Technical and Bibliographic Notes / Notes techniques et bibliographiques

The Institute has attempted to obtain the best original copy available for filming. Features of this copy which may be bibliographically unique, which may alter any of the images in the reproduction, or which may significantly change the usual method of filming, are checked below.

L'Institut a microfilmé le meilleur exemplaire qu'il lui a été possible de se procurer. Les détails de cet exemplaire qui sont peut-être uniques du point de vue bibliographique, qui peuvent modifier une image reproduite, ou qui peuvent exiger une modification dans la méthode normale de filmage sont indiqués ci-dessous.

- [ ] Coloured covers/ Couverture de couleur
- [ ] Covers damaged/ Couverture endommagée
- [ ] Covers restored and/or laminated/ Couverture restaurée et/ou pelliculée
- [ ] Cover title missing/ Le titre de couverture manque
- [ ] Coloured maps/ Cartes géographiques en couleur
- [ ] Coloured ink (i.e. other than blue or black)/ Encre de couleur (i.e. autre que bleue ou noire)
- [ ] Coloured plates and/or illustrations/ Planches et/ou illustrations en couleur
- [x] Bound with other material/ Relié avec d'autres documents
- [ ] Tight binding may cause shadows or distortion along interior margin/ La reliure serrée peut causer de l'ombre ou de la distorsion le long de la marge intérieure
- [ ] Blank leaves added during restoration may appear within the text. Whenever possible, these have been omitted from filming/ Il se peut que certaines pages blanches ajoutées lors d'une restauration apparaissent dans le texte, mais, lorsque cela était possible, ces pages n'ont pas été filmées.

- [ ] Coloured pages/ Pages de couleur
- [ ] Pages damaged/ Pages endommagées
- [ ] Pages restored and/or laminated/ Pages restaurées et/ou pelliculées
- [x] Pages discoloured, stained or foxed/ Pages décolorées, tachetées ou piquées
- [ ] Pages detached/ Pages détachées
- [ ] Showthrough/ Transparence
- [x] Quality of print varies/ Qualité inégale de l'impression
- [x] Continuous pagination/ Pagination continue
- [x] Includes index(es)/ Comprend un (des) index

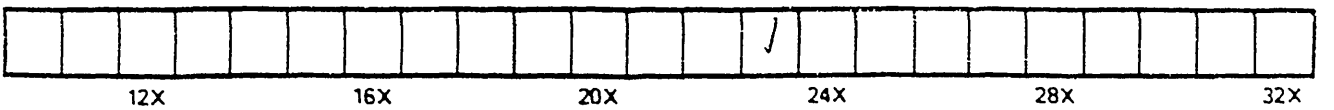
Title on header taken from:/ Le titre de l'en-tête provient:

- [ ] Title page of issue/ Page de titre de la livraison
- [ ] Caption of issue/ Titre de départ de la livraison
- [ ] Masthead/ Générique (périodiques) de la livraison

- [x] Additional comments:/ Commentaires supplémentaires: Page 517 is incorrectly numbered page 51.

This item is filmed at the reduction ratio checked below/
Ce document est filmé au taux de réduction indiqué ci-dessous.

10X 12X 14X 16X 18X 20X 22X 24X 26X 28X 30X 32X



THE CANADIAN JOURNAL.

NEW SERIES.

No. XXX.—NOVEMBER, 1860.

NOTES ON LATIN INSCRIPTIONS FOUND IN BRITAIN.

PART VI.

BY THE REV. JOHN McCAUL, LL.D.,
PRESIDENT OF UNIV. COLL., TORONTO.

26. In the University of Glasgow a monumental tablet is preserved, which was found many years ago in the Roman Station at Ardoch in Scotland. It is figured in Stuart's *Caledonia Romana*, (*ed. Prof. Thomson*, pl. v. fig. 5.) and the following explanation is given of the inscription:—

DIS MANIBVS
AMMONIVS DA
MIONIS * COH
I HISPANORVM
STIPENDIORVM
XXVII HEREDES
F·C

"To the shade of Ammonius Damion, Centurion of the First Cohort of the Spanish Stipendiaries, who served for 27 years, his heirs have erected this monument."

To this translation are subjoined notes to the effect, that others have regarded *Damionis* as governed by *filius* or *servus* understood; and that it would perhaps be more correct to join xxvii to *heredes*,—i.e. his twenty-seven heirs.

Horsley (*Britannia Romana*, p. 205) expresses his preference for considering *Damionis* as the nominative case, and compares such names as *Petilius Cerealis*.

It is not easy to discover where Stuart found any authority for the word *Stipendiaries*, which he introduces into his translation, for on the supposition that he mistook the meaning of *Stipendiorum*, we are then at a loss for the Latin denoting "who served for." Nor is it possible to reconcile *Ammonius* in the nominative with his translation—"of Ammonius Damion." Professor Thomson's suggestion to connect xxvii with *heredes* is so obviously unwarrantable, that it is surprising that any one could for a moment have entertained the idea. There is no doubt that the words—COH I HISPANORVM STIPENDIORVM XXVII HEREDES F·C·—mean "of the first cohort of Spaniards, of twenty-seven years' service, his heirs have caused [this memorial] to be erected;" and the only questionable point is as to *Damionis*. I am inclined to take it as the genitive case, F either being omitted, or perhaps obliterated by the fracture of the stone between S and C, where there seems to be sufficient space both for it and for >, the symbol of *centurio*.

27. In the year 1736, a fragment of a grave-stone was found in *Bath*, which, according to Dr. Stukeley (*Phil. Trans.*, 1748), bore the inscription:—

L·VITELLIVS·MA
NIAI·F·TANCINVS
CIVES·HISP·CAVRIESIS
EQ·ALAE·VETTONVM·CR
ANN·XXXXVI·STIP·XXVI
H·S·E

i.e. "*Lucius Vitellius Maximiani filius Titus Ancinus, civis Hispanus Cauriensis equitum alæ Vettonum Curator anno* 46 *Stipendiorum* 26 *hic sepultus est.*"

Mr. Warner (*History of Bath, Append.* p. 118) reads *Mantani* for *Maximiani*, *Tancinus* for *Titus Ancinus*, *Hispaniæ* for *Hispanus*, *centurio* for *curator*, and *hic situs est* for *hic sepultus est*. He translates the whole inscription thus: "Lucius Vitellius Tancinus, the son of Mantanus, a citizen of Caurium, in Spain, centurion of the Vettonensian auxiliary horse; who died in the forty-sixth year of his age, and the twenty-sixth of his military service."

The term *centurion* is explained on the supposition that the *ala*, "here spoken of was probably attached to the twentieth legion; in this Tancinus bore the office of centurion; a command somewhat analogous to the captaincy of a troop in our service." Mr. Scarth (*Proceedings of Somersetshire Archæolog.* and *Nat Hist. Society*, 1852, p. 102) remarks, that "the stone was erected on the place of

interment of '*Lucius Vitellius Tancinus*, the son of Mantaus or Mantanus,' a citizen of Caurium, in Spain, a centurion of the Vettonensian horse, who died at the age of forty-six, having served twenty-six years." Both Mr. Warner and Mr. Scarth observe, in illustration, that Caurium was a town in Lusitania, and that the Vettones were a neighbouring people, who supplied the Romans with excellent heavy-armed horse.

There is no doubt that Mr. Warner's expansion is an improvement on that given by Dr. Stukeley, but it is far from being satisfactory. Of the suggestions which have been offered relative to MANIAI·F, I prefer Mr. Scarth's reading MANTAI·F; but perhaps we should substitute E for I, *i.e.* MANTAE.* The reading TANCINVS is supported by the inscription in Gruter, p. CMXVII, n. 8, cited by Mr. Warner; but HISPANUS, not HISPANIAE, is conformable to usage. The expansions EQVITVM for EQ· and CVRATOR or CENTURIO for C·R are unquestionably erroneous. EQ· stands for EQVES, and C·R for CIVIVM ROMANORUM. As to Mr. Warner's suggestion, that the deceased may have been a centurion in an *ala Vettonum* attached to the 20th legion, it is sufficient to observe that there is no authority for a centurion in an *ala*, nor for an *ala* being attached to a legion.

28. In the *Archæologia Æliana* (new series, vol. i. p. 261) a slab is figured, which bears the following inscription:—

DIISDEABVSQVESE
CVNDVMINTERPRE
TATIONEMORACV
LICLARIAPOLLINIS
COH·I·TVNGRORUM

Dr. Bruce reads and translates it thus:—

"DIIS DEABVSQVE SE-
CVNDVM INTERPRE-
TATIONEM ORACV-
LI CLARI APOLLINIS
COH[ORS] PRIMA TVNGRORVM.

"The first cohort of the Tungrians (dedicated this structure) to the gods and the goddesses, according to the direction of the oracle of the illustrious Apollo."

* I have never seen an example of *Mantanus*, *Mantaus*, or *Manta*. The nearest approach to the name, which I have observed, is on an altar found at Clausentum. *Vide Journal of Archæological Association*, 1857, p. 210, fig. 2.

I have no doubt that I in CLARI stands, as is common, for II; and that CLARII is the well-known epithet which Apollo derived from *Clarus* (near Colophon, in Ionia), where he had a celebrated temple and oracle. It is scarcely necessary to cite illustrations from ancient authors. Amongst the most obvious are Virgil, *Æn.* iii. 360, "Qui tripodas, *Clarii* lauros, qui sidera sentis;" and Tacitus, *Ann.* ii. 54, "Relegit Asiam appellitque Colophona, ut *Clarii Apollinis oraculo* uteretur."

29. In the same work (p. 226) we find the following inscription on another slab:—

IMP·CÆSMAVR SEVE
RVSALEXANDERPIE
AVG HORREVMVETV
STATECONIABSVMM
COH IIASTVRVM S·A
SOLORESTITVERVNT
PROVINCIA REG * * *
MAXIMO LEG * * * *
* AIMARTI * * * *

Dr. Bruce reads and translates it thus:—

"IMPERATOR CAESAR MARCVS AVRELIVS SEVE-
RVS ALEXANDER PIVS FELIX
AVGVSTVS·HORREVM VETV-
STATE CONLABSVM M(?)
COHORS SECVNDA ASTVRVM SECVNDVM ARTEM
A SOLO RESTITVERVNT
PROVINCIA REGNANTE
MAXIMO LEGATO.....
KALENDIS MARTII .....

The Emperor Cæsar Marcus Aurelius Severus Alexander, the pious, happy, and august.—The second cohort of the Astures restored from the ground, in a workmanlike manner, this granary, which had fallen down through age, in the kalends of March ....., Maximus governing the Province as (Augustal) Legate."

Dr. Bruce's expansion and interpretation are in the main correct; but there are some points which require emendation. I regard M, at the end of the fourth line, as standing for MILITES, and COH II, of the fifth; for COHORTIS SECVNDÆ. This view is supported by the use of RESTITVERVNT instead of RESTITVIT. The ex-

pansion SECVNDVM ARTEM for S·A is, in my judgment, unsatisfactory. I regard the letters as standing for SEVERIANÆ ALEXANDRIANÆ. Orelli, n. 3395, furnishes an example of a similar use of them. The reading "PROVINCIA REGNANTE, governing the province," is unquestionably erroneous. Whether *provincia* be regarded as the ablative, or, as is most probable, as used for *provinciam*, there is no authority for the government of either accusative or ablative by *regnare*, nor for the application of the term to the government of a province by a legate or other Roman officer. I would suggest PRO[V]INCIA[M] REG[ENTE]. Thus Tacitus, *Hist.* i. c. 48, "Vinius proconsulatu Galliam Narbonensem severe integreque *rexit*."

It may also be of importance to add, that Dr. Bruce's translation "happy" does not express the sense of *felix* as an epithet of the Emperors. It signifies what we mean by "fortunate," "lucky," and is expressed in Greek by εὐτυχὴς. It was first applied, as is well known, to Commodus, to mark his good fortune in being rid of Perennis, whose treasonable designs were abruptly terminated by his murder by the soldiers.

30. In the same work (vol. i. p. 251), a stone bearing a funereal inscription is figured:

C·VALERIVS·C·VOL·
IVLLVS·VIAN * MIL
LEG·XX·V·V

Dr. Bruce explains it thus:—

"The inscription may probably be read thus: Caius Valerius Caii (filius) Voltinia (tribu) Tullus vixit annos quinquaginta miles Legionis Vicesimæ Valentis Victricis. (In memory of) Caius Valerius Tullus, the son of Caius, of the Voltinian tribe, a soldier of the Twentieth Legion (styled) Valiant and Victorious (who) lived fifty years. Hodgson's reading is: Caius Valerius Caius Voltinius Julius vixit annos, &c. * * The age of the soldier has been cut upon a nodule of ferruginous matter, which has fallen out: there is not space for two letters, so that there is little doubt that the inscription originally had L."

Dr. Bruce's expansion is a great improvement on Mr. Hodgson's, but I am not satisfied with it. The position of MIL·LEG·, &c., without any distinguishing mark between VI and AN,* lead me to be-

* In the original, as figured by Dr. Bruce, there are leaf-points after *Valerius*, C, *Vol*, and *Tullus*.

lieve that VIAN [N or A] stands for *Vienna*, his birth-place, especially as it is in the right position, according to the normal collocation. This conjecture is confirmed by the circumstance that all the natives of Vienna (scil. *Allobrogum*), mentioned in inscriptions, belonged to the Voltinian tribe ;* e. gr. Orelli, n. 445.

C · VALERI
VS · C · F · VOL
CAMPANVS
VIENNA MIL
L · XI · C · P · F ·
&c. &c. &c.

Vide also Horsley, *Brit. Rom. Yorkshire*, n. 8; Orelli, n. 453; Letronne, *Inscr. de l'Egypte*, Pl. xxxi. 3; &c.

I would read the inscription thus: Caius Valerius, Caii[filius], Voltinia [tribu], Tullus, Vienna, miles Legionis xx, Valeriæ (not *Valentis*, for which there is no competent authority†) Victricis. According to this reading, I regard the A in VIAN as a mistake either of orthography or of reading for E; but it is possible that VIANA, a town of Rhætia or Noricum, may be intended, as Reinesius interprets the inscription, which he gives in Class viii. n. 38. It is worthy of notice, however, that the person named in that inscription also was of the Voltinian tribe.

31. In p. 261 of the same work, an altar is figured, which bears the following inscription :—

SOLI
APOLLINI
ANICERO.

* I do not mean to say that all the natives of Vienna were of the same tribe. There are examples which prove that some who had the same town as their birth-place were of different tribes. *Vide* Orelli, n. 3104; and Henzen, n. 6426.

† I regard VALEN· applied to the xxth Legion in Gruter, cccexcii., 5, as a mis-reading. VALERIA is confirmed, (as Mr. Maughan, *Journal of the Archæological Institute*, xv. 159, remarks), by Dion Cassius, lv. 23, and by Spon's Miscellanea, p. 195, cited by Orelli. To these references add Henzen, nn. 6680, and 6871. The remark in the Journal, *l. c.* that "the title occurs in the form of VALERIANA, on an inscription in Bath" is, so far as I am aware, incorrect. I have not seen a copy of any inscription found there, in which the titles of the xxth Legion are given otherwise than V. V. Mr. Warner (*History of Bath, appendix*, p. 121,) gives VALERIANA as an expansion, but the stone has only V.

Dr. Bruce offers no explanation, but remarks :—

"It was found together with three others of Mithraic character, The third line is somewhat obscure, and the subsequent lines are nearly obliterated by the action of the weather. Mr. Thos. Hodgson has described this and the other altars found on the same occasion in the *Arch. Æliana*, vol. iv. p. 6."

On reference to Mr. Hodgson's description, I find that the only letters of the doubtful word, which he attempts to explain, are the first four ANIO. These he regards as "the dative case of ANIVS, who was the son of Apollo and Rhea," and he cites in illustration (apparently with approval!) one of Mr. Faber's wild speculations, that "Rheo" [thus Mr. F. calls the mother of Anius] "is the same as Rhea, a mere personification of the Ark; Apollo is the solar Noah; and Anius is also the great patriarch, under the title of *Aniun*, the *naval deity*."

It appears, from a comparison of the representations of the altar, as figured by Dr. Bruce and Mr. Hodgson, that it is doubtful whether the fourth letter is C or O; and that the last two, read by Dr. Bruce as RO, are not distinct.

I am of opinion that the true reading is ANICETO, and that the word is nothing more than the Greek ANIKHTΩ[I] in Latin characters, i.e. *ἀνικήτῳ, invicto*, the epithet so frequently applied to Mithras, Sol, and Apollo.

32. In the *Journal of the Archæological Association*, Vol. IX., p. 91, there is a description of various articles of the Roman period, which were exhibited by Mr. Gunston, who stated that he was informed that they had been found in London. In addition to the reasons which are there given for believing that the information communicated to that gentleman was incorrect, there seems to me to be in one of the inscriptions ground for suspicion that it was not found in Britain. The inscription to which I refer, is

L · AVTRONI
VRBANI · OL · II

The reading of this is evidently:—*Lucii Autronii Urbani ollæ duæ.* Now there is no example, so far as I am aware, of any British inscription mentioning the *ollæ*, which are so commonly noticed in stones found in Italy. The only sepulchral designations in inscriptions found in Britain, so far as I recollect, are *monimentum, tumulus,*

and *memoria*. There is, however, a sepulchral stone, which, if my reading be correct, furnishes a term that I have never met with in any other inscription. As the examination of it may be of some interest, I shall devote the next article to the consideration of it.

