof. Ewing and the author that very weak solutions of this salt have a smaller volume than the water used in making them. If then these solutions are made by the addition of anhydrous salt to water contraction must occur. The experiments show that the greatest contraction occurs in the case of a solution containing 1·34 per cent. of anhydrous salt, in which case the contraction is 0·0048. The solution containing 5·95 per cent. of anhydrous salt has the same volume as the water required to make it.—Blowpipe reactions in plaster of Paris tablets, by Prof. E. Haanel, Ph.D. This paper was a continuation of that presented to the Society last year. The author described the result of the treatment of copper with hydrobromic acid, and of iron and selenide of mercury with hydriodic acid. He held the range of coatings *per se* for those tablets to be greater than for any other support used in blowpipe analysis, and described these coatings for selenium, tiemannite, arsenic, silver, alloys of bismuth, antimony, and lead with silver, galena, orpiment, realgar, mercury, tellurium, carbon, cadmium, and gold.—Description of an apparatus for distinguishing flame-colouring constituents when occurring together in an assay, by Prof. E. Haanel, Ph.D. The apparatus consists of a spectacle frame furnished for the left eye with plain colourless glass, and for the right eye with four glasses—red, green, violet, and blue. These glasses revolve on an axis, and can be brought either separately or in any combination before the eye of the operator.—"Essai sur la Constitution atomique de la Matière," by the Very Rev. T. E. Hamel, D.D.—The algebraical development of certain functions, by Prof. N. F. Dupuis, M.A.—Contributions to our knowledge of the iron ores of Ontario, by Prof. E. J. Chapman, Ph.D., LL.D. The paper contained a series of analyses of magnetic and other iron ores from samples obtained personally by the author from various parts of Ontario. The geological conditions of the deposits are also briefly given.—"Note sur une fait météorologique particulier à Quebec," by Rev. Prof. J. C. K. Laflamme, D.D.

Section IV. (Geological and Biological Sciences).—The following papers were read:—Note of observations in 1883 on the geology of a part of the north shore of Lake Superior, by A. R. C. Selwyn, LL.D., F.R.S. In these observations the author considered he was able to show that the great masses of columnar trap which form the summit of Thunder Cape, Pic Island, and McKay's Mountain were not part of a "crowning overflow," as they have been described to be, and newer than the Keweenian series, but that they are contemporaneous with the black slaty shales of the Animikie series, which immediately and conformably underlie them.—Revision of the Canadian Ranunculaceæ, by Prof. George Lawson, Ph.D. LL.D. (Halifax, N.S.). The author referred to his "Monograph of Ranunculaceæ," published in 1870, to the extensive collections that had been subsequently made, and to works published upon the North American flora, all of which enabled a fuller and more accurate description of Canadian ranunculaceous plants to be given now than was possible when the previous paper was prepared. The greater precision given to recent observation had also enabled the geographical range of these plants to be stated more fully. The striking diversity of modification in the form, number, and arrangement of the several parts of the flower and of the fruit in the several genera was pointed out. The number of Canadian species is 78 and of varieties 18: viz. Clematis 4, Anemone 14, Thalictrum 6, Ranunculus 29, Myosurus 2, Pæonia 1, Caltha 3, Trollius 1, Coptis 2, Aquilegia 2, Delphinium 5, Aconitum 2, Hydrastis 1, Actæa 2, Cimicifuga 1, Trautvetteria 1.—Geology and geological work in the Old World in their relation to Canada, by Principal Dawson, C.M.G., LL.D., F.R.S.—The Taconic question in geology, part 2, by T. Sterry Hunt, LL.D., F.R.S. The writer having given in the *Transactions* of the Royal Society of Canada for 1883 the first part of this paper, it remains in the second and last part to show, in the first place, more fully than has yet been done, the relations of the Taconian or Lower Taconic series of stratified rocks to the succeeding Cambrian or Upper Taconic, which some geologists have confounded with the Taconian. In this connection is given a critical discussion of the studies of Perry, Marcou, and others, and the opinions of Dana as regards the Cambrian of the Appalachian region of North America. In the second place is considered the probable equivalence of the Taconian to the Itacolumite series of Brazil and to similar rocks elsewhere in South America and the West Indian Islands, as well as in Hindostan and Southern Europe. All of these comparative studies, it is said, tend to establish the distinctness of the Taconian as a great and widely-spread series of crystalline stratified rocks occupying a horizon between the Cambrian and Montalban or younger gneiss series of Europe and North America.