33. In Horsley's *Britannia Romana* (*Yorkshire n.* 15) we have the following inscription:

DMS
CADIEDI
IAE FO
TVNA*
PIA·V·AX*

Mr. Horsley expands it thus: *Dis Manibus sacrum Cadiedinia Fortuna Pia vixit annos decem.* Mr. Ward had previously read it: "*Cadillae Jeriae Piae Fortunata Pia*, all which names are in Gruter." It is obvious that Mr. Ward's reading should be at once rejected. According to the process which he adopted, almost anything could be made out of anything with the help of Gruter's Index. I am not satisfied, however, with Horsley's expansion. The chief objection, which I have to it, arises from the singularity of the names *Cadiedinia*, and *Fortuna Pia*. There can, I think, be no doubt that *pia* is not a name, but an adjective expressing the character of the deceased female. There are many examples of this use of *pius* and *pia* (not *pie*) e. gr. Renier's *Inscriptions de l'Algérie*, n. 2814:

D M S
SITTIA
MENOPHI
LA · PIA · VIX
ANXXV
H S E

i.e. Dis Manibus sacrum. Sittia Menophila. Pia vixit annis viginti quinque. Hic sita est.

If this view be adopted, it follows then that there are not two persons named in the inscription under consideration, but only one, whose second name is FORTVNA or FORTVNATA. The question then, is as to her first name. Adopting Horsley's conjecture, I would supply N as the first letter of the third line, but would limit the name to the letters EDINIAE, which I regard as used for the

more usual form AEDINIAE by the ordinary substitution of E for AE. The name AEDINIA frequently occurs, e. gr. in Renier's *Inscriptions de l'Algérie, Ædinia Julia* in n. 1924, *Ædinia Lucilla* in n. 2598, *Ædinia Rogata* in n. 3015, and *Edinia* in n. 2802. In n. 195 we have *Ædia Fortunata.* From what has been advanced, it may, I think, be reasonably inferred that the correct reading of the inscription, omitting CADI, is *Dis Manibus sacrum Ediniæ Fortunæ* [*or Fortunatæ*]. *Pia vixit annis* X * But we have yet to examine CADI. I am inclined to suggest that it is a designation of the receptacle for the remains of the deceased. I am unable to cite an example from any other inscription, but Virgil, *Æn.* VI., v. 228, supplies the following authority:

"Ossaque lecta *cado* texit Corynæus aheno."

It is well known that *cupa* and *cupula,* both signifying barrels, are used as designations of receptacles of the dead, and to these I think *cadus* should be added, as denoting, perhaps, an earthen vessel of the form of a cask, used for the same purpose. Gutherius (*de jure Manium, Græv. Antiq.* XII, p. 1224) figures a *cupa* made of stone. As to the construction, *cadi* may be either in the nominative plural or in the genitive singular. It is not easy to decide on the construction on the latter supposition; but there seems to be no doubt that it was used—e. gr. Orelli, n. 4477:

D·M
LOCI IN QVO
CORPVS T·LV * *
SABINIAN LV
CIANI CREMA
TVM EST.

As it is not probable that the genitive is after *dis manibus,* we must suppose the omission of some such word as *signum* or *titulus,* indicating that the stone was the mark of the place or receptacle.

34. The discovery of inscribed stones has made a large addition to the number of the deities in the ancient Pantheon. Besides those noticed in Gruter's great work, Spon made a collection of inscriptions on altars *ignotorum atque obscurorum quorundam deorum;* and in De Wal's *Mythologiæ Septentrionalis monumenta epigraphica Latina,* we have notices of most of the northern deities, who were known up to the time of the publication of the volume in 1847, but no complete list

has yet been published. The most comprehensive catalogue, of which I am aware, is to be found in Henzen's *Index* to Orelli's Inscriptions, Vol. III, but even it, although very carefully prepared, and giving information up to 1856, is defective. There are some deities, named in inscriptions found in Britain, that are not mentioned in it. Amongst these is a god, whose name appears in three inscriptions found on the site of a Roman villa at Lydney, in Gloucestershire. The name in one is NODONTI, in the dative case; in another NVDENTE, which seems to be used for NVDENTI in the dative case; and in the third NODENTI, also in the dative case, and NODENTIS in the genitive case. The only explanation,* which I have seen relative to this deity, is contained in "The Romans in Gloucestershire," a Lecture by the Rev. Samuel Lysons, M. A., London, 1860. Mr. L. regards the name of the deity as NODONS or NODENS, and identifies him with Æsculapius, on the following grounds:

"The remains of a very considerable Roman building were discovered on an eminence in Lidney Park, on the forest side of our county, and carefully explored by the late Right Hon. Charles Bragge Bathurst. A very good series of interesting coins was then discovered, which is, I believe, still in possession of the present proprietor: but what adds great interest to that discovery was the finding of several votive tablets to a divinity,—which has caused no little speculation among antiquaries,—the god Nodens or Nodons. The difficulty was, to identify his name with the statues of the god himself, which were discovered at the same place, and bore all the characteristics of Æsculapius, viz.:—a dog, a cock, and serpents twining round a rod or staff, reminding one of Moses' contest with the magicians of Egypt. Pausanias relates that Æsculapius was represented in his temple at Epidaurus, as leaning on a serpent with a dog at his feet; and Plato, in his Phaedo, mentions the cock as sacred to the god of Medicine. * * * But a little reflection shows us how the Romans in their later occupation of this island had perverted Æsculapius' Greek attribute of *ἀνώδυνος*, the alleviator of pain (whence our term anodyne) into the deity, Nodons."

The explanation offered by Mr. Lysons, does not commend itself to me. In the first place, there seems to be doubt as to the statues which were discovered. A learned correspondent, well versed in archæological investigations, informs me that the statues found there were terminal figures, one of Pan and the other probably of Diana. But,

* The inscriptions are, I believe, given in Lysons' *Reliquiæ*, but I am not able to consult that work.

however, independently of this, I am not aware of any authority for ἀνώδυνος or νώδυνος as an epithet of Æsculapius.

It is difficult to arrive at any definite conclusion relative to the god *Nodons, Nodens,* or *Nudens,** and the only suggestion which I am able to offer on the point, is that the deity is the same as *Nodutis* or *Nodutus,* a rural god presiding over the *nodi culmorum.* As but very little is known of this deity, the following references may be found useful: Arnobius, *adversus gentes,* IV, p. 131, (ed. Leyden, 1651)—"*Nodutis* dicitur Deus, qui ad nodos perducit rec satas." Augustine, *de civ. Dei,* IV, 8, p. 94, (*ed. Paris,* 1685)—"Præfecerunt ergo Proserpinaom frumentis germinantibus geniculis nodisque culmorum deum *Nodotum.*" "Quando *Nodotus,* adjuvaret in bello, qui nec ad folliculum spicæ, sed tantum ad nodum geniculi pertinebat ?" Another reading of the name is *Nodinus,* which more nearly approaches that in the inscriptions. *Vide* also Tomasinus, *de donar. ac tab. vot.* c. 26; Voss. *de Idololatria,* 11, 61; Lexicon Etymol. in *Nodus;* Rhodiginus, *Ant. Lect.* XXV, 30, and Struvius, *Ant. Rom.* 1, p. 151.

35. Of the three inscriptions noticed in the preceding article, the following seems to be the clearest:—

D · M · NODONTI
FL · BLANDINVS
ARMATVRA
V · S · L · M

which I read,—*Deo Magno Nodonti Flavius Blandinus armatura votum solvit libens merito.* The epithet *Magnus* suggests Mithras, but it is also applied to other deities. *Vide* Orelli, n. 3596.

For *armatura* in the sense of *miles, vide* Muratori, 801, 8; and compare Steiner, i. *Rhen,* n. 332, and n. 473; Henzen, n. 6794; and Borghesi (cited by Henzen), *Ann. Inst. Arch.* 1839, *Iscr. Renane,* p. 5. It is not easy to determine the characteristics of the *armaturæ.* They are mentioned by Vegetius, ii. 7, 15, 17; and Ammianus Marcellinus, xiv. 11; xv. 4 and 5; and xxvii. 2.

According to the former, they seem to have been younger soldiers, lightly armed; and according to the latter, body-guardsmen.

* The nominative may also end in *on* or *is,* as *Nodon* or *Nodontis.*

As light infantry, they may have been connected with a legion, as our light company is with one of our regiments. From the *Notitia*, it appears that there was a *cuneus armaturarum* in Britain, at *Bremetenracum*, possibly (as Böcking suggests) detached from the sixth Legion. According to this view, *armatura* in the inscription may be translated, a light-infantry soldier;* according to the other, a life-guardsman.

36. Another stone found at Lydney bore the inscription:

PECTILLVS
VOTVMQVOD
PROMISSIT
DEO NVDENTE
M DEDIT

which I read,—*Pectillus votum quod promisit Deo Nudenti magno dedit. Promissit* is used for *promisit*, and *Nudente* for *Nudenti*, by an orthographical irregularity not uncommon in epigraphy.

37. The most interesting, and most difficult, of the three Lydney inscriptions, is the following, which is engraved on a leaden or pewter tablet:—

DIVO
NODENTI SILVIANVS
ANVLVM PERDEDIT
DEMEDIAM PARTEM
DONAVIT NODENTI
INTER QVIBVS NOMEN
SENICIANI NVLLIS
PERMITTAS SANITA
TEM DONEC PERF * RA *
VSQVE TEMPLUM NO
DENTIS

* Some have regarded the *armaturæ* as cavalry; e.g. Camden (*Brit.* Gibson, p. 835) "those *armaturæ* were horse armed cap-a-pee, but whether they were *duplares* or *simplares* (Veget. II, 7,) my author has not told us." Thus also *Vales*, in his note on Ammianus Marcellinus, xv. 5, citing Julian in Orat. 1, ad Constantium, p. 48 ed Spanh. and Orat. II. i. f. asserts—"Armaturas *equites* fuisse apparet; but the examination of the passages, cited by Vales, shows that they do not warrant his inference. The term *cuneus*, however, designating the body at *Bremetenracum* favours the opinion that they were cavalry, for *cuneus* in the *Notitia* is never applied, so far as I am aware, to infantry; although Vegetius iii. 19, defines it as "multitudo *peditum*."

Mr. Lysons (*Romans in Gloucestershire*, p. 54) reads and explains the words thus:

"*Divo Nodenti Silvianus annulum perdidit dimidiam partem donavit Nodenti: Inter quibus nomen Seneciani nullis permittas sanitatem donec perferant usque templum Nodentis.* It is, in short, nothing more or less than a hand-bill,* issued by a certain Silvianus, for the recovery of a ring which he had lost. He promises to give half its value, on recovery, to the god Nodens, and seems rather to insinuate that a certain Senecianus must know something about it, and threatens him with the loss of health until he shall bring it back to the temple of Nodens; thus identifying that deity with power over the diseases of the body."

To the reading of Mr. Lysons I see no objection, but his explanation does not at all satisfy me; nor can I understand what construction or translation he proposes for the words *inter quibus nomen Seneciani*. I am inclined to think that the circumstances under which this tablet was placed were these: Silvianus made a bet with Senecianus—whether it was a law-wager or not does not appear—he put down his ring, as was usual, as his stake, in lieu of the amount that he had bet, and vowed to the deity one-half of the sum that he expected to win, or one-half of the value of the ring. Senecianus won the bet, and, refusing to be bound by the vow of Silvianus, left the performance of it to him. Silvianus, to avert the anger of the god, erected this tablet in performance of his vow.

Let us now examine the inscription in detail.

DIVO NODONTI. *Divus* instead of *Deus* is unusual, but not unprecedented. ANVLVM PERDEDIT. The orthography of these words is not rare. Both *annulus* and *anulus* are written, and the use of E for I is common. As to the meaning, there can, I think, be but little doubt that the sense, which would at once suggest itself, is, *threw away a ring*, i.e., lost it, not accidentally but through his own fault. I do not mean to say that *perdo* is not sometimes used with the signification of *amitto*, but merely that that is not the sense which would first present itself on reading the words. If then the meaning be *threw away a ring*, the question is—in what way? The probable answer seems to be, by making a foolish bet. The ancient custom of using the ring in bets or wagers may be illustrated

* The only example which I have seen of a Latin advertisement of this kind is amongst the *graffiti* of Pompeii, and it does not at all resemble this inscription. *Vide* Wordsworth's *Inscr. Pomp.*, p. 26.

from the following passages: "Celebratior quidem anulorum usus cum fœnore cœpisse debet: argumento est consuetudo vulgi ad sponsiones etiamnum anulo exsiliente."—Pliny, *Nat. Hist.* xxxiii. i. "Si quis sponsionis causa anulum accepit, nec reddidit victori."—Ulpian, *Dig.* xix. 5, 18. "Pono pallium, ille suum annulum opposuit.—Plautus, *Curcul.* ii. 3, 17.

DEMEDIAM PARTEM DONAVIT NODONTI. The construction of *donare* either with the accusative of the person and the ablative of the thing or (as here) with the accusative of the thing and the dative of the person is well known. The meaning of the words, according to my view, is—Silvianus, to obtain the aid of the deity in winning the wager, vowed that he would present to him one-half of it if the decision should be in his favour.

INTER QUIBVS SENICIANI NOMEN NVLLIS PERMITTAS SANITATEM. The construction from *quibus* to *sanitatem* is plain, and the sense is clearly,—grant health to none of those who bear the name Senecianus—*quibus Seniciani nomen* est. But *inter* remains unexplained. Probably the simplest suggestion is, that the construction is *inter* eos *quibus*, i.e. *permittas sanitatem nullis inter* eos *quibus Seneciani nomen* est. But I am not satisfied with this. Can it be that *inter* stands for *in termino*, i.e. *Nodenti in termino*: to Nodon, whose terminal figure stands here? This view is countenanced by the conjecture that one of the statues found on the site was that of Nodon, possibly that one regarded as representing Pan. It is also supported by the contrast between the neighbourhood *in termino*, and the distance denoted by *perferant usque templum*. It is proper, however, that I should add that I do not recollect ever having seen TER· used for TERMINVS. The prayer for bad health is not conclusive evidence that the reference is to Æsculapius, for every deity was supposed to have the power of visiting with sickness or other punishment. The special office of Æsculapius was restoration to health.

PERFERANT USQVE TEMPLVM NODENTIS. The selection of the words *perferant* and *usque* seems to indicate the distance of the temple, and the consequent labour in reaching it. The use of *usque* without *ad* is well known. The only question which now remains, is as to what they were to carry to the temple. According to my view it was the *dimidia pars* (either of the sum wagered or of the value of the ring), which Silvianus had presented to the deity by a vow, the obligation of which Senecianus refused to acknowledge.

OBSERVATIONS ON THE PHYSICAL GEOLOGY OF THE WESTERN DISTRICTS OF CANADA.

BY CHARLES ROBB, C.E., HAMILTON, C.W.

The investigation and illustration of the geological structure of the surrounding country, whether we regard it simply as a matter of scientific interest or of practical utility, must ever form one of the most prominent objects of such Associations as that of which this *Journal* is the organ. To those whose previous studies have given them a taste for, and aptitude in, such pursuits, no subject can possess greater interest, or add greater zest to the enjoyment of their excursions, whether of business or pleasure; while even to those whose acquaintance with geological science may be but superficial, the knowledge of those causes which have operated in determining the configuration of our coasts, and in producing the most prominent featu ' of the scenery by which we are surrounded, must be a source of ' e and elevating enjoyment. Again, as a striking instance of the u efit of such investigations in a utilitarian sense, I need only adve o the fact that both in Canada and in the neighbouring State of New York, before the deductions of geological science were brought to bear upon the public mind, large sums of money were squandered in abortive attempts to find coal in rocks below the carboniferous series. In exposing the absurdity of such attempts, and thereby rendering the resources thus wasted available in more profitable channels, the science of geology has conferred on this Province a service which will amply justify the expenditure of the sums granted by Government for the prosecution of these researches.

Sir Roderick Murchison computes that the money expended in England alone, before geology was understood, in searching for coal where it would now be considered madness to expect it, would be sufficient to effect a correct general geological examination of the entire crust of the globe.

I propose, in this and subsequent papers, to lay before the readers of the *Canadian Journal* the results of such investigations into the physical geography of the western districts of Canada as I have had it in my power to make during a residence of upwards of eight years in those parts of the Province. The region embraced in these ex-

plorations is that lying between the Niagara and St. Clair Rivers, and the object in view in undertaking and prosecuting them was chiefly the gratification of my own tastes, for which, however, professional engagements have afforded both opportunities and further stimulus. I lay but little claim to the merit of originality in the observations I shall have to record; the geological structure of the regions in question having been fully investigated and most ably reported on by our Provincial Geologists; and in stating my own observations I shall endeavour, as far as the nature of the subject will admit, to avoid repetition of the facts and phenomena which have been so fully chronicled by them, and to confine myself to such supplementary details and to such deductions and inferences as my own enquiries and studies may enable me to make. As illustrative of some of the most interesting peculiarities of structure in the region under notice, I propose also to reproduce the arguments of Sir Charles Lyell and other observers relative to the retrocession of the Falls of Niagara; in corroboration of which I have noted some additional facts which have not hitherto been recorded.

Section I.

GEOLOGICAL FEATURES OF THE NIAGARA AND GORE DISTRICTS.

General Description.—The range of high lands which we are accustomed to denominate "the Mountain" running eastwards far into New York State—maintaining throughout a nearly uniform elevation of about four hundred feet above the level of Lake Ontario, and forming a platform or table land, in a basin of which Lake Erie is situated—bends round the head of Lake Ontario and continues in a north-easterly direction till it gradually disappears in the neighbourhood of the Bay of Quinté. The same geological formations do not, however, occur throughout the whole of this distance, as I shall hereafter point out. Along the southern shore of the lake, the ridge runs at a distance varying from four to eight miles from the shore, and presents a nearly uniform precipitous escarpment on its northern flank. Around Burlington Bay it approaches still nearer the margin of the lake, and at East Flamboro' bends to the northward and loses for the most part its precipitous character, and recedes gradually further from the shore, being not less than twenty-four miles distant in the rear of Toronto, though again, as we

proceed farther east, we find it approach within nine miles. With the exception of the Niagara River, no streams of any importance empty themselves into Lake Ontario throughout this region, as might naturally be expected from the proximity of the ridge to the shore; and that remarkable river itself, as I shall hereafter show presents anomalies and peculiarities perhaps nowhere else to be met with in nature.

The geological structure of this region is remarkably simple, exhibiting no faults or distortions of the strata; but it is far from being less interesting either to the geologist or the general observer on that account. The rocks immediately underlying the superficial deposits consist of various members of the Silurian or oldest fossiliferous strata. They belong to those divisions of the Silurian system called the Middle and Upper Silurian, corresponding to, and no doubt contemporaneous with, the Carradoc, Ludlow and Wenlock groups of England. Nowhere do we find a more interesting region in a geological point of view. Referring to it, or rather to the continuation of the same formations in New York State, Sir Charles Lyell remarks:—"If we wish to see in perfection the oldest monuments of the earth's history, so far at least as relates to its earliest inhabitants, we must look here. Certainly in no other country are these ancient strata developed on a grander scale, or more plentifully charged with fossils; and as they are nearly horizontal, the order of their relative position is always clear and unequivocal. They exhibit, moreover, in their range from the Hudson River to the Niagara, some fine examples of the gradual manner in which certain sets of strata thin out when traced to great distances, while others become intercalated in the series. Thus, for example, some of the limestones which are several hundred feet thick in the Helderberg Hills, near Albany, are scarcely forty feet thick in the Niagara district; and, on the other hand, the rocks over which the cataract of Niagara is precipitated, dwindle away to such insignificant dimensions when followed eastward to the hills south-west of Albany that their place in the series can scarcely be recognized." Sir Charles adds "that a comparison of the fossil remains found in those ancient strata with those of a corresponding age and position on the other side of the Atlantic, shows that while some of the species are identical the majority are not, and that however close the general analogy of the forms may be, there is evidence of the same law of varieties in space.

as now prevails in the living creation." Since Sir Charles wrote the above remarks it has been ascertained on a more minute investigation that the number of species common to the Silurian rocks on both sides of the Atlantic is between thirty and forty per cent.; and it is a most interesting fact that those which are identical are precisely those which are found most widely diffused both geographically and in the order of superposition, and consequently seem to have been most capable of surviving many successive changes in the earth's surface.

Professor Sedgwick, at the recent meeting of the British Association in Aberdeen, in speaking of this order of geological formations, characterized them by a figure quaint and graphic, though derived from modern feminine usages. He speaks of the limestone formations as a great girdle, or (in plain terms,) "hoop," over which Dame Nature had spread her "glorious palæozoic petticoat." Certainly nowhere on the face of the globe has this skirt attained a greater expansion, or been more gorgeously bedecked with the forms of ancient life, than in the locality now under notice.

Details of the Rock Formations.—A very complete and most interesting section of the strata in a line running north and south, is afforded by the cutting on the line of the Niagara Falls and Lewiston Railroad, and by the ravine itself through which the great river flows.* Taking the section at this most interesting locality as the basis of our future enquiries, I shall proceed to describe briefly the component parts, and shall take occasion while it is under review to recapitulate the arguments of Lyell and others, to prove the fact of the retrocession of the Falls from Queenston Heights to their present site.

The strata in ascending order consist, first, of a soft red shaley and purely argillaceous marl, partially striped and spotted with green, seen in the bank of the river at Queenston and extending thence to Lake Ontario, and attaining a height of about one hundred and ten feet at the escarpment at Queenston. This formation, which is entirely devoid of calcareous matter, is regularly stratified, and interspersed with thin veins of a light green rock of similar composition though somewhat harder, the colors being evidently derived from the presence of iron. The traces of organic remains in this bed are

* This section is represented graphically in Sir Charles Lyell's *First Visit to the United States*, 1841-2, Vol. I. page 36, to which we would refer our readers.

very obscure though not altogether wanting, and it is chiefly remarkable as forming the base of the system, and as occupying the entire area between the foot of the slope of the mountain and the lake shore for the whole distance from the Niagara River to Oakville.

The second stratum is a bed of very hard light grey quartzose sandstone, marked frequently with ferruginous spots, but forming an excellent building material, and quarried extensively at Lewiston, Hamilton, Dundas and other places. This bed is about fifteen feet thick at Queenston, and contains the remains of fuci or sea weeds. I have also observed it to be distinctly ripple-marked in some localities. Above this for a thickness of about sixty feet occur alternate layers of red shale or marl, similar to No. 1, and of sandstone or limestone, the former principally near the top of the formation. The harder rocks here are particularly rich in organic remains, some in a beautiful state of preservation, and all remarkably characteristic of the geological epoch to which these formations belong, consisting of corals, brachiopods of various species, tentaculites, encrinites and trilobites. Of the trilobites, a remarkable crustacean genus strikingly characteristic of the Silurian system all over the world, I have only detected a few fragments, but they are sufficiently unequivocal.

Next in succession is a grey and mottled sandstone about fifteen feet thick, forming the upper member of what is called by the New York State Geologists the Medina Sandstone group. Encrinites, corals and broken shells prevail in great abundance at the top. Overlying this bed is a band of light green shale five feet thick, turning into clay on exposure to the atmosphere. This stratum forms the lower member of the Clinton group of New York, and is remarkable as being traceable for vast distances east and west in precisely the same relative position, and of identical mineral character. Next in order occurs a compact bed of light grey, very hard limestone, about sixteen feet in thickness, copiously charged throughout its entire mass, but chiefly towards the top with the bivalve shell *Pentamerus* (a genus also found extensively in a corresponding position in the Silurian systems of England and Russia) as also with a few species of *Atrypa*, a remarkable coral called *Favosites gothlandicus*, &c. This bed forms the upper member of the Clinton group, and wherever it is found is an exceedingly handsome and durable stone for building purposes. Owing to its hardness it forms a distinct escarpment wherever exposed for any length of time to the weather. Then

follows the formation usually denominated Niagara shale, about eighty feet thick, consisting of a homogeneous stratified or laminated mass of bluish-grey, sometimes nearly black, argillaceous, arenaceous and calcareous slatey rock, hard and solid in the bed, but decomposing and crumbling when exposed to the atmospheric influences. It seems to be devoid of fossils, except towards its junction with the underlying hard limestone, where it is plentifully charged with *Pentamerus* and *Atrypa.*

Lastly. the escarpment is capped by the Niagara limestone, (so called) a massive and very hard dark blue or more nearly black rock, the lower portions being in very thick solid beds, while towards the top the partings occur more frequently. This rock is magnesian and silicious in mineral character, and is highly bituminous, being known in many places to emit inflammable gas through the seams. Occasionally it is cavernous in structure, and is copiously interspersed with druses or cavities containing calc-spar, gypsum and sulphate of Strontian. I have been unable to detect any fossil remains in this formation, although I believe they are not altogether wanting. It is over this rock that the great cataract is precipitated, and it forms from its hardness a species of coat of mail or armour of proof to resist the too rapid erosions of the torrent.

Proofs of Retrocession.—It will serve at once to illustrate strikingly what may be called the mechanical properties of the strata we have been considering, and at the same time to show by a most remarkable example the value of geological evidence in regard to duration of time, if we take up at this stage the subject of the recession of the great Falls.

It has long been a well known fact, that behind the mighty cataract there existed a vast cavern formed by the action of the water and air set in violent motion by the descending torrent upon the soft shales underlying the Niagara limestones; and this fact must have suggested to an enquiring mind the idea, that as the soft material became gradually undermined or excavated, the weight of the superstructure and impetus of the water must have caused the harder superincumbent rock from time to time to give way, and thus occasion a recession of the Fall in its position. In accordance with this idea, it is found from historic evidence, (which unfortunately in this point affords less corroboration to geological theories than in questions relating to the old world), that changes of the kind referred to had

actually taken place; and the appearance of the bank below the Falls where these changes had occurred within the memory of man is so precisely identical in character with the whole gorge for seven miles below, that a philosophical observer of the phenomena of nature would be irresistibly impelled to the conclusion that the great Fall formerly existed at Queenston, and that the river must have sawed its way through this whole distance—provided sufficient time were allowed for the completion of the work. Sir Charles Lyell concludes, after the most careful and repeated investigation of the recorded facts, as well as the varying nature of the strata, that the average recession was not more than one foot per year, and that consequently it must have taken 35,000 years for the retreat of the Falls from the escarpment at Queenston to the present site. It seems by no means improbable that such result would be no exaggeration of the truth, although we cannot assume that the retrograde movement has been uniform. At some points, owing to the greater softness of the strata and the lesser width of the ravine, it might be expected that quicker progress might be made; but on the other hand, it must be observed that at the commencement of the process the Fall must have been nearly twice its present height and consequently the amount of material to be excavated proportionally greater. This estimate of the time required for the scooping out of the gorge, as Hugh Miller remarks, is based upon exactly the same process of reasoning by which one would infer that a labourer who had cut a ditch two hundred yards long at the rate of ten yards per day and was still at work without intermission, had begun to cut it just twenty days previous.

This theory based upon historical, is amply corroborated by geological evidence. If we examine the structure of Goat Island, between the American and Horse Shoe Fall, we shall find that the superficial deposit consists of regularly stratified horizontal fresh water beds of gravel, sand and loam, in all about twenty feet thick, copiously charged with shells of the same species as now inhabit the waters of Lake Ontario and the Niagara river. These beds are entirely above the level of the water as it precipitates itself into the mighty gulf. Precisely the same formation will be found on the American side of the river exactly opposite, and extending for a considerable distance below the Falls on the top of the cliffs, and bounded towards the east by a distinctly traceable ancient river

terrace cut out in the clay or drift formation which covers the whole country. This deposit, in which also the remains of a Mastodon have been found, occupies the place which the ancient bed, and alluvial plain of the Niagara would naturally have filled, if the river had extended farther northwards at a level sufficiently high to cover the greater part of Goat Island. At that period the ravine could not have existed, and the river must have been dammed back several miles lower down. The old river banks are distinctly traceable facing each other on both sides of the gorge, at least as far down as the Whirlpool, and vary in width from about thirty to three hundred feet from the brink of the precipice. At the summit of the cliffs overhanging the Whirlpool on the American side, there occurs a deposit forty feet thick of fluviatile strata, precisely identical with those on Goat Island; and it must be borne in mind that nowhere do these deposits extend, or can they be traced, beyond the old river banks.

Here then we have the most unequivocal evidence that at a date comparatively modern in the geological epochs, though very remote as regards the history of our race, the great Falls must have been situated at least four miles below their present site; and in the absence of distinct traces of their existence still further northward we may reasonably and justly infer that they must have primarily been situated at the escarpment at Queenston. There is no ground for supposing that the excavation was assisted by an original rent in the rocks, and no appearance of a fissure occurs at the present site of the Falls.

The dip of the strata being twenty-five feet to the mile southward, and the slope of the river bed about fifteen feet in a mile northwards, these two inclinations combined have occasioned a diminution of forty feet in the perpendicular height of the Falls for every mile that they have receded southwards. When they were situated at the Whirlpool, the hard quartzose sandstone was at the base of the precipice, and here the cataract may have remained stationary for ages. Even now the obstruction occasioned by this ledge in the bottom of the river causes a partial damming back of the water, which, overleaping this barrier, rushes with still more fearful velocity down the gorge. This phenomenon, together with a remarkable break (which I shall afterwards advert to) in the continuity of the strata on the Canadian side at this point have no doubt given rise to the Whirlpool. In regard to the future retrocession of the Falls it is susceptible of clear proof that when they have travelled back two miles or opposite to the

village of Chippewa, the massive Niagara limestone now at the top will then extend also to the base of the Falls, and its great hardness will probably arrest the excavating process, if it should not have been previously stopped by the descent of larger masses of the same rock from the cliffs above. In this latter case, instead of a fall we shall have a rapid of about the same slope as the present rapids above the falls, (fifty feet in three-fourths of a mile); but very much more broken and irregular owing to the greater size of the masses of rock forming the bottom.

The next question to which we are naturally led, relates to the origin of the Falls, but this subject I shall defer till the close of this article, when, after describing the principal geological features of the region bordering on the head of Lake Ontario, I shall attempt to indicate the succession of events which have produced them.

Strata traced Westwards.—The various members of the series of rocks already described, are also exposed in tracing the escarpment running parallel to the shores of the lake, from Niagara to Flamboro'. The strata lie nearly horizontally from east to west, but dipping slightly to the eastward, the dip of the lower standstone bed (called by the quarrymen the Gray band,) which rests immediately on the red marl, being at the rate of twenty-two inches per mile. An attentive observation of the section thus exposed will shew the remarkable manner in which certain of the beds thin out and die away as you follow them westwards; while others not to be discovered at the Niagara river are intercalated in the series, and as they are traced in a northwest direction attain to a great thickness, still retaining their distinctive characters. Thus the great deposit of dark shale, which at the Falls shews a thickness of eighty or ninety feet, is represented at Flamboro' by a bed of only five feet thick; while the encrinal and cherty limestone, which at Flamboro' occupy a most prominent place in the group, die out gradually and are scarcely to be detected at the Falls.* This same encrinal limestone, which at Flamboro' is only

* This phenomenon, which is not peculiar to the Silurian or to any other system, though nowhere perhaps more strikingly apparent than in this locality, may, I conceive, be accounted for in three ways: Either, 1st. That in the wide and deep ocean in which these deposits were made, certain of them never reached the deeper portions, but subsided along its shores; Or, 2nd. It may have been caused by certain portions being too shallow or even upraised above the surface of the water. Or, 3rdly. After the deposition of the stratum, it may have been uplifted so near to the surface of the sea, as to have been worn away by the waves, and thus have allowed a succeeding deposit to come directly upon one of preceding date.

about twenty feet thick, is observed to attain a thickness of one hundred feet in Eramosa, Nassagaweya and Caledon. This limestone, as well as the underlying Clinton limestone, is everywhere well adapted to form an excellent and durable building material, and is likewise of good quality for burning into lime. It forms wherever it crops out a bold escarpment (which may be called the Niagara ridge) owing to its solid and apparently unstratified character. This escarpment is distinctly traced from West Flamboro' eastward into Nelson, where it takes a sweeping turn to the north, and maintains a nearly straight course in that direction until it reaches Owen Sound near Sydenham village. The dark bituminous limestone which forms the upper member of the group follows the same course, which, however, is not so distinctly marked, owing to its being stratified in thinner beds, and occupies throughout from the Niagara River to Owen Sound, a breadth of country varying from eighteen to twenty or twenty-two miles.

The red marl which forms the base of our series of rocks is supposed to be about 614 feet thick. The bore which yields the mineral water at St. Catherines pierces it for a depth of nearly four hundred and seventy feet without passing through it, and the level at which the bore commences is one hundred feet below its upper surface. It seems geographically to come to an abrupt termination at the west bank of the Creek at Oakville, and is there succeeded by the Lorraine Shales, or Hudson River Group—an older formation consisting of alternate very thin beds of limestone and shale, which extend from this point along the north side of Lake Ontario to the River Rouge in the township of Pickering, immediately adjoining Scarboro'. A good section of this formation is exposed on the east bank of the Don at Toronto. A bore which was executed under my directions at the Toronto Station of the Great Western Railway, penetrated it for a depth of one hundred and fifty feet without change. The water which this bore yielded was salt and bitter, and a considerable quantity of carburetted hydrogen gas was evolved.

I may here remark in passing that in the spring of 1855 a great land-slide occurred on the slope of the mountain a little below Dundas Station, which displaced a portion of the track of the Great Western Railway, and was caused by the weight of the debris of the harder rocks above sliding along the face of the soft shales which, by exposure to the weather, resolve themselves into an unctuous sort of clay.

may also notice that in filling up the old channel of the Desjardins

canal, enormous quantities of material were thrown in and disappeared, producing no effect in forming a bank, but forcing up the soft material in the original bottom of the marsh, to a considerable extent and height above the surface. This affords a good illustration on a small scale, of what the geologist often finds on a large scale, and may be puzzled to account for; I refer to the displacement of strata, formed in horizontal position and thrown up into a highly inclined or even vertical position.

Waterlime and Ochre.—Before noticing the superficial deposits of this region, I shall direct attention briefly to the waterlime and ochre beds of Thorold, which are somewhat extensively worked for commercial purposes, and occur about three hundred feet above the level of the Lake, and close on the line of the Welland Canal at Thorold. The waterlime deposit consists of a series of thin layers (each layer not exceeding eight to ten inches thick) in all about three and a half to four feet thick, of very hard compact dark blue limestone, corresponding in position and probably identical with the Clinton group. These beds are in some places a perfect congeries of large bivalves, called *Pentamerus oblongus*, some of them measuring three and a half to four inches across, while the partings of the beds are beautifully marked with fucoids of various species. The limestone from this bed, when calcined and ground to powder, forms an hydraulic cement of the best quality; owing this peculiar property to the presence of a large proportion (over ten per cent.) of silica or silicates. Immediately underlying and overlying this bed, are thin layers of a softer stone, which, when calcined and ground, forms an excellent drab coloured pigment; a rich brown paint, said to be fireproof, is also manufactured at Thorold, from material found in the same quarries. Whether these peculiar products extend far to the east or west of the localities where they are at present quarried, I am unable to say; but at Rochester there occurs an iron ore bed at the same place in the series, and Dr. Mack of St. Catherines has ascertained that the stone from the drab ochre bed contains forty per cent. of iron.