—Note on the occurrence of certain butterflies in Canada, by W. Saunders, London, Ontario. *Papilio cresphontes*, once a rare butterfly in Ontario, is now widely disseminated throughout that province. In the Southern United States its larvæ feed on the leaves of the orange and lemon, but in Canada they appear to thrive upon the foliage of such members of the *Ruiaceæ* as *Xanthoxylon*, *Ptelea*, *Ruta*, and *Dictamnus*. *Papilio philenor* is also extremely rare in Canada, but a large flock of this species was observed by the Rev. C. J. S. Bethune near Woodstock, Ontario, in 1858. The writer also recorded the capture of *Terias mexicana* and *Thecla smilacis* at Point Pelée, Ontario, in 1882, and concluded by remarking that twenty-three years ago he had taken two specimens of a new species of *Thecla* at London, Ontario, which has since been described by Mr. W. H. Edwards as *T. læta*.—On some deposits of titaniferous iron ore in the counties of Haliburton and Hastings, Ontario, by Prof. E. J. Chapman, Ph.D. This paper, after referring to the occurrence of numerous deposits of magnetic iron ore in certain zones or belts of country in the counties of Victoria, Haliburton, Peterborough, and Hastings, describes their conditions of occurrence as those of large isolated masses or "stocks," forming in some cases "sheathed stocks," or *Stockscheiders* and *Skölars* of German and Swedish miners, as in the great iron ore zone of Arendal in Norway. Whilst these stock-masses of iron ore are for the greater part quite free from titanium, one of vast size in the township of Glamorgan, and another equally large mass in Tudor, are shown to contain a considerable amount of titanium. Detailed descriptions of these are given, with analysis of the ore by the writer.—On mimetism in inorganic nature, by Prof. E. J. Chapman, Ph.D. Mimetism—as recognised in organic nature—has been regarded on the one hand as the direct result of a protecting Providence, and, on the other, as originating in minute approaches towards the imitated object, these becoming intensified in successive generations until the imitation becomes complete or reaches its extreme limit. In this paper the writer attempts to show that neither hypothesis may be absolutely correct, but that the peculiarity may be due to some occult law of "localism" by which associated forms often become impressed with mutual resemblances. In support of this view he refers to several curious cases in which certain minerals, normally and generally of very dissimilar aspect, become closely mimetic under certain local conditions, as seen in examples of quartz and zircon, pyroxene and apatite, &c., in the phosphate deposits of the Ottawa region.—A monograph of Canadian ferns, by Dr. T. J. W. Burgess and Prof. J. Maconn, M.A., F.L.S. Prof. Maconn stated that twenty years ago the total number of ferns known to occur in Canada was forty-six, while at the present time it had increased to sixty-three. In illustrating the range of the more interesting species, he particularly noticed the occurrence of *Phegopteris calcarea* in Anticosti, where he had found it in 1882, and remarked that the same plant has recently been collected by Dr. G. M. Dawson and R. Bell in the country around and to the east of the Lake of the Woods.—On geological contacts and ancient erosion in the province of New Brunswick, by Prof. L. W. Bailey, M.A., Ph.D. This paper summarises the more important and well-established lines of physical contact between the geological formations of New Brunswick, as bearing upon the relative age of the latter and the disturbances to which they have been subjected. Three well-marked breaks separating groups of widely diverse character were recognised among pre-Cambrian strata,—the supposed equivalents of Laurentian, Huronian, and possibly Montalban horizons,—a very marked one at the base of the Cambrian, and others successively between later formations to the base of the Trias. The evidence of such breaks was shown to be of various character, including discordance of dip and strike, overlap, igneous extravasations, and intermediate erosion, and the bearing of the facts determined on the physical and geological history of North-Eastern America, was briefly discussed. The granites, which constitute so marked a feature in the geology of the Acadian Provinces, were described as intrusive, and as the cause of the extensive alteration exhibited by the formation, which they have invaded. The erosion which accompanied or followed upon the disturbances described was shown to have been enormous.—Illustrations of the fauna of the St. John group. Part III. Conocoryphidæ, with notes on the Paradoxidæ, by G. F. Matthew. The species of *Conocoryphe* referred to and illustrated are *C. matthewi*, Hartt, with three varieties; *C. elegans*, Hartt; *C. baileyi*, Hartt, with two varieties, and a new form which the author describes as *C. walcotti*. Critical remarks are also made upon *Paradoxides lamellatus*, Hartt, and *P. acadicus*.