Superficial Deposits.—I shall now, as briefly as the subject will admit, direct your attention to the superficial deposits of this region, and the proofs of glacial action which they afford. It is now pretty generally conceded, and in fact cannot on any reasonable ground be denied, that the thick deposit of clay, sand, gravel and boulders which covers the Western districts of Canada, (in many places upwards of

one hundred feet beneath the general surface, and along the shores of Lake Erie and elsewhere forming hills one hundred and fifty feet above the general level,) is due to what is called by geologists the glacial period, and the phenomena referable to this epoch, are precisely similar on both sides of the Atlantic. From well known cosmical laws, ice-bergs and fields of floating ice are constantly, in seas north of the fortieth parallel of latitude, passing from the Polar regions in a direction from N.E. to S.W. and are conveyed for hundreds of miles from their original birth-places; and these are frequently found to be charged with vast quantities of mud, sand and boulders, the debris of the granitic rocks which mostly occupy these regions. These ice-islands become stranded in seas too shallow to float them, and as the ice is melted, deposit their insoluble contents at random over the bottom of such seas, and the deposits thus formed would be stratified or unstratified according as the water was in a quiescent state or disturbed by currents. The slow passage of these ponderous masses, armed with such refractory materials, over the rocks forming the bottom of the seas, would grind down their upper surfaces, removing great quantities of their constituent materials, and producing grooves, furrows and scratches in the normal direction of their course. We have, on a small scale, an example near our own doors of the effect of ice in removing masses of rock. I refer to the fact that the isolated rock called Gull Island, between Cobourg and Port Hope, two miles from the northern shore of the lake, and on which the lighthouse is built, formed at the time of the early settlement of the country, an island of over two acres in extent, but is now only a sunken reef, owing doubtless to its having been as it were decapitated by the ice forming over and adhering firmly to its upper beds, which would be borne away with the floating ice during storms. The same process is continually going on upon a larger scale in Lake Superior, and the observations of navigators in the Arctic regions supply, on a still more extensive scale, all the "modern instances" requisite for the corroboration of the theory.

Now it is an interesting and important fact that the constituent materials of the clay, sand and gravel which cover the greater part of Canada West, are derived from granitic and trappean rocks; that the boulders embedded in the clay and strewed over the surface are, for the most part, fragments of the same rocks; that these rocks are found in their native beds invariably in a North-easterly direction, and that

the surfaces of the harder rocks *in situ* in the peninsula, wherever exposed by the removal of the drift, are found to be smoothed, polished, furrowed and scratched in a direction from N.E. to S.W. Any one who has had occasion to visit Niagara Falls will see this phenomena strikingly developed along the top of the cliff on the American side, and at the excavation for the Hydraulic canal, about half a mile below the Fall. That this smoothing and scratching of the rocks could not be produced simply by the action of torrents of water carrying stones with it, may be satisfactorily proved by examining the rocks in the bed of the river, which, even where the current is most rapid, exhibit no analogous effect.

General Inferences.—In order to account for all the phenomena I have thus briefly sketched, we are irresistibly impelled to the conclusion that subsequently to this region having acquired its present geographical configuration, so far as relates to the outline of the older rocks, the land was submerged under the sea to a moderate depth, and that large ice-islands were driven by currents from the north, charged with mud, sand and boulders, which, as they grounded on the bottom, pushed along all loose materials of sand and pebbles, broke off all angular and projecting points of rock, and when fragments of hard stone were frozen into their lower surfaces, scooped out furrows and grooves in the subjacent rocks. When the icebergs melted, the soft and loose insoluble materials which they conveyed subsided into the bottom, filling up valleys in the ancient rocks, covering them under a mass of clay and sand where currents were powerful enough to reduce the deposits to a general level, and forming mounds and hillocks of the same, in places where such currents did not prevail. That this was actually the case is proved by independent evidence, namely, the occurrence of marine shells of recent species, in the drift formation at various heights above the level of the sea in the region drained by the St. Lawrence.

Burlington Beach and Heights.—Of this nature and origin I have no doubt are the remarkable formations of the Burlington Beach and Heights, which seem to have been expressly designed by Providence, the first as a natural rampart and breakwater to protect our magnificent harbour, and the latter as a bridge to facilitate our communications by land. The immense masses of clay and drift which conceal the older formations between Dundas and Copetown render it impossible to say with certainity whether the latter preserve the same precipitous

and continuous character round the head of Burlington Bay as along its north and south flanks; but there is the strongest reason to believe that they do. If then we conceive the rocks to have run continuously at the same elevation round the head of the valley, and at the same time imagine the sea to have covered them as explained before, we have here precisely the circumstances which would produce all the phenomena we now behold. A bay or basin would thus be formed entirely sheltered from currents, and into which large quantities of the floating ice-islands would be driven by the winds; and thus would be produced that irregular, rolling and deeply indented surface which we find prevailing from the eastern limits of Hamilton to Copetown. A succession of ridges of sand and gravel, no less than seven in number, in some places more, and in others less distinctly marked, have been traced for great distances along the north shore of Lake Ontario, and as far east as the Montreal Mountain and the slopes of the White Mountains in Vermont; each preserving, as far as the Lake Ontario region is concerned, a uniform level at their bases, and all nearly parallel to each other and to the present beach of the Lake; but the lowest of these is one hundred and ten feet above the Lake at its base, and hence there is no reason to believe that the Heights form any portion of an ancient sea beach, as the others unquestionably are.* It is asserted by Lyell, on what seems to be uncontrovertible grounds, that these beaches indicate the succession of levels of the sea as the country underwent a gradual and intermittent upward movement after the deposition of the boulder or drift formation, which was the last great change previous to the present era in the earth's history.

I may remark here that the deep notch or indentation formed by the Niagara river at the whirlpool on the Canadian side, is bounded by a formation consisting exclusively of clay, cemented gravel and sand, with boulders both of granitic and limestone origin, precisely similar to the formation at Burlington Heights; and that there is an obvious connection between this break in the older strata and the opening in the escarpment at St. David's, indicating that here a deep

* In the year 1852 in excavating through the Burlington Heights for the Great Western Railway, a gigantic tusk of a Mammoth or *Elephas Primigenius* was exhumed, having been buried in the solid conglomerate at the depth of forty feet below the surface; and in the same cutting, the horn of a Wapiti or Canadian Stag was brought to light. This latter species is not yet quite, although rapidly becoming, extinct on this continent; and the occurrence of its remains, associated with those of a species which has been extinct previous to the historic period, forms an interesting link between the past and present geological epochs.

valley had originally existed, which, during the glacial period, was filled up with the materials peculiar to it.

The average depth of the clay over the area comprised between the foot of the slope of the mountain and the lake shore seems to be about twelve feet; but at the artesian well at St. Catherines it is forty feet thick. There is a remarkable break in the continuity of the red marl of the Silurian formation, commencing at the eastern limits of Hamilton and terminating at the west side of the old canal; the intervening space being filled to an unknown depth with laminated clay and sand. May not this be accounted for by the abrasion and grinding down of the older soft marl, produced by the agitation of the icebergs which I have supposed to be congregated and imprisoned in this locality? The clay has been pierced to a depth of from sixty to seventy feet at the passenger station of the Great Western Railway without passing through it.

Succession of Changes.—I shall now in conclusion give a brief general retrospect of the probable succession of events which have produced the geographical and physical configuration of the region under notice.

The first event to which we must recur is the successive deposition, at a time vastly and immeasurably remote, of the stratified rocks shewn in these sections. I have said that they belong to the oldest fossiliferous rocks, and probably they contain the records of the first of living forms. That they are of marine origin is indisputable from the sea weeds and deep sea shells which they contain, but no trace of fishes, of vertebrated animals or of terrestrial vegetation can be discovered in them, and it seems to have been for many ages a creation of molluscs, corals and crustaceans. These rocks remained nearly undisturbed and horizontal from the era of their formation to a comparatively modern period, during which interval the whole of the geological formations subsequent to the Silurian system were deposited in different parts of the globe; and the vast succession of species of animals and plants whose histories we find written in these rocks have flourished and perished and been slowly entombed. During this interval also, and while the rocks in question still remained submerged in the ocean, they were denuded by currents, that is, portions were worn off and transported away, so as to form irregularities of surface, such as the basins of our great lakes, and

such valleys as those of St. Davids and the Welland Canal. They at length emerged slowly, and portions of their edges were removed by the action of waves and currents by which cliffs were formed at successive heights, such as those I have already adverted to around Flamboro' Heights. After this event another submergence under the sea occurred, and was followed by the glacial period, which it is to be remarked was of comparatively modern date. As soon as the table land between Lakes Erie and Ontario emerged, subsequently to the deposition of the drift and successive formation of the sea beaches, the River Niagara came into existence, the basin of Lake Ontario still forming part of the sea. The cataract would then be at Queenston, falling directly into the sea; and then would commence the retrograde course of the river, continuing uninterruptedly as already described, till the present time.

REMARKS ON THE CLASSIFICATION OF MAMMALIA.

BY THE REV. W. HINCKS, F.L.S.
PROFESSOR OF NATURAL HISTORY IN UNIVERSITY COLLEGE, TORONTO.

I will introduce the few remarks I have to submit on this subject, by referring to an attempt which I made, at one of the meetings of the Canadian Institute, to give an improved expression of the affinities of the different groups in the class Birds, on the principle of a central body especially typical, with deviations of structure to suit special tendencies or special conditions.

I then endeavoured to show that if the great body of Insessorial or perching birds, be considered as the truest representatives of bird structure, there would be found to be five principal deviations from it which have been deemed so important as to be regarded by most ornithologists as forming distinct orders:—Raptores or birds of prey, Scansores or climbers, Rasores or poultry and game birds, Grallatores or waders, and Natatores or swimming birds. I pointed out also that there are families among the Insessorial birds, of greater or less extent, approximating to each of these deviative groups; and that there are

remarkable lateral connections between the deviative groups themselves. These views I endeavoured to render clear by the aid of a diagram.

Were I now going over the same ground I might somewhat modify the details, but on the whole, frequent reconsideration with the practical reference of plans to an extensive collection of specimens has confirmed me in the views I brought before you, and I have been led to extend their application to some other departments of Natural Science. Without doubt if my principle is good it will admit of very wide application, though there may be natural classes consisting entirely of a central group of families, without any considerable deviations of structure, and others formed by a circle of characteristic structures that might seem to have relation to some common central body, though none such exists, or is known to us. My object on the present occasion is to bring under your notice an application of the same principle of a typical central group, with deviations that admit of a circular arrangement to the class mammalia. Not to trouble you here with details of various systems, the Cuvierian arrangement of mammals as improved to correspond with the present state of knowledge gives us no less than twelve orders in that class :— 1st. Bimana, for man only; 2nd. Quadrumana, monkeys and lemurs; 3rd. Cheiroptera, bats; 4th. Insectivora, moles, shrews and hedgehogs; 5th. Carnivora, cats, dogs, weasels, bears, and seals; 6th. Cetacea, whales and dolphins; 7th. Rodentia, squirrels, rats, beavers, &c.; 8th. Edentata, ant-eaters and sloths; 9th. Pachydermata, elephants, swine, horses; 10th. Ruminantia, antelopes, oxen, deer, &c.; 11th. Marsupialia, pouched animals, as opossums and kangaroos; 12th. Monotremata, the Echidna and Ornithorhyncus. Respecting the reality of these as so many natural groups, the great question is, whether the lower organisation of the brain and the reproductive system in the marsupialia and monotremata presents the kind of difference that should characterise orders. The settlement of this question depends on what we ought to understand by orders. One great philosophical naturalist whose authority stands deservedly high—Agassiz—in the introduction to his noble work recently issued, maintains that whilst "*classes* are natural divisions, characterised by the manner in which the plan of their respective great types is executed and by the means employed in the execution; *orders* are natural groups, founded upon the degree of complication of the structure.' Degree of development should, according to this view, be the principal

test of the characters of orders, and whilst a common plan, and correspondence in certain important particulars are deemed a sufficient justification for uniting intestinal worms with anellida, and Epizoa Cirrhipeda and even Rotifera with Crustacea, it would afford no reason for combining the Sarcophagous Marsupials with Carnivora, the vegetable feeders with Rodentia, or the Monotremata with Edentata. I must confess that I look upon orders as minor classes; groups which are, like the classes and all other useful divisions, really marked in nature, so that in laying them down we are interpreting nature, but which differ from the classes rather in the extent and importance of the characters than in their essential qualities. If we look at examples amongst the best marked and most generally recognised orders, we *shall, I think, find abundant justification for this view. I cannot* consider the various tribes of mammals without being impressed with the feeling that if the received order Rodentia be placed in the centre, Insectivora, Cheiroptera, Edentata, and the Marsupial tribes corresponding to two of these, and to the tribes included in Rodentia, are all closely associated together, differing from each other only in the same degree as among birds the Dentirostres, Fissirostres and Tenuirostres differ from the Conirostres. Here then I find the great centre groups of mammals typically represented by the carnivorous and herbivorous Rodentia, and making approaches in various directions to the great deviative classes. Of these Quadrumana represent Scansores among birds; Carnivora Raptores; Ruminantia, Rasores; Pachydermata, Grallatores; Cetacea, Natatores. Within the great centre group Insectivora represent Dentirostres; Cheiroptera, Fissirostres; Edentata, Tenuirostres. The kangaroos in their intermediate position between the family Leporida of Rodentia and the Ruminantia, correspond well with Columbidæ among birds. The Camelida form a link between Ruminantia and Pachydermata of the same kind that the Ostrich forms between Rasores and Grallatores; and the Hippopotamus and the Manatida or sea-cows connect Pachydermata with Cetacea much as the Flamingo does Grallatores and Natatores. Unwilling to trespass on your time, and to trouble you with details that might prove tiresome, I confine myself here to a general statement of my plan, but it seems to me that whilst expressing the affinities of mammals more clearly and naturally than is done by the prevalent systems, there is no small advantage gained by the beautiful correspondence maintained between the arrangement of mammals and birds, and

I cannot but hope that improved knowledge of fishes and reptiles might enable us to range them also in corresponding groups.

The speculations of McLeay, Swainson, and their followers, respecting an absolute number of divisions naturally belonging to every department of organized nature, and repeated in each subdivision; though probably pushed to an extreme, and doubtless often erroneous in the details, may express their perception of an important fact, which, properly considered, may bring us at last to the most natural classification. Is it not true that each grand division of the animal kingdom expresses a certain idea of structure; a certain general character as compared with the other divisions? Is it not likewise true that the classes into which each branch or grand division resolves itself, when really natural and judiciously limited, consist of one eminently typical, and others making up the number of the other branches and exhibiting tendencies towards each of them? Each class has its orders, and do not these again give us either a central typical group with a set of deviations expressing the ideas of the primary branches, or else the latter without the former? The tribes again contained in each order often do, and, if we were better acquainted with their limits and positions, would more frequently, convey to us the same ideas, which are often repeated even in inferior groups. The plan of a central group peculiarly expressing the characteristic idea with deviations, each prominently exhibiting the character of one of the primary branches, has not perhaps, been sufficiently attended to, and as soon as we determine that we must find everywhere a peculiar number, we begin to run into forced combinations or separations; yet the fact of general correspondencies in the natural distribution of different classes, is too important to be overlooked, and may ultimately conduct us to general conclusions of the highest interest, which at present we can but dimly imagine. In the arrangements of birds and quadrupeds which I have brought before you, I have surrounded each central body with five deviative forms.

It is true that Cuvier recognizes only four great sub-kingdoms or branches of the animal kingdom, and, if it is now acknowledged that his Radiata possessed too miscellaneous a character, still when the groups really belonging to the higher divisions are removed, the proposed sub-kingdom Protozoa can only contain Infusoria, properly

limited, Rhizopoda and Porifera. The latter class, consisting of the sponges, many naturalists assume to be vegetable. Agassiz contends that Rhizopoda probably are so also, and argues from several known cases, some of them ascertained by his own observations, that the remaining Infusoria are embryonic forms of various worms. I must say that I very obstinately cling to the conviction of the animal nature of sponges. I can see no pretence for maintaining the vegetable nature of Rhizopods, and I believe that when all embryonic forms of other creatures, as well as all true vegetables, are withdrawn, the class Infusioria will still be sufficiently numerous; as, therefore, these groups cannot naturally be included in Radiata, and in the absence of a definite nervous system and of the distinct organs for the different functions are sufficiently distinguished from all others, I think Protozoa may safely be added as a fifth branch or sub-kingdom of the animal kingdom. Most naturalists now admit Amphibia as a fifth class of Vertebrata, and thus in these important cases the numbers are brought to correspond. Perhaps a reasonable combination and limitation of classes in Articulata and Mollusca might produce the same effect, and if we consider the position of Radiata and Protozoa we may see no cause to wonder at their presenting a reduced number of classes omitting the modifications of lower development found in the other divisions.

I have endeavoured to express by a diagram my idea so far as I have yet carried it out.* Several particulars, perhaps, claim fuller explanation and defence than I have given them, but I hope enough has been done to enable those who are interested in the subject to judge of the advantages arising from my plan. In these few remarks I have been chiefly anxious to show the completeness of the analogy as to all the leading divisions between mammalia and birds, but I wish the whole to be considered rather as suggestions thrown out for examination than as a carefully elaborated system which I am prepared to maintain in every particular.

* It is not thought necessary to engrave this diagram, the nature of which will be understood from the preceding observations. In the long interval between the reading and the publication of this paper, in consequence of its having been mislaid, the author has given much attention to Owen's classification of mammalia, which he has studied with great pleasure and profit though without being induced to abandon the leading features of his own scheme.

A POPULAR EXPOSITION OF THE MINERALS AND GEOLOGY OF CANADA.

BY E. J. CHAPMAN,
PROFESSOR OF MINERALOGY AND GEOLOGY IN UNIVERSITY COLLEGE, TORONTO.

(*Continued from page* 182.)

Our last paper of this series, inserted in the present volume of the *Journal*, pages 168–182, contained a tabular distribution, with brief descriptions, of all Canadian minerals of metallic aspect: these falling under sub-divisions *A* and *B* of the classification given on page 170. The present paper includes the minerals belonging to sub-division *C;* and in the next number, those of the fourth sub-division will be given, completing this portion of our subject.

C. Aspect, non metallic (stony, glassy, etc.) Hardness sufficient to scratch glass

C. 1—*Infusible. Very hard, not yielding to the knife.*

[Quartz is the only mineral of common occurrence, belonging to the present section. In colour, degree of transparency, and general appearance, this substance varies exceedingly; but its specific gravity is always under 2·9, whilst the other minerals (of Canadian occurrence) included in the section, exceed 3·0 in density. Feldspar is sometimes confounded by beginners with quartz; but the former in thin splinters, is more or less readily fusible. The two minerals may be distinguished also, at once, by the following characters: Quartz breaks with an uneven or conchoidal fracture, and never exhibits smooth cleavage planes. Feldspar, on the other hand, possesses a strongly-marked lamellar structure, and breaks easily in certain directions, so as to present a smooth, polished, and somewhat pearly fracture-plane.]

Corundum.—Red, blue, brown, greenish, black, &c. In small granular masses and hexagonal crystals. H. 9·0, and hence much above that of quartz; sp. gr. 3·9-4·1. Quite infusible. Corundum consists, normally, of pure alumina. The transparent red varieties constitute the *Ruby* of commerce, and the blue varieties the *Sapphire.* The coarser dull-coloured varieties are called *Adamantine spar;* and the opaque, black and dark grey varieties (often mixed with magnetic iron ore) form *Emery,* a substance used largely, from its great hardness, as a polishing material. Some of the finer kinds of corundum exhibit when cut, a beautiful opalescent six-rayed star. These are

called *asteria sapphires, &c.*, according to their colour. Red (and blue) corundum occurs sparingly in the crystalline limestone (Laurentian series) of Burgess township, Lanark Co., C. W.

Spinel.—Red, blue, dull-green, black, &c. In small granular masses, but chiefly in regular octahedrons, simple or modified; figs. 29, 30. The latter figure represents a common twin-form, or combination of two octahedrons. Infusible, H. 8·0; sp. gr. 3·5-4·5. Spinel is an aluminate of magnesia, but a portion of the magnesia is usually replaced by oxide of iron, as in the black varieties called *pleonaste*, more especially; or by oxide of zinc, as in the Swedish dark green variety called *Gahnite* or *automolite*. Normally, it consists of alumina 72, magnesia 28. The clear red varieties are employed in jewellery under the name of Spinel or Balas ruby. Well-crystallized black specimens occur in the Laurentian limestone of Burgess township, C. W.; and bluish specimens with *clintonite* (a chloritic, altered mineral,) in D'Aillebout, Joliette Co., C. E.


Fig. 29.


Fig. 30.

Magnetic Iron Ore.—Black with black streak, and in general, a sub-metallic lustre. Massive, or in octahedrons and rhombic dodecahedrons. *Strongly magnetic*, often with polarity. See *A* 4, above.

Chromic Iron Ore.—Black; chiefly massive, and usually with sub-metallic lustre. Streak, dark brown. Imparts a fine green colour to borax before the blowpipe. See *A* 4. above.

Quartz.—A substance of a vitreous or more or less stony aspect; colourless, or of various colours, as purple, brown, red, green, yellow, &c. Occurring in crystals and crystalline groups, figs. 31, 32, and also in nodular, botryoidal, and amorphous masses. The crystals are commonly six-sided prisms, streaked across, and terminated by a six-sided pyramid. H. 7·0; sp. gr. 2·6-2·7. Infusible; but melting (with great effervescence) with carbonate of soda, into a clear glass. Quartz consists normally of pure silica, the coloured varieties owing their tints to minute and accidental admixtures of sesqui-oxide of iron, bituminous matter, and other inessential ingredients. Special names have been applied by lapidaries and others to


Fig. 31. Fig. 32.

the leading varieties of quartz. Thus we have, *Rock Crystal* (including the so-called "Quebec diamonds," &c.); *Smoky Quartz*, a brown variety of rock crystal; *Amethyst*, a purple or violet-coloured quartz, in which the edges of the crystals are usually more deeply coloured than the other parts; Cairngorm, a yellow transparent quartz; *Rose Quartz*; *Milk Quartz*, a white translucent variety; *Calcedony* and *Cornelian*, grey, white, bluish, yellow, and red, uncrystallized translucent varieties of quartz; *Cat's-eye*, an opalescent or chatoyant calcedony; *Chrysoprase*, a light green translucent variety; *Heliotrope*, a dark green variety, sometimes with red spots and then called *Bloodstone*; *Plasma* and *Prase*, other green varieties, the latter often mixed with actynolite; *Agate*, *Onyx*, *Sardonyx*, &c., uncrystallized varieties of various banded colours; *Jasper*, coarse, opaque, red, brown, and other coloured specimens, often striped, and with dull lustre on the fractured surface; *Flint* and *Hornstone*, &c. Crystallized quartz occurs in various parts of Canada, more especially where Laurentian rocks prevail, and in the altered rocks of the eastern townships. Amethyst is found abundantly on Spar Island, where it forms a broad vein with calc-spar holding native silver, and at Thunder Bay and other spots on Lake Superior. Agates, also, in great variety, occur in the trap rocks and in the shingle beaches of that region (Michipicoten Isle, St. Ignace, Thunder Bay, &c.) A jasper-conglomerate, evidently an altered sedimentary rock, occurs on the north shore of Lake Huron. Agates and red and green jaspers occur also in Gaspé. Red jasper passing into jaspery iron ore, likewise near Sherbrooke; and, with veins of calcedony, on the river Ouelle (Kamouraska Co.) C. E. Silica often constitutes the fossilizing substance of organic remains, as in the Devonian corals of western Canada; and it is frequently found in crystal-groups in the inside of many fossil shells. Finally, it may be observed, quartz forms one of the essential components of granite, gneiss, and many other crystalline rocks. Sandstones also consist essentially of quartz grains cemented together, or consolidated by pressure; whilst in beds of sand and gravel we have the same substance in loose grains and pebbles, as explained more fully in Part III.

Zircon.—Red, brown, or grey, with resino-vitreous aspect. Chiefly in small crystals: (square-based prism-pyramids), fig. 33. H. 7·5; sp. gr. 4·0-4·7. Quite infusible. One hundred parts consist of: silica

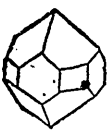


Fig. 33.

33·2, zirconia 66·8. The transparent, yellowish-red varieties are employed in jewellery under the name of *Hyacinth.* Small crystals, sometimes of good quality, occur in the crystalline limestone (Laurentian Series) of Grenville township, Argenteuil Co., C. E. Those which have come under our observation are simply interesting as mineral specimens, but Sir William Logan has obtained some of fine colour and transparency, "constituting veritable gems." (Esquisse géclogique du Canada.)

Andalusite.—Chiefly grey or pale red; in granular masses, and in rectangular or rhombic prisms. The latter are sometimes compound, presenting a cruciform figure on the cross section. These constitute the variety *Chiastolite,* (fig. 34.) H. (normally) = 7·0-7·5, but often less by alteration or weathering; sp. gr. 3·1-3·2. Quite infusible. General composition: silica 37, alumina 63. In Canada, this mineral occurs in reddish crystals and small masses in micaceous schists (altered Silurian strata,) around Lake St. Francis in the counties of Megantic and Beauce. It may be distinguished from feldspar by its higher specific gravity, and also by its complete infusibility.

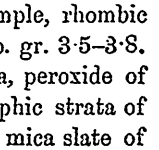


Fig. 34.

Staurolite:—Brown, red, greyish. Commonly in cruciform (Trimetric) crystals; otherwise in more or less simple, rhombic prisms. H 7·7·5, but sometimes less by alteration; sp. gr. 3·5–3·8. Quite infusible. General composition: silica, alumina, peroxide of iron. This mineral occurs sparingly in the metamorphic strata of the Eastern townships, although it is abundant in the mica slate of Maine, Vermont, &c.

Rutile:—In small crystalline scales and grains, and in flattened square-based prism-pyramids, of a red or orange colour, with semi-metallic lustre. H. 6·0-6·5; sp. gr. 4·15-4·25. Infusible. Forming with borax in a reducing flame a dark amethystine-blue glass, which by exposure to an intermittent flame, becomes transformed into a light-blue enamel. In Canada, Rutile, in a distinct form, occurs only in small quantities in the iron-ores of the Eastern metamorphic region, as in the townships of Sutton, Bolton and Brome; and with *Ilmenite* in the Laurentian rocks of Baie St. Paul, Canada East. It consists of Titanic acid (=Oxygen 39, Titanium 61.)

Condrodite:—Chiefly in small granular masses of a deep yellow

colour, imbedded (usually with accompanying scales of graphite,) in crystalline limestone. H 6–6·5; sp. gr. 3·1-3·2. Infusible, but becomes white before the blowpipe. With borax, melts into a clear glass, which, if thoroughly saturated, may be rendered milky by flaming. This mineral is a silicate of magnesia, combined with a small proportion of fluoride of magnesium. It dissolves with gelatinization in hydrochloric acid. Condrodite occurs in some abundance in the crystalline limestones of our Laurentian rocks, more especially in the townships of South Crosby (Leeds Co.) C. W., and Grenville (Argenteuil Co.*) C. E. Also in St Jerome, (Terrebonne Co.) in the Lower Province.

Olivine:—In green, yellow, or brownish grains and granular masses (sometimes crystalline) in the eruptive rocks of Montreal, Rougemont, Montarville, etc., in Eastern Canada, as first recognised by Mr. Hunt of the geological survey. H 6·0-6·5; sp. gr. 3·3-3·5. Infusible, gelatinizes in hydrochloric acid. Composed of silica and magnesia, the latter usually in part replaced by protoxide of iron.

Tourmaline:—(Infusible varieties): yellow, green, etc., mostly in three or nine-sided prisms. This mineral is described under C 3, the Canadian varieties being (chiefly) fusible.

Feldspar (Including *Orthoclase, Albite, etc.,*):—In white, red, green, or greyish cleavable masses and crystals. Fusible in thin splinters. See Section *C 3*.

The following minerals may also be referred to, in connection with this group:—

Opal.—Hydrated silica. A vitreous, or resino-vitreous mineral of various colours, occurring only in nodular or amorphous forms. Sp. gr. 2·0-2·2. Gives off a little water in the bulb-tube. The iridescent varieties constitute the *noble opal;* the colourless glassy variety in botryoidal masses, forms the *hyalite;* whilst the opaque, or faintly translucent varieties, of white, grey, red, brown, and other colours, comprise the *semi-opal, milk opal, wood-opal,* &c. Although this mineral, at least in its coarser varieties, is exceedingly common in the old world, (chiefly in amygdaloidal cavities in trap and volcanic rocks,) it appears to be of very rare occurrence in North America.

Beryl.—Chiefly in six-sided prisms and columnar masses of a light green colour. Fusible with great difficulty, and only on the thinnest edges. H. 7·5–8; sp. gr. 2·6–2·8. Common in many parts of the United States. The clear bluish-green varieties are employed in jewellery under the name of *Aquamarine.* The rich, deep green varieties (chiefly from New Grenada) form the well-known *Emerald.*

* This is incorrectly printed 'Addington Co.' at page 178, line 5.

Topaz.—Chiefly in yellow, colourless, or bluish crystals and rolled pebbles, easily distinguished from quartz by their facile cleavage in one direction. The crystals are combinations of rhombic prisms and pyramids (see figs. 16 and 18 in Part I.) H. 8·0; sp. gr. 3·4-3·6. In the United States, Topaz occurs in Connecticut and North Carolina.

Tin stone or Cassiterite.—Brown, grey, black, etc. In granular masses, pebbles, and Dimetric crystals, the latter often in twin combinations. Very hard and very heavy, (H. 6·0–7·0; sp. gr. 6·3–7·0.) Infusible, but yielding tin globules before the blowpipe, especially with carbonate of soda. The lustre is often semi-metallic. This is the "ore" of tin, properly so-called. One hundred parts consist of: oxygen 21·38, tin 78·62. In the United States it occurs but sparingly, and no traces of it have as yet been found in any part of Canada.

C. 2. *Infusible. Yielding easily to the knife.*

Cyanite.—Chiefly in lamellar and bladed or broad—fibrous masses of a pale-blue, or pearl-grey colour, though often white, reddish, &c. Lustre somewhat pearly. The edges of the lamellæ scratch glass with ease, whilst the flat surfaces yield readily to the knife. Sp. gr. 3·5-3·7. Infusible before the blowpipe, and very slowly soluble in borax. One hundred parts consist of: silica 37, alumina 63. Not met with, apparently, in Canada, but it occurs in mica slate in Vermont, and is of frequent occurrence in other States.

Apatite or Phosphate of Lime:—Chiefly in six-sided prisms (often with rounded edges) of a light green colour; or in green and brownish cleavable and concretionary masses. H. 5·0; sp. gr. 3·0-3·3. Infusible (or in some specimens fusible with difficulty on the thinnest edges), but it dissolves readily in borax and in salt of phosphorus, yielding a glass which becomes opaque on cooling or when "flamed." By this character, as well as by its inferior hardness (as it scratches glass but feebly, and may readily be scratched by a knife,) *Apatite* is easily distinguished from *green feldspar* and *beryl*. It differs from *Fluor Spar* in being hard enough to scratch glass: also by its infusibility, crystalline form, &c. Apatite occurs in the crystalline limestones of our Laurentian rocks. Amongst its more important localities, we may cite the townships of Burgess and Elmsley, in Canada West; with Grand Calumet Island on the Ottawa, and Hull township, in Eastern Canada. In the township of Burgess it occurs in a red-coloured coarse-grained limestone in such abundance as to form, according to the estimate of Sir William Logan, about one-third of the mass. In North Elmsley, a fine locality has recently been discovered by Dr. James Wilson, of Perth. Small nodular

masses of phosphate of lime, presenting a brown colour and shining lustre, occur also in the sandstones of the Sillery group (at the top of the Lower Silurian series) on the river Ouelle, and in the shales of Point Lévi in Canada East. These are supposed to be coprolites. It is perhaps needless to observe, that phosphate of lime, whether derived from inorganic or organic sources, constitutes an agricultural fertilizer or manure of the highest value.

In this group, may be placed also, the *Silicate* and *Carbonate of Zinc*, but these minerals have not been discovered as yet in Canada. The *Silicate of Zinc* occurs chiefly in white or yellowish crystalline aggregations, or in botryoidal and sometimes earthy masses, often of a dull brownish yellow tint from intermixed peroxide of iron, and occasionally also coloured green by silicate of copper. The crystals are pyro-electric, and are slightly fusible on the edges. Sp. gr. 3·3-3·5; H. 5 0. Gives off water in the bulb-tube, and dissolves in heated hydrochloric acid. Composition: Silica 25, oxide of zinc 65·5, water 9·5. *Carbonate of Zinc*, in colour, etc., resembles the silicate, but the crystals are rhombohedrons. H. 5.0; sp. gr. 4·0–4·4. Dissolves with effervescence in acids. Composition: carbonic acid 35·2, oxide of zinc 64·8. These minerals are frequently found intermixed. They constitute (with Red Zinc Ore) the essential "ores" of Zinc, properly so-called. See the remarks under *Zinc Blende, B* 3, (page 182) above.

C 3. *Fusible. Not yielding water in the bulb-tube.*

Garnet :— Colour, chiefly red of various shades, but also black, brown, green (both dark and pale,) yellow, and even white. Commonly in crystals (rhombic dodecahedrons and trapezohedrons, figs. 35 and 36); otherwise in granular and rounded masses, or amorphous, with lamellar structure H. 6·5–7·5; sp. gr. 3·5–4·2. More or less easily fusible, the dark specimens yielding a magnetic bead. Composition, essentially silica and alumina, (or silica, alumina and sesquioxide of iron,) with either lime, or magnesia, or protoxide of iron or manganese, or several of these bases combined. (See a very complete series of analyses in Dana's "System of Mineralogy," vol. 2, pages 191–2.) Garnets are of comparatively common occurrence in the gneissoid rocks of the Laurentian formation, more especially in contact with beds of crystalline limestone. The mineral thus occurs in bands of gneiss properly so-called, quartz, hornblende rock, &c., along or near to the edges of the limestone beds in very many localities, although it is found also in various places more or

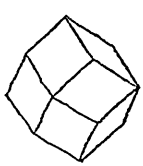


Fig. 35.

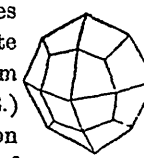


Fig. 36.

less remote from these beds. Briefly, amongst other Laurentian localities of Garnet, we may mention the following:—Various spots along the Muskoka river, as the Lake of Bays, &c.; the townships of Marmora and Elzevir, Hastings County, C. W.; Barrie and other townships in Frontenac County, C.W.; Hull, Ottawa County, C.E.; Chatham, Chatham Gore, and Grenville townships (dark red and hyacinth-red varieties) in Argenteuil County, C. E ; the parish of St. Jérome in Terrebonne County, C.E.; Rawdon township, Montcalm County, C.E.; Hunterstown, Maskinonge County, C. E.; &c. In some of these localities, (St. Jérome especially, see Sir William Logan's Report for 1853) the garnets are sufficiently abundant to be available as a polishing material in place of emery. Amongst the altered strata south of the St. Lawrence, Mr. Hunt has discovered certain white or light-coloured beds which exhibit the composition of a lime garnet. In the township of Oxford, one of these consists of irregular rounded masses of white garnet.—H. 7·0 ; sp. gr. 3·536 —associated with serpentine; and at the Falls of the River Guillaume in Beauce County, the same substance forms a compact homogeneous rock (See Mr. Hunt's Report for 1856.)

Idocrase.—This mineral is identical with *Garnet* in composition and general characters, but differs in crystallization. It occurs in modified square-based prisms and pyramids of the Dimetric system, at least when crystallized. In other respects it cannot be distinguished from garnet. Idocrase has been found, associated with crystalline limestone, in Clarendon township Frontenac county, C. W.; Calumet Island on the Ottawa; and Grenville township, Argenteuil County, C. E.

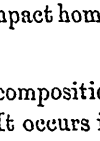


Fig. 37.