—The Glacial deposits in the neighbourhood of the Bow and Belly Rivers, by Dr. G. M. Dawson, A.R.S.M.—On the geology and economic minerals of Hudson's Bay and Northern Canada, by Robert Bell, M.D., LL.D., Assistant Director of the Geological Survey of Canada. By Northern Canada the author meant the whole of the Dominion northward of the organised Provinces and Districts, as far as known. His information was derived from his own observations around Hudson's Bay and in the North-West Territories, and from the reports and maps of the scientific men who had accompanied the various Arctic expeditions by sea and land. Specimens and interesting notes on the geology of Great Slave Lake had been received from Capt. H. P. Dawson, R.A., who had spent last year there in charge of the Canadian Station of the Circumpolar Commission. The distribution of the various formations from the oldest to the newest was illustrated by a large geologically-coloured map of the whole Dominion. Referring first to the Laurentian system, Prof. Bell showed that it forms the surface-rock over an enormous area of circular form on the main continent, and that the central part is occupied by the waters of Hudson's Bay, which are surrounded by a border of Palæozoic rocks. If we included the Laurentian rocks of Greenland and the Atlantic coast from Newfoundland to Georgia, it would be observed that their general outline corresponds with that of the continent, which has been built up around this ancient nucleus. The Huronian strata, which constitute the principal metalliferous series in Canada, were closely associated with the Laurentian, and appeared to be always conformable with them. The largest and best-known areas were between Lake Huron and James's Bay, but Dr. Bell had found four belts of them on the east coast of Hudson's Bay, and others had been recognised in the primitive region to the west of it. Indeed wherever the older crystalline rocks had been explored in Canada, belts having the character of the Huronian series had been met with. Limestones, slates, and quartzites, interstratified with amygdaloids, basalts, &c., corresponding with the Nipigon formation of Lakes Superior and Nipigon were largely developed on the Eastmain coast and adjacent islands of Hudson's Bay, and apparently also on the Coppermine River and to the westward of it. But a set of hard red siliceous conglomerates and sandstones were seen to come between the Huronian and the Nipigon series at Richmond Gulf on the Eastmain coast, which appeared to be unconformable to both. Mr. Cochrane and Dr. Bell had found similar rocks on Athabasca Lake, Capt. Dawson, R.A., on Great Slave Lake, and Sir John Richardson to the north-east of Great Bear Lake. The conglomerates, slates, and gray argillaceous quartzites of Churchill and the white fine-grained quartzite of Marble Island were probably of this horizon. Silurian rocks were well known to be widely spread on some of the largest of the Arctic islands, and along the most northern channels of the Polar Sea. They formed an irregular and interrupted border on the western side of Hudson's and James's Bays. A large basin of Devonian strata, containing gypsum and clay-ironstone, extended southward from James's Bay. West of the great Laurentian area, Devonian rocks could be traced here and there all the way from Minnesota to the mouth of the Mackenzie River. They were not, however, so widely distributed as had been supposed by the older travellers, who had passed rapidly through the country in the early part of the century, when the whole subject of American geology was in its infancy. The so-called bituminous shale of Sir John Richardson and others, so prevalent along the Athabasca and Mackenzie Rivers, was found by Prof. Bell to consist of soft Cretaceous strata, saturated and blackened by the petroleum rising out of the underlying Devonian rocks, which here, as in Ontario, Ohio, and Pennsylvania, are rich in this substance. The principal features and the geographical distribution of the Carboniferous, Liassic, Cretaceous, and Tertiary rocks of the northern regions were next described. Among other points of interest in reference to the post-Tertiary period, Dr. Bell mentioned that the remains of both the mastodon and mammoth had been found on Hudson's Bay, and that there were reports of the occurrence of elephants' tusks on an island in its northern part. Isolated discoveries of elephantine remains had been made in the North-West Territories and several on the Rat River, a tributary of the Youkon, near the borders of Alaska. In referring to the economic minerals, Prof. Bell said that even the coarser ones, such as granite, limestone, cement-stone, slate, flagstones, gypsum, clays, marls, ochres, sand for glass-making, moulding, &c., would yet have their value in different parts of the great region under consideration. Soapstone, mica, plumbago, asbestos, chromic iron, phosphate of lime, salt, pyrites, &c., had been noted