Tourmaline.—Of various colours, black, brown, yellow, green, blue, and pale red ; sometimes colourless. The black variety is commonly known by the name of *Schorl*. Tourmaline occurs in modified three, six, nine, or twelve-sided prisms longitudinally striated, or in columnar or fibrous masses. The crystals are generally triangular on the cross fracture, owing to the predominance of three prismatic planes; and this character is usually sufficient to distinguish the mineral from other substances. H. 6·5–7·5 ; sp. gr. 3·0–3·3. The black, and most of the brown varieties fuse easily, the others, as a

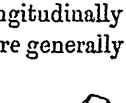


Fig. 38.

general rule, being either infusible, or fusible on the edges only. Tourmaline presents a somewhat complex composition, but its essential constituents comprise: silica, boracic acid, alumina (or alumina and sesqui-oxide of iron) with lime or magnesia, or one of the alkalies, or several of these bases combined. Fine examples of this mineral occur in connection with the crystalline limestones of the Laurentian rocks at Calumet Island on the Ottawa (greenish-yellow crystals); in the township of Fitzroy, Carleton County, C. W.; in Clarendon township, Frontenac County, C. W.; in the townships of Bathurst and Elmsley, Lanark County C. W.; in Hunterstown, Maskinongé County, C. E.; at St. Jérome, Terrebonne County, C. E; and other localities. In addition to the general triangular form of its crystals and columnar concretions, tourmaline may be distinguished from hornblende and other minerals of this section, by exhibiting electrical properties when heated. The clear varieties moreover, are generally translucent when viewed transversely, and quite opaque when viewed longitudinally, even in the shortest fragments.

Sphene.—This mineral, as regards Canadian localities, occurs in small masses or little sharp-edged crystals of an amber-yellow colour in the crystalline limestones of the Laurentian series generally; and in the eruptive trap rocks of the eastern Province. H. 5·5; sp. gr. 3·4–3·6. Fusible on the edges with bubbling into a dark glass: Essential components: silica, titanic acid, and lime. Our best known localities comprise Grand Calumet Island on the Ottawa; Burgess township, Lanark County, C. W.; Grenville township in Argenteuil County (in crystalline limestone and also in trap); St. Jérome parish, in Terrebonne County, C. E.; and the eruptive rocks of Mount Johnson, Yamaska, &c., of the district of Montreal.

Epidote.—Chiefly in modified oblique prisms, and in fibrous and lamellar masses of a dark or light-green colour, passing into greenish-yellow, brown and grey. H. 6·0–7·0; sp. gr. 3·2–3·5, expands before the blowpipe into a slag-like mass, which melts upon its edges but resists further fusion. By this latter character it may be easily distinguished from hornblende, augite, idocrase, and other minerals of this section. Epidote occurs in many of our eruptive rocks, as in the greenstones of Lake Superior and the north shore of Lake Huron, and in some of the traps of Eastern Canada, although

nowhere, apparently, in very prominent specimens. Mr. Murray, in his report for 1858, cites the east shore of Portage Harbour, Lake Huron, as a locality of this mineral.

Hornblende.—Dark or light-green, black, brownish, and sometimes light-grey or colourless. In prismatic crystals (of the Monoclinic System) figs. 39 and 40, or more frequently in amorphous masses of a fibrous or lamellar structure. The dark varieties are commonly known as *Hornblende* or *Amphibole;* the bright or light-green varieties, as *Actynolite*; and the greyish or colorless varieties, as *Tremolite*, H. 5·5–6·0; sp. gr. 3·0–3·4. Easily fusible, the dark specimens yielding magnetic beads. Composition: silica and magnesia, the latter in part replaced by protoxide of iron or lime; alumina being also sometimes present. This mineral forms one of the essential components of many metamorphic and eruptive rocks. It thus occurs in syenitic gneiss, hornblende-slate, &c., throughout the large area occupied by the Laurentian strata, and in the intrusive syenites associated with these—as in the township of Grenville, Argenteuil county, C. E., and other localities. It occurs also in crystals and fibrous masses in the beds of crystalline limestone belonging to this series. Amongst other Laurentian localities, we may enumerate, Grand Calumet Island (Tremolite, &c.); Blasdell's Mills, river Gatineau; Grenville, &c.,—in Canada East; with the neighbourhood of Perth, &c., in Lanark County, C. W. (the acicular variety termed "Raphilite"); Elzevir township, Hastings County (dark-green, and in places, black fibrous masses which have been taken for coal); Barrie and other townships in Frontenac County; the Muskoka river, the Falls of the Madawaska, &c.,—in Canada West. In the more modern metamorphic district south of the St. Lawrence, hornblende occurs largely as a rock constituent, as in Beauce and other counties. Also in crystals and crystalline grains in the eruptive masses of Shefford, Belœil, &c., of that district.

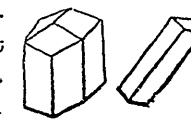


Fig. 39. Fig. 40.

Augite.—This mineral in colour and all general characters, as well as in composition and blowpipe comportment, closely resembles *Hornblende.* The crystals belong likewise to the Monoclinic Sytem, but differ in aspect, as shown by fig. 41, one of the most common combinations. The front prism-angle (and the angle of cleavage-

masses) = 124°30′ in *hornblende*, and 87°5′ in *augite*; but some of the lightcoloured (*diopside*) crystals belonging to the latter, occur in flat rhombic prisms like fig. 40 above, and give an angle of 141°21′*. Structure, lamellar or fibrous. H. 5·0–6·0; sp. gr. 3·2–3·5. Fusible, the dark varieties yielding magnetic globules. Composition, as in Hornblende: see above. The dark-green, black, and brown varieties commonly bear the name of *augite* (proper) or *pyroxene*; the clear green varieties, that of *sahlite*; and the white, greyish, or pale-green varieties, that of *diopside*—but many additional names have been bestowed on this mineral, in relation to locality, structure and other conditions. Both *hornblende* and *augite*, it should be remarked, offer a transition to *serpentine*: one stage in this transition producing the peculiar varieties, *asbestus* and *amianthus*. These are chiefly of a light-green or white colour, fibrous, silky, and flexible—often to such an extent as to admit of being woven into cloth. *Diallage*, described below, appears to be a transitional form of this kind. Augite occurs in the bands of crystalline limestone—and in some places as a rock component, forming, in admixture with *Wollastonite*, distinct beds—interstratified with the gneissoid rocks of the Laurentian Series, as in the counties of Argenteuil, Terrebonne, &c. In Argenteuil county, a green, granular variety (*Coccolite*) is also found. This mineral occurs likewise in the metamorphic schists of the eastern townships, and in crystals and granular masses in the eruptive rocks of Montarville, Rougemont, &c., belonging to that section of the Province.

Fig. 41.

Hypersthene. Bronzite. Diallage.—These are generally regarded as varieties of Augite. They occur in cleavable masses of a pinchbeck-brown, green or greenish-grey colour, usually with a pseudo-metallic lustre. Sp. gr. 3·2–3·5. Fusible more or less readily, the dark varieties yielding a magnetic bead. *Diallage* is of low hardness, and it yields almost always a little water in the bulb-tube, and hence will be referred to amongst the minerals of *D* 4 and *D* 5 below. In composition, these minerals, like augite, are essentially silicates of magnesia (or of magnesia and protoxide of iron.) Hypersthene

* If we denote the first prism in augite by V, this latter prism = V¼. It is the most common form of the diopside prisms imbedded in our crystalline limestone.

occurs in small quantities in the feldspar bands of the Laurentian strata, as in the counties of Terrebonne, Lanark, &c. Also in foliated masses in a mixed feldspathic rock, in the parish of Château-Richer, (Montmorency County,) below Quebec, (T. Sterry Hunt: Report for 1854.)

Wollastonite (*Tabular Spar.*)—White or light-grey, (rarely red or brownish.) Chiefly in tabular masses with fibrous structure. H. 5·0; sp. gr. 2·77–2·9. Fusible more or less easily. Composition: silica 52, lime 48. Found principally in the Laurentian limestones, as in the parish of St. Jérome, and in Morin township, Terrebonne County, C. E.; in Grenville township, Argenteuil County, and other localities. Wollastonite forms also, in union with augite, a distinct rock belonging to the Laurentian metamorphic series, (See the "*Esquisse géologique du Canada*," by Sir W. E. Logan and T. Sterry Hunt.)

Orthoclase or Potash Feldspar.—This mineral occurs in white, red, pink, light-green, and greyish cleavable masses, and in crystals (frequently twins,) of the Monoclinic System, figs. 42 and 43. The cleavage planes meet at an angle of 90°. H. 6·0; sp. gr. 2·5–2·6. Fusible with difficulty, although the edges of a thin splinter become easily rounded. By this character, as well as by its lamellar cleavable structure, feldspar may be readily distinguished from quartz. Composition, essentially: silica, 64·8; alumina, 18·4; potash, 16·8. Feldspar is one of the component minerals of granite, syenite, gneiss and other eruptive and crystalline rocks—and, as such, occurs abundantly throughout the area occupied by the Laurentian deposits; and also amongst the eruptive masses of the more modern metamorphic region, including the district of Montreal, &c. Amongst special localities, we may cite the following:—Lanark County, C. W., where the beautiful "avanturine" variety termed "Perthite," and green and other specimens, occur. Grenville, and Chatham, in Argenteuil County: red and other crystals in porphyritic trap. Chambly, in the County of that name: large yellowish-white crystals in porphyritic trap. The Yamaska Mountain; &c. Feldspar yields by decomposition a white clay or earthy mass termed "Kaolin" or "porcelain clay," largely used in the arts.

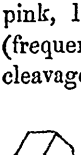


Fig. 42.

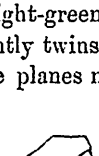


Fig. 43.

Albite or *Soda Feldspar.*—This mineral closely resembles common feldspar in colour and general characters, but differs in belonging to the Triclinic System, and by containing soda in place of potash. Its cleavage planes do not meet at right angles, but at inclinations of 93° 36′ and 86° 24′. It enters generally into the composition of trap rocks, and replaces the orthoclase of some granites and syenites. In Lanark County, C. W., a beautiful iridescent variety, the so-called "*peristerite,*" is met with.

Labradorite or *Lime Feldspar.*—Chiefly light or dark grey, greenish, or lavender-blue, with frequently a beautiful reflection of green, blue, orange, and other colours. Commonly in cleavable, lamellar masses, the cleavage planes (one of which is usually striated) meeting at angles of about 93½° and 86½°. H. 6·0; sp. gr. 2·67–2 77. Somewhat easily fusible in thin splinters. Composition: essentially—silica, alumina, and lime, with a portion of the latter replaced by soda. Labradorite (or a mixture of various triclinic feldspars,) forms one of the metamorphic rocks of the Laurentian series, interstratified with the gneissoid and other crystalline rocks of that age. Fine examples of the mineral occur in Lanark County, C. W.; and in St. Jérome, Morin, Abercrombie, and the seignory of Mille Isles, in Terrebonne County, C. E. Many of these examples are (externally) opaque-white, by weathering. Boulders containing opalescent feldspar masses, occur also abundantly in Grenville, &c., in the neighbouring County of Argenteuil.* Labradoritic rock (a mixture, according to Mr. Hunt, of labradorite and andesine,) occurs also in the parish of Château Richer in Montmorency County, C. E.; and opalescent specimens are cited from islands off the north-east shore of Lake Huron.

Note.—Mineralogists have established under the names of *Anorthite, Andesine, Oligoclase* &c., various additional species of lime feldspar. These are triclinic in crystallization, and more or less closely related. As a general rule, indeed, they are only to be distinguished by accurate chemical analysis. Practically, they may be classed with *Albite* or *Labradorite.* To Anorthite, the so-called *Bytownite* is referred. This is a greenish-white feldspathic mineral, found in boulders about Ottawa city. Another smoky or greenish-blue mineral, of a somewhat feldspathic character, from Perth, Canada West, is referred also to the same species.

Scapolite or *Wernerite.*—White, greenish, reddish, &c. Chiefly in lamellar and fibrous masses, and in crystals of the Dimetric System,

* A beautiful vase worked from one of these boulders may be seen in the Museum of the Geological Survey in Montreal.

of which an example is given in fig. 44. H. 5·5 (but much less in weathered specimens); sp. gr. 2·6–2·8. Easily fusible. Composition, essentially: silica 49, alumina 28, and lime 23, the latter in part replaced by a little soda. Scapolite occurs in the Laurentian limestone-bands, as in Calumet Island on the Ottawa; Grenville township, on that river, (Argenteuil County); Hunterstown in Maskinongé County, C. E.; and Golden Lake (with graphite, &c., Mr. Murray: Report for 1854) in Algona township, Renfrew County, C. W. A peculiar mineral, or rather rock, of a peach-blossom-red colour, occurring in Lanark County, C. W., and known as *Wilsonite*, (after Dr. James Wilson of Perth,) is an altered or semi-decomposed scapolite containing carbonate of lime and a little water.

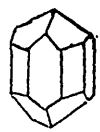


Fig. 44.

C 4.—Fusible. Yielding water in the bulb-tube.

Prehnite.—Green of various shades, generally pale, and sometimes colourless. Chiefly in botryoidal and globular masses with radiated-fibrous structure; or in closely aggregated, flat, prismatic crystals belonging to the Trimetric System. H. 6–6·5; sp. gr. 2·8–3·0. Fuses easily, and with continued bubbling; and yields from 4 to 5 *per cent.* of water in the bulb-tube. Composition: silica, alumina, lime, and water. Prehnite occurs most commonly in association with trap rocks, and is occasionally found in the veins which traverse the Huronian formation on the north shores of Lakes Huron and Superior. On the south (and also on the north-west) shore of the latter lake, it occurs in great abundance, often closely associated with the native copper of that region. At Isle Royale a beautiful variety occurs in small water-worn, nodular pieces of a rich green colour and radiated-fibrous structure. The fibres radiate from many central points, and these often consist of a nucleus of magnetic iron ore. This variety is commonly known by the name of Chlorastrolite (signifying green star-stone.) It is considered by some observers to be a distinct species, as its sp. gr. (2·98–3·20,) is somewhat higher, and its amount of water somewhat greater. than that of prehnite. The former arises however from the intermixed iron ore (to the presence of which, also, the deeper colour is to be attributed,) and the latter I find to be exceedingly variable. Five specimens in selected fragments, yielded respectively the following per-centage of water;—4·86, 5·51, 4·11, 4·18, 4·60. Chlorastrolite

forms, when polished, a handsome (though opaque) stone, fit for rings and brooches. In some directions, a slight chatoyance is observable.

Datolite.—Chiefly pale green or colourless, in botryoidal and fibrous masses, and in monoclinic crystals. H. 5·0–5 5; sp. gr. 2·95–3·0. Fusible with bubbling; imparting a greenish tint to the flame; and yielding in the bulb-tube about 5 or 6 per cent. of water. Composition: silica, boracic acid, lime, and water. Occurs with prehnite, laumonite, &c., in association with the traps of the north shores of Lakes Huron and Superior. Fine crystals are found at Isle Royale, and on the south shore of Lake Superior, in the copper region.

Thomsonite.—Chiefly in white or light-coloured acicular crystals and fibrous masses, in (or connected with) the traps of Lakes Huron and Superior. H. 5·0–5·5; sp. gr. 2·3–2·4. Fusible, with previous intumescence. If free from weathering, in which case it will be translucent, it yields about 13 per cent. of water in the bulb-tube. Composition: silica, alumina, lime, soda, and water.

Analcime.—Chiefly in trapezohedrons (fig. 45,) of a white or greyish colour, associated with the traps of Michipicoten Island and the shores of Lakes Huron and Superior. H. 5·0–5·5; sp. gr. 2·0–2·1. Fusible quietly, *id est*, without intumescence or bubbling. Yields in the bulb-tube from 8 to 9 per cent. of water. Composition: essentially, silica, alumina, soda, water.

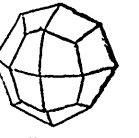


Fig. 46.

Apophyllite.—In lamellar masses and dimetric pyramidal crystals of a white or light colour, with pearly opalescence on the top or basal plane. H. 4·5–5·0; sp. gr. 2·32–2·37. Exfoliates before the blowpipe and fuses with bubbling. In the bulb-tube, yields about 16 per cent. of water. Composition: silica, lime, potash, and water. Found here and there in connection with the traps of Lakes Huron and Superior. Fine crystals come from the copper region of the south shore of the latter lake. Thomsonite, apophyllite, and other "zeolitic" minerals, occur also, it may be observed, both abundantly and in fine examples, in the trap rocks of Nova Scotia. These are sometimes red, greenish, &c., as well as colourless.

[*Wilsonite—Altered Scapolite.*—In columnar masses of a peach-blossom-red colour, from Lanark County, C. W. See under "Scapolite," *C* 3, above.

(To be continued.)

REVIEWS.

Historical Pictures retouched; a volume of Miscellanies. In two parts. *Part I. Studies; part II. Fancies.* By Mrs. Dall, author of "*Woman's Right to Labor.*" Boston: Walker, Wise & Co. 1860.

In noticing the contents of a volume, confessedly a miscellany, we shall best satisfy the taste of that class of readers to whom a popular work chiefly appeals, by selecting one of its themes in illustration of the whole. Yet while speaking of this volume as one appealing to its readers by popular elements of incident and biographical narrative, as well as by inventive fancy, it would be a grievous misrepresentation of its author's aim to convey the idea that it is written merely for the purpose of beguiling a passing hour. The authoress is one of that class of American ladies who believe that their sex is wronged by the present conventionalities, usages, and habits of thought, of our civilized social life. In her previous volume, "Woman's Right to Labor," she has handled, with equal earnestness and delicacy, one of the most difficult subjects that can engage a woman's pen; and the aim of the present volume is, chiefly by the example of distinguished women in other countries and ages, to show how much wider is the sphere of woman's labour, than society is willing to allow. The subject is one of the great questions of the day, which meets us in many and very diverse forms. It suggested the theme of Elizabeth Barrett Browning's, elder "Drama of Exile," as well as of her later and better "Aurora Leigh." It is the subject of Tennyson's playful yet earnest and beautiful "Princess;" and is begetting a host of works, from Miss Agnes Strickland's "Queens" and Dr. Anderson's "Ladies of the Covenant," to Mrs. Oliphant's "Women of the Times." Like some other great questions of the day, this one of "Woman's Rights" does not owe its rise to the writings of its zealous phalanx of advocates. It is with it, as with slavery, intemperance, and other social evils. The current had silently set in the direction of reform, and public opinion, though undefined and ill-informed, was already striving to grapple with the complex difficulties of the question, before it was consciously presented as a subject of controversy, by skilful, earnest advocates; and also by unskilled, one-sided, though not less earnest special pleaders. Into the broad question of woman's rights, or her

social duties and privileges, we have no thought of entering. We doubt not it will right itself, under the same divine guidance which can be traced through all the social changes, by means of which we now see on our own American Continent the contrasting pictures of the Indian savage, with woman as the tiller of his fields, the bearer of his burdens, his meek uncomplaining slave and household drudge; and on the other hand woman in the happy domestic circles of English and American social life, the sunshine of his hearth, and the true helpmate of man. We are well content to leave woman to work out her destiny, with all the aids that philanthropy and the earnest, wisely directed christian zeal of womanhood can bring to bear on a cause best left in such hands:

> Let her make herself her own,
> To give or keep, to live and learn, and be
> All that not harms distinctive womanhood.
> For woman is not undeveloped man,
> But diverse. Could we make her as the man,
> Sweet love were slain. His dearest bond is this,
> Not like to like, but like in difference.

In the "Studies" which occupy the larger part of this volume, we have critical and biographical sketches of "The Women of the House of Montefeltro," "of the Women of Bologna," and of various remarkable selected examples of noble womanhood, from Aspasia to Madame de Stael and Margaret Fuller. Let us select one example from the fair and gifted daughters of Italy, to whom so large a share of the volume is devoted.

The name of *Properzia dei Rossi* is not now introduced for the first time to English readers. A brief notice of the learned Isotta Nogarolo, of Bologna, concludes in this characteristic fashion: "When one of the Foscarini became Podesta of Verona in 1451, Isotta entertained the learned company around her with a discussion upon the comparative guilt of Adam and Eve. Her thesis, which proved Eve to have been the seduced rather than the seducer, was printed a century after her death. She never married. Lady Morgan says it was to show her contempt for that sex of which Adam was an example; but a masculine critic wickedly suggests, that the countenance which hangs in the library at Bologna could never have found many admirers. She died about 1466,—it is generally thought at an early age; and left a large number of manuscripts, chiefly orations and epistles, in Latin."

Our authoress then proceeds:—

It is after praising the eminence to which Isotta attained that Vasari introduces to us the name of Properzia dei' Rossi, "a maiden of rich gifts, who, equally excellent with others in the disposition of all household matters, gained a point of distinction in many sciences, well calculated to arouse the envy, not of women merely, but of men." Alidosi calls her the daughter of Martino Rossi of Modena; but, if she was not born in Bologna, it was there that she grew up, and there that she exercised her talents.

Properzia was distinguished by remarkable beauty of person. She sang and played better than any woman of her time in Bologna; and to satisfy an exuberant fancy, began her life as an artist by carving peach-stones. More fortunate than many children of more modern times, she found among her immediate friends warm and appreciating admirers. No one said, "A foolish fancy, that: she had better be taking care of the house." And when she finally completed, on this small surface, a sculptured Crucifixion, containing many heads besides those of the executioners and the apostles, no one added, "It is but a womanish trick of art, after all." The true lovers of beauty, beside and around her, said, "See what better you can do." So encouraged, she executed numerous arabesques in stone, of flowers, animals, and so on, for the principal chapel of Santa Maria del Baracano.

Just at this time, the superintendent of the Cathedral was authorized to ornament with marble figures the three doors of the principal façade of San Petronio. For a portion of this work, Properzia now applied; and here occurs an inconsistency in her biographer, which we cannot explain by any authors within our reach. At the beginning of the Life, Vasari says, "she was a maiden of rich gifts:" he now says that she applied to the superintendent of this work through "her husband;" and again, that she succeeded in a certain piece of sculpture all the better for a *disappointment in love*, all the more grievous to bear, because, with this exception, she was perfectly successful in all things.

However she applied, she was commanded to produce a specimen of her work as a proof that she was capable of what she undertook; and, for this purpose, she executed from the life that admirable bust of Count Guido Pepoli, now preserved in the Church of San Petronio. Upon this, she was entrusted with the execution of two groups. She chose the wife of Pharaoh's steward and the Queen of Sheba for her subjects, and delighted the whole city by her eminent success. But there was one critic whom she could not please,—a certain Maestro Amico Aspertini, who is elsewhere described as having his head full of vapour and vain-glory; who never spoke well of any one, yet was always full of babble and gossip; and who had so little true love of art, that, when he made any fortunate discovery, he immediately destroyed all traces of it, lest some other person should by chance derive some benefit from it.

Properzia was a woman, and she did not care to struggle with this incarnation of the evil passions. Having finished several noble works already undertaken, she turned her attention to copperplate engraving, wherein she soon established an enviable reputation. The rumor of her lofty genius spread through Italy, and

reac' .d the ears of Clement VII. Having crowned Charles V. at Bologna in 1530, he sought out Properzia. She had died that very week, and been buried, at her own request, in the Spedale delle Morte.

Vasari describes in highest terms of admiration the drawings of this gifted and versatile artist; and specimens of her sculpture and exquisite minature carvings remain to attest her singular genius. On a peach-stone, still preserved in the Florentine Cabinet, there is a "Glory of the Saints," carved by Properzia, on which more than sixty heads may be counted. Our authoress repels with just scorn some vulgar slanders associated by modern Italian cicerones with this gifted woman's name; but she is, perhaps, disposed to look with scarcely less favour on so undignified an episode in the life of one whom genius had so elevated above the capacities common to either sex as "a disappointment in love;" and remands to a foot note the romantic incidents, vaguely glanced at by biographers, but which chiefly touched the tender poetical sympathies of the gentle authoress of "the Records of Women." "The simple fact," says our authoress, "appears to be, that she loved and was beloved by a man greatly her superior in rank; that her eyes opened too late, when she found in what manner he sought her, and her woman's heart broke with a grief too heavy for the artist's pride."

Felicia Hemans took hold of a diverse art-tradition better suited to her vein of thought, and the tremulous, tearful sympathies which her own life-drama had intensified, in a peculiarly tender womanly nature. A painting by Ducis represents the fair Bolognese sculptor showing her last work, a basso-relievo of Ariadne, to a Roman Knight, the object of her unrequited affection, and while she looks wistfully in his eyes to read the impression which the poetry of her chisel produces, he regards it with cold indifference. It may be the mere romance of the painter's pencil, eked out by a confused tradition; but gifted men, and women too, have been even so o'ermastered; nor would we willingly believe that the intensifying fire of genius quickens the intellect of woman at the expense of her susceptibilities to those deep loving emotions of lover, sister, wife, and mother, on which the authoress of "The Records of Women" dwelt perhaps too fondly. In her poetical picturing of Properzia Rossi, the soul's lofty gifts have proved vain to quench its haunting thirst for happiness. The Knight has looked

coldly on the marble which glowed with all her genius and her passion; and what to her is the world's empty mockery of fame?

> The world will see
> Little of this, my parting work, in thee,
> Thou shalt have fame! Oh mockery! give the reed
> From storms a shelter,—give the drooping vine
> Something round which its tendrils may entwine,—
> Give the parch'd flower a rain-drop, and the meed
> Of love's kind words to woman! Worthless fame!
> That in *his* bosom wins not for my name
> Th' abiding-place it asked! Yet how my heart,
> In its own fairy world of song and art,
> Once beat for praise!—Are those high longings o'er?
> That which I have been can I be no more?—
> Never oh! never more; tho' still thy sky
> Be blue as then, my glorious Italy!
> And tho' the music, whose rich breathings fill
> Thine air with soul, be wandering past me still,
> And tho' the mantle of thy sunlight streams,
> Unchanged on forms, instinct with poet-dreams;
> Never, oh! never more! Where'er I move,
> The shadow of this broken-hearted love
> Is on me and around! Too well *they* know,
> Whose life is all within, too soon and well,
> When there the blight hath settled;—but I go
> Under the silent wings of peace to dwell;
> From the slow wasting, from the lonely pain,
> The inward burning of these words—"*in vain.*"

But such is not the phase of womanly character that the authoress had in view in retouching her historical pictures; and in justice to her, we must let her speak for herself. In closing her selections of female portraiture from the Galleries of Bologna, she remarks:

Whoever writes in the present day can hardly remain neutral with regard to the responsibleness of women toward women. Upon this subject let us say, in closing, a few words. Let every conscientious woman beware, lest an unlucky witticism, a smart saying, or a careless slur, injure for ever a reputation of which she knows nothing with certainty. Public opinion is a mingled stream, flowing from a thousand nameless sources.

An example will show how really liberal and right-thinking women may swell the current of popular prejudice.

Lady Morgan, whose merits no one can appreciate more highly than ourselves, since she has always preserved, through the remarkable honors and distinctions to which genius has raised her, her unaffected, sprightly, democratic air; Lady

Morgan, whose books are so crowded with incident and literary gossip, that we forgive the awkward air with which recent acquisitions seem to sit upon her,—says above, "that erudition is in England, in 1820, a greater female stigma than vice itself." Yet in the same chapter, in speaking of the Institute at Bologna, she says, "The anteroom of the Library has an interest of its own, from being covered with the portraits of the learned; among which, *strange to say*, the ladies hold a distinguished place. *At the head, as 'chef de brigade,' stares* Isotta da Rimini. 'Le due Isotte,' as they are called, and Madam Dacier, compose a group that *can never be mistaken for that of the Graces.* They are indeed *fearful examples*, to convince the most indigo-blue stockings, that the waters of the Pierian springs are not among the most *efficacious cosmetics.*"

Does this prove that a bold courtesan stands at the head of literary women in Italy, or that learned women are never beautiful? Yet how strongly it implies something of the sort!

In a note, she says Cassandra Fedele was far too "pretty for a pedant;" and farther on, that, "*in woman*, genius and abstruse learning never yet went together." She reckoned without her host; though it is perfectly true, that in herself genius has supplied the *want* of abstruse learning.

Trivial as such remarks may seem, every one who adds without cause to the number does something to lower the popular estimate of women. It was because of the almost infinite power of *light words* that our Saviour said, "Let your conversation be as Yea, yea."

Let every true-hearted woman speed all other women striving for honorable distinction; and so, in good time shall come a happy emancipation.

What is implied in such "happy emancipation" varies widely according to the speaker or writer by whom it is employed; but what true-hearted woman strives for as an honourable distinction, true-hearted men need not fear her attaining to. Noble aspirations never beget unworthy results; and as it has been the triumph of Christianity to elevate woman to her true place as the helper and equal companion of man, so must we expect, as civilization progresses, that she will claim her due place and share in every advancement he achieves. D. W.

A Summary of Canadian History, from the time of Cartier's Discovery to the present day. By J. A. Boyd, B.A. Toronto: James Campbell, 1860.

The author of this little unpretending volume has accomplished, with complete success, the difficult task of compressing into the compass of little more than a hundred pages an accurate and connected relation of the chief incidents connected with Canadian history from the time of Cartier's discovery to the present day. It is written in a

pleasing and attractive style, and not only comprehends an interesting notice of such leading events in the history of the Province as are to be found in the various bulky volumes already written on the subject; but our examination satisfies us that the author has gone for his materials to the original sources; and his facts and dates are not only well arranged and placed in an attractive form for reference, but he has also corrected errors which have been repeated by one writer after another, in volumes of much greater pretension. Mr. Boyd's historical sketch has been prepared expressly for the use of schools, and for the instruction of our Canadian youth in the history of their country. For this it is admirably fitted. The only regret which the teacher must feel is, that after guiding his pupil through so excellent a summary of the History of Canada, he must be at a loss where to direct him for the larger and more comprehensive History to which such a volume should be the fitting introduction. We should be glad to learn that the same pen which has been so well employed on this little summary, was engaged on a full critical survey of the interesting story of Canadian discovery, settlement, and progress, through all the interesting events of its three historic centuries. D. W.

Palæontology, or a Systematic Summary of Extinct Animals and their Geological Relations. By Richard Owen, F.R.S. Edinburgh: Adam and Charles Black, 1859.

It is somewhat singular, that, whilst few studies in England can compete with Palæontology in popularity, the English language should be still without a really comprehensive treatise on the subject, properly adapted to the student's wants. We possess, it is true, many isolated monographs of the highest authority on special departments of the science, quite equalling, in this respect, the palæontological literature of any country; and we have also sundry popular works of general treatment; but we possess nothing, for example, of the systematic and comprehensive character of the *Lethæa geognostica* of Bronn, or the *Traité de Paléontologie* of Professor Pictet. For a work of this description we must still wait; but, in the meantime, the student may welcome, with much satisfaction, the reproduction in a convenient form of Professor Owen's article on Palæontology, published in the late edition of the *Enclycopedia Britannica*. This, with a few modifications, has been reprinted in the

form of an octavo volume, containing all the original illustrations, together with a classified index, and other additional matters.

The work, as implied by the author in its title, is essentially of a synoptical character—the treatment indeed, within the scope of a single volume, of so extended a subject as that of palæontology, must necessarily be so—but the condensation has been performed with no ordinary judgment, and a far greater amount of information is contained in the volume, than one might at first thought be led to expect. This applies more especially to the *Vertebrata*, to which series about three-fourths of the work are devoted. In his introductory remarks to the class of fishes, Professor Owen takes exception to the whole (and strong exception to the greater number) of Pander's new genera from the Silurian formations of Russia. The so-called "conodonts," considered by Dr. Pander to be fish teeth, appear to Professor Owen (as the result of careful microscopic examination) to be the hooklets or denticles of naked mollusks or annelids. But whatever the fossil bodies in question may prove to be, all earnest inquirers must agree with Professor Owen in his remarks, that, "the formal publication of these minute ambiguous bodies of the oldest fossiliferous rocks, *as proved evidences of fishes* is much to be deprecated." Sooner or later, palæontologists will be forced to unite and adopt a fixed resolution to disallow all determinations (with their consequent nomenclature) whether referring to higher groups or to genera and species, founded on fragmentary or incomplete evidence. Without some united action of this kind, that daily-augmenting evil, the accumulation of synonymes, bids fair to acquire, before long, unmanageable proportions; whilst the false reasonings and deductions flowing from these uncertain determinations, and widening as they flow, constitute, if possible, a still more serious obstacle to true progress. Talleyrand's celebrated admonition—"pas de zèle" should, in one sense at least, be admitted as an axiom into palæontological inquiries.

The class Reptilia is subdivided by Professor Owen into thirteen orders (including the batrachians,) in accordance with his recent views, as developed in a paper on the subject before the meeting of the British Association at Aberdeen*. This classification, although at first sight a somewhat complicated one, will be found greatly conducive to a just conception of the relations existing between the varied forms of reptilian structure. It commences with the order

* See the present volume of the *Canadian Journal*, page 73.

Ganocephala, in which is manifested an intermingling, as it were, of the fish and reptile organizations; and it terminates, properly, with the *Chelonia*—each order foreshadowing more or less distinctly, the one above it. By this arrangement, however, admirable as it is in its details, the batrachians are thrown out of position, being placed unavoidably at the end of the series, or between the chelonia and the next succeeding class, the birds. The limits of the work forbid any very minute treatment of this succeeding class, and of the mammalia; but of the obscurer mesozoic forms of the latter, a sufficiently copious analysis is given, together with various able generalizations embodying the leading points of interest belonging to the other types. The reader consequently, who may desire a compendious view of the present state of Palæontology, will find, in Professor Owen's treatise, a work exactly suited to his wants. E. J. C.

Handbuch der Mineralchemie. Von C. F. Rammelsberg, Leipsig: Engelmann, 1860.

Original investigators are not, in the way of authorship, proverbial for great industry. Professor Rammelsberg, however, forms a remarkable exception to the class. In addition to constant communications to scientific journals, scarcely a year elapses without the emanation from his fertile pen, of some learned treatise or useful manual. His latest production of this kind is a closely printed octavo, of over a thousand pages, bearing the title placed at the head of this notice. This title, however, is somewhat inappropriate, and likely to lead to misconception regarding the true character of the book: the present volume being strictly a treatise on *chemical mineralogy,* comprising a detailed view of the chemical characters and composition of all known minerals, with some introductory remarks on classification, mineral formulæ, isomorphism, and other cognate subjects. It is therefore, if not actually, at least essentially, a revised edition of the "*Handwörterbuch des chemischen Thiels der Mineralcgie*" brought up to the present state of the science. The author, in his preface, claims for the work the character of an entirely independent production, and this is so far true, inasmuch as the earlier work has been entirely rewritten; but in general plan, and treatment of subject, the two are essentially alike. The present work contains (with a few accidental

omissions) all the new analyses published since the issue of the last supplement of the Handwörterbuch in 1853. The older analyses, moreover, have been re-calculated, and the formulæ are arranged throughout in accordance with modern views. The atomic constitution of *silica*, $Si\,O^2$, as now universally accepted in place of $Si\,O^3$, is thus adopted; and that of zirconia is made $Zr\,O^2$, in place of the older $Zr\,^2O^3$. Zircon itself, in the classification, is removed from the Silicates, and placed with Rutile and Cassiterite amongst the Oxides. Some other changes of this kind might also have been appropriately carried out, not perhaps in the body of the work, but in the tabular outline of the classification. Mere chemical formulæ in themselves, it cannot be too strongly insisted upon, are no true exponents of natural affinities—witness, for example, the collocation of molybdenite with iron pyrites, and the wide separation of magnetic pyrites from the latter, as adopted by the author in his present work according to the orthodox but very artificial system so generally in vogue. There is some unknown quantity, as it were, within these formulæ-relations which at present eludes our grasp. The true part sustained by water in the constitution of hydrated minerals, for instance, remains still wrapped in impenetrable obscurity. Professor Rammelsberg discards the idea that this water is in any part basic; and he appears disinclined to allow the union of hydrates with other compounds, as usually admitted in the case of the serpentines, &c. In malachite and blue carbonate of copper, nevertheless, not to mention other examples, the admission of a union of this sort appears more natural than to suppose in these allied compounds the existence of two dissimilar carbonates. In malachite we have two atoms of copper oxide, one atom of carbonic acid, and one of water; in the blue carbonate, three atoms of copper oxide, two of carbonic acid, and one atom of water. If we do not admit the presence of the hydrate of copper oxide in these minerals, the above numbers yield, respectively: $2\,CuO, CO^2 + HO$; and $3\,CuO, 2\,CO^2 + HO$. But if we admit the presence of the hydrate, these formulæ become $CuO, CO^2 + CuO\,HO$; and $2\,(CuO, CO^2) + CuO\,HO$—each containing a carbonate of like composition. This is the usually received view. The true constitution, however, may be in no way represented by these more or less imperfect guesses.