in different localities. Among ornamental stones known to occur, might be mentioned the rare and beautiful mineral lazulite discovered by Dr. Bell at Churchill, also malachite, jade, agate, cornelian, chrysoprase, &c. Lignites of various qualities, some being very good, were found in many places throughout the great tract occupied by the Cretaceous and Tertiary rocks of the Athabasca-Mackenzie Valley and on the coasts and islands of the Arctic Sea; also in Tertiary strata at Cumberland Bay and in Greenland, on the opposite side of Davis' Strait. The lignites found by Dr. Bell on the Albany and Moore Rivers were of post-Tertiary age. Anthracite of fine quality had been found on Long Island in Hudson's Bay. True bituminous coal had been reported to occur on Banks' Land, Melville, and Bathurst Islands. Petroleum, which proceeded from Devonian strata as elsewhere in North America, was very abundant along the Athabasca and Mackenzie Rivers, and vast quantities of asphalt resulting from the drying up of the exuding petroleum were found on the Athabasca, around Great Slave Lake, and at various places in the interior. In reference to the metals, the ores of iron were abundant. Inexhaustible quantities of rich manganiferous carbonate of iron existed on the islands of the Manitounik chain. It lay in beds upon the surface over hundreds of square miles, and was broken up by the frost into pieces of convenient sizes for shipping. Valuable deposits of magnetic iron had been found on Athabasca and Knee Lakes, and a great bed of pure clay-ironstone on the Mattogomi River. Capt. Dawson had found a vein of specular iron on Great Slave Lake. Copper ore had been met with on Hudson's Bay and near Lake Mistassini, and large quantities of the native metal were known to occur on the Coppermine River. A band of limestone, running from Little Whale River to Richmond Gulf, was rich in galena. Zinc, molybdenum, and manganese had been found on Hudson's Bay, and antimony in the north. Both gold and silver had been detected in veins on the Eastmain coast, and alluvial gold had been washed out of the gravel and sand of the streams among the mountains in the tract to the west of the lower part of the Mackenzie River, which Dr. Bell thought might yet become the great gold and silver region of the north, corresponding with Colorado and Nevada to the south. The fine gold-dust found in the drift in one section of the North Saskatchewan may have been derived, during the Glacial period, from the upper valleys of the Liard, on one of which the famous Cassiar gold district is situated; although Dr. Bell had some years ago originated the theory that this gold might have come from Huronian rocks in the district to the north-eastward of Edmonton.—"Note sur certains dépôts aurifères de la Beauce," by the Rev. Prof. Laflamme, D.D.—"Découverte de l'émeraude au Saguenay," by the same.—Description of a supposed new Ammonite from the Upper Cretaceous rocks of Fort St. John on the Peace River, by Prof. J. F. Whiteaves, F.G.S., &c.; On a new Decapod Crustacean from the Pierre Shales of Highwood River, N.W.T., by the same. The Ammonite referred to in the first of these communications appears to be a previously undescribed species of *Prionocyclus*, closely allied to the type of that genus, the *Ammonites woolgari* of Sowerby, but with much more closely coiled volutions. It occurs in flattened nodules, in shales which are believed to be the equivalents of the Fort Benton group of the Upper Missouri section. The Decapod Crustacean from Highwood River, a tributary of the Bow, is doubtfully referred to the genus *Hoploparia* of McCoy.—Notes on the manganese ores of Nova Scotia, by E. Gilpin, M.A., F.G.S.—A revision of the geology of Antigonish County, Nova Scotia, by the Rev. D. Honeyman, D.C.L.—"Notes sur la constitution géologique de l'Apatite Canadienne," by S. Obalski.

THE RAINS AND THE RECENT VOLCANIC ERUPTIONS[1]

THE rains this year have been more persistent than usual. At Perpignan they have been extraordinary. Is it necessary to see any relation between this circumstance and the recent volcanic eruptions? The beautiful crepuscular colorations of the past autumn and winter have been attributed to these eruptions; ought we also to attribute to them the extraordinary spring rains? I should be inclined to believe it. It is acknowledged that the presence in the atmosphere of solid particles facilitates the condensation of vapour. This would be in conformity with the position maintained by Mr. Aitken in his paper on Dust, Fog, and Clouds (volume for 1880-81, *Trans. R.S.E.*). He concludes thus:—"In an atmosphere saturated with vapour, but free from dust, there is formed neither cloud nor fog; whenever the vapour of water is condensed in the atmosphere, it is owing to the presence of those solid particles, each of which becomes, so to speak, a centre of condensation, or the nucleus of a small crystal of ice."

[1] Paper read at the Paris Academy of Sciences by M. Gay, June 23.