The nature of this laborious treatise, as will readily be perceived, necessarily precludes any attempt at extract or extended analysis.

We must content ourselves therefore, with the present brief statement of the general plan and character of the volume. As a work of reference it will prove indispensable, for many years to come, to all engaged in mineralogical investigations.* E. J. C.

SCIENTIFIC AND LITERARY NOTES.

GEOLOGY AND MINERALOGY.

ON THE FORMATION OF MOUNTAIN RANGES. BY PROF. JAMES HALL.

Mountain ranges, as well as surface inequalities generally, are usually considered to have been produced by the direct agency of elevating forces, or by that of denudation; or, in certain cases, by the two combined. Professor Hall, whilst admitting the action of these forces to some extent, maintains the existence of a third cause in the production of the results in question—viz., the unequal deposition of sedimentary matter, or, in other words, the special accumulation of sediments, by currents, along certain lines or tracts of country. In our notice of the first portion of the "Geology of Iowa" in the present volume of the *Journal*, we fear that we may not have done entire justice to the author's particular views in this respect—having been under the impression that his arguments were couched principally against the supposed influence of elevating or disturbing forces in the formation of mountain chains, as opposed to the effect of denudation. Nevertheless, if we admit with Professor Hall, that (in certain cases,) mountain elavations have arisen from the cause he advocates—denudation, it is evident, must be looked upon in connection with this cause, as an accessory power of no inconsiderable moment. The occurrence of outliers, for example, (and that of synclinals on ridge-summits, as mentioned by Prof. Hall, below) shews clearly the influence of this action; and the opponents of the "special accumulation theory" might argue with some show of fairness, that in many instances, the diminished thickness or the absence of particular strata at a given spot, was caused to a certain extent, or perhaps wholly, by denudation also. Be this, however, as it may, we are happy to lay before our readers the following summary of some observations on this subject, made by Professor Hall at a recent meeting of the Albany Institute:—

"Mr. Hall began by stating that the views which he should bring forward were the result of many years of personal observation and investigation upon the older strata of the North American continent. It was ten years since he had first propounded similar views, though with hesitancy, hoping that the questions involved would be discussed by others. Farther examination and reflection had only tended to strengthen the opinions then entertained, and in his address at Montreal in 1857 he had put forth more strongly the same views.

* The right of translation, we observe, as regards France and England, is reserved by the publisher under the present international arrangement.

After some preliminary observations upon the laws governing the distribution of sediments, and the accumulation of calcareous materials in geological formations, Mr. Hall proceeded to show that throughout the entire interval from the older Silurian to the end of the Coal period, the accumulation of sedimentary matter along the line of the Appalachian chain had been far greater than west of it. He showed that in tracing some of these formations westward, they thin to one-tenth or even one-twentieth of their thickness in the east.

During all this accumulation of 40,000 or 50,000 feet of sediments in the line of the Appalachian chain, there were evidences of shallow sea, in the fucoidal markings and mud cracks upon the strata. This great accumulation, therefore, could only have taken place by a sinking of the ocean bed during the period of deposition; and this in accordance with what we know from the established laws, that the translation or removal of large amounts of matter from one part of the earth's crust to another, will cause a depression of that part beneath which the accumulation takes place.

He farther showed that such depression, occurring along a zone of two hundred miles in width and many hundreds in length, corresponding to the zone of accumulation, could not take place in a simple curve, but that the sediments, the laminæ of which would slide over one another to a very limited extent, must become folded and contorted during the process, and that these foldings and plications, which would constitute numerous synclinal and anticlinal axes, would have their longitudinal direction corresponding with the line of accumulation, or the line of the ancient transporting current. That these foldings and plications would gradually diminish in force with their distance from the centre of the line of accumulation, and gradually die out with the thinning of the beds; this thinning depending on the original transporting force, which, gradually diminishing on either side of the great current, allowed the beds gradually to thin out. * *

Subsequently these folded strata were subjected to the denuding action of water; and the foldings of the anticlinals, having broken or weakened their outer beds, made them subject to more extensive and extreme denudation, till these original ridges are now often the valleys, while the synclinals are the summits of the mountain ridges.

In all the Appalachian chain it was shown that nowhere any evidence exists of the elevation of the mountain ranges by action or elevation from below. The crystalline or metamorphic condition of the strata was due to other causes, and he had shown that this metamorphism was coincident with the line of original accumulation; and in greater or less degree coextensive with the folded and plicated beds; its incipient stages being visible in the first gradual or gentle foldings of the strata outside the great disturbed and crystalline zone.

In the Mississippi valley, where there is no important folding or plication, we have outliers of these strata, or mounds, as they are termed, measuring one thousand feet of elevation above the Mississippi valley, the fundamental rock there being the Potsdam sandstone. In the Appalachian chain we find no rock of older date than the Potsdam sandstone, and this is seen only on the flanks of the chain, or rarely elsewhere, but the mountains rise to four, five, or six thousand feet above the sea. In the Mississippi valley the measurement of elevation is the

thickness of the strata; in the Appalachians the elevation of the mountains is not more than one-fifth or one-tenth even in many places, so that these mountains do not give an elevation equal to the thickness of the original accumulations had the latter been left undisturbed and simply cut by ravines or watercourses. * *

Mr. Hall proceeded to say that he regarded the present relations of these mountain chains, as well as others, to be not due to elevation along certain lines, but that the whole country, whether mountains or plains, is a continental elevation; and that the more elevated portions at the present time are due to a larger amount and greater thickness of sediment along certain lines,—in other words, that mountain elevations are due to original accumulations of sediments along the lines of the more powerful transporting currents; and that the direction of these mountains has been determined by the original course of these currents, which themselves were determined by a pre-existing cause,—that the foldings of the strata and the production of synclinal and anticlinal axes have been produced in the instances cited, and doubtless in many or all others occurring on an extensive scale, by the subsidence consequent on the great accumulation of material;—that this subsidence and the attendant influences have produced the metamorphism which characterizes the strata forming these mountain ranges, and which is everywhere coincident with their extent.*

Mr. Hall expressed his belief that the facts before stated as the result of extended observations upon a series of strata, and essentially a single mountain chain, would be found applicable to many others; and he regarded the laws here set forth as applicable to all similiar examples, and as affording a natural and simple explanation of these phenomena, for the solution of which unknown and unexplained forces had been appealed to as the active agents."

SIMPLE RULES FOR CALCULATING THE THICKNESS OF INCLINED STRATA.

BY E. J. CHAPMAN.

The following simple rules for calculating the thickness of inclined strata, if copied into a blank leaf of the field-book, may prove useful, at times, to some of our geological and engineering readers. The results come out in all cases within a few inches of the truth.

Given the angle of dip, and the distance across the beds (i. e., *at right angles to the line of strike*;) *required the thickness of the strata.*

(1.) Multiply the dip by 92·15, and multiply the product of this by the distance in *miles*: the resulting product will be the thickness in *feet*.

Or, for short distances:

(2.) Multiply the dip by 0·01745, and multiply the product by the distance in *feet*: the resulting product will be the thickness in *feet*.

Or, when the dip is less than 1°.

(3.) Divide the constant value (as given above) by the fraction of the degree

* The author does not deny the influence of other causes acting upon the crust of the earth, as contraction, etc., but he considers the effect usually attributed to such agencies, to be far too great.

constituting the dip; and multiply the quotient by the distance. The resulting product will give the thickness in feet.

Examples:—(1.) Let the angle of dip = 2°, and let the distance be 8 miles: 92·15 × 2 × 8 = 1474·40 (feet).

(2.) Let the angle of dip = 5°, and let the distance be 5 chains or 330 feet: ·01745 × 5 × 330 = 28·79 (feet).

(3.) Let the dip = 20', and let the distance be 10 miles: $\left(\frac{92{\cdot}15}{3}\right) \times 10 =$ 307·16 (feet.

The above rules, it will of course be understood, pre-suppose the non-existence of foldings, or other irregularities, in the strata to which they are applied.

CANADIAN EXPEDITIONS TO THE NORTH-WEST TERRITORY.

We extract the following very favorable notice of the recent expeditions to the Red River, &c., from the September Number of the American Journal of Science and Arts. Dr. Petermann, from whose Journal the notice is condensed, ranks as a well known authority amongst geographers:—

"The interest which has been manifested in the Report of the Pallisser expedition, leads us to condense and translate from Dr. Petermann's excellent *Mittheilungen* (January, 1860) an account of the explorations of the Red River which were made in 1857 and 1858 by Gladman, Dawson, Hind, and Napier. We regret that we cannot reproduce the admirable maps which accompany the article. The writer in Petermann's Journal remarks substantially as follows:

Although the Canadians had long endeavoured to direct the attention of the British Government to that vast portion of British North America, which stood until very recently under the immediate supervision of the Hudson's Bay Company, and had tried to induce them to effect a revision of the claims of that mercantile body, it was nevertheless, not until 1856, when gold was discovered in Fraser's and Thompson's rivers, that the British government took the matter into serious consideration, and in 1857 sent out an expedition (Pallisser's expedition) and declared in 1858 New Caledonia, as it was called under the above mentioned company, an independent colony, to be known in future by the name of British Columbia. At the same time it was urged that the government of Canada might be empowered to incorporate adjacent portions of land, particularly the so-called Saskatchewan district, east of the Rocky Mountains. This expedition accomplished its chief object, to find a passage across the Rocky Mountains, and also reported favorably in regard to future settlements in the Saskatchewan district, which may be called the intermediate district between the settled portion of British North America and the new gold region in British Columbia. At the same time with Palliser's expedition, another expedition was started directly by the Canadian goverment, and it is our object in the present paper, after having presented a few general remarks on the country, to give a brief synopsis of the course of this latter expedition.

The Saskatchewan district between the Red River and the Rocky Mountains

has already, since the beginning of the present century, been the object of many explorations, the most prominent of which are those of Astronomer Thompson,* Lefroy, Richardson, Lord Selkirk, Blodget, and others. They all agree that the Saskatchewan district is well adapted for cultivation. It comprises an immense area, and as early as 1805, Lord Selkirk said that it could give bread to at least 50 millions of people. In regard to the climate, Blodget, who is most thoroughly acquainted with the subject, says that the average temperature in winter is not below that of St. Petersburg and Moscow; in summer it equals that of northern Italy and New York. The temperature increases, just as in Europe, as you go from east to west. Spring commences at all points almost at the same time. There is no want of rain; grass, forests and buffaloes abound. Useful timber is abundant; coal is found in many places, but particularly rich deposits exist at the foot of the Rocky Mountains, and near the Little Sauris River. The country is level and appears so even, that Blakistone remarked that for the construction of a railroad nothing was required but to put down the rails. Its numerous lakes and rivers can easily be connected for internal communication, and afford even now the only means of transport between the different stations of the Hudson's Bay Company. The Saskatchewan district can also be easily connected with the new gold region by means of commodious roads through Palliser's passage across the Rocky Mountains. This new colony will, by reason of its very favourable situation, its beautiful harbors, but particularly by reason of its wealth in gold, surely rise as speedily as Southern California; and, as it is less capable of agriculture, would naturally become the great market for the products of its eastern neighbors, in the Saskatchewan district.

We may therefore well be justified in prognosticating for this district a prosperous future in regard to agriculture, but we cannot agree with such opinions expressed some time ago in the Montreal *Pilot*, that by a regularly established road from Lake Superior to Lake of the Woods, Red River, Lake Winnipeg, Saskatchewan River, across the Rocky Mountains to the rivers of British Columbia, thence to Pacific, all commercial intercourse between Europe and China, Japan and India would take this route. A road which changes so often between land and water can never become a general commercial road for such a distance, not to mention the almost insurmountable difficulties for vessels of a larger draught, such as sudden bends, rapids, falls, shallow waters, etc., and the entirely uncultivated state of the country,

After these few remarks we return to our subject proper. We can give but a brief synopsis, and refer those who desire a detailed account of the Canadian expedition, to the "Reports on the exploration of the country between Lake Superior and Red River Settlement." A still more minute account is given in the "Papers relative to the Explorations of the Country between Lake Superior and the Red River settlement, presented to both Houses of Parliament

* Thompson was from 1790, over 30 years, in the employ of the Hudson's Bay Company, and the reports of his explorations (37 vols.) are deposited in the Archives of this Company. From fragments of them it appears that Thompson possessed a great knowledge of the country, but it is doubtful whether these reports will ever be accessible to such as are not connected with the Company. Until now the Company has kept them back.

London, 1859." Three charts by Hind (one a reprint of Thompson's) and a sketch of the regions which Dawson travelled through, by himself, appeared at the same time.

The members of the Canadian expedition landed July 21, 1857, at Fort William, and started in boats along the usual route of the Hudson's Bay Company for Lake Winnipeg, in order to ascertain the practicability of the route. To this end surveys of rivers were made and a very minute determination of levels. Napier estimates the whole length of the route to be 747 miles, viz: from Lake Superior to Rainy Lake 335 miles; thence to Rat Portage at the northern extremity of Lake of the Woods 176 miles; from this point to Fort Garry on the Red River 236 miles. Of these three portions only the middle one, upon Rainy Lake, which is at an average 460 feet wide and 6 feet deep, forms a continuous water road. Its falls (Chaudière falls near Fort Francis, 22 feet,) may, according to Dawson, easily be made harmless by two water gates. The two remaining portions of the route can only be travelled by land, unless one prefers the tedious transport from one little river to another. The Kaministiquoria on the first portion of the route cannot be navigated, as its rapids, shallow water places, and falls (Kakabeka falls. 119 feet,) are too numerous. From Little to Great Dog Lake, a distance not over a mile, this river falls 348 feet, and yet the portage in this place has still an elevation of 142 feet over Great Dog Lake. This is the steepest descent on the whole route. The passage upon Dog River is partially obstructed by rocks and sandbanks, and on Prairie Portage, between Lake Superior and Lake Winnipeg, it leads mostly through swamps. The difference of elevation between Lake Superior and Prairie Portage, 54 miles distant from one another, is, after Dawson, 879 feet, according to Napier 887 feet; that between Prairie Portage and Lake Winnipeg (325 miles) is calculated by Dawson 892, by Napier 870 feet. Thus the descent towards the east is much more rapid than towards the west. The canoe route from Savannah River to Rainy Lake has too many portages, and the Rivière la Seine is, by reason of the numerous difficulties in its course, entirely objectionable. But the Winnipeg River, from Lake of the Woods to Lake Winnipeg, was by all declared to be the most difficult and impracticable on the whole route. The canoe route on the Pigeon River, from Lake Superior to Rainy Lake along the boundary, is the shortest, but it has 29 portages, of which many lead through United States territory. Another route to the Red River, which is still used by the Hudson Bay Company, commences from Fort York, near Hudson's Bay, and goes up Hays River, through Knee and Holy Lake, Wepinapanis River, White Water Lake and Sea River, down to Lake Winnipeg; but it requires three weeks of hard work to travel it; besides, the access to Fort York through Hudson's Bay, is only open about two months during the year. But the most commodious and most frequented road to the Red River over St. Paul and Crow Wing leads entirely through United States territory. In the English possessions the best connection between Lake Superior and the Red River would be established by country (!) roads, the one from Lake Superior to Rainy Lake, the other from Lake of the Woods to the Red River. In regard to the first, however, nothing has as yet been done, and only in the latter district have explorations been made with this view. When Gladman had arrived at Fort Garry (September, 1857,) he sent out engineers Napier and Dawson to reconnoitre

this hitherto entirely unknown district, which explorations were continued by Gaudet and Wells during the winter of 1857–1858.

The whole country between the Red River and Lake of the Woods appeared perfectly level, although it actually descends toward the east nearly 400 feet. Dry prairies change alternately with wooded districts and extensive swamps, the latter being particularly frequent toward the north. The establishment of a road through this district seemed to them an utter impossibility.

Hind went up the Assiniboine River, explored the Great and Little Rat river, examined the valley of the Red River up to Pembina, and followed the Reed Grass or Roseau river up to a great swamp, which separated this stream from a lake of the same name. Unfortunately Hind could not survey this river up to its sources, but all the Indians who lived there agreed that a swamp of 9 miles in extent existed between Roseau lake and Lake of the Woods. This swamp sends the Reed river, 30 miles long, to the latter lake, and another little rapid river, about 40 or 50 miles long, to lake Roseau. From the Great Muskeg morass goes a little river westward into an extensive swamp, from which the Rat river issues.

Gladman was relieved from his post as chief in April, 1858, and Napier was also recalled about this time. But Hind went the same spring again with Dickinson, Fleming and Hine on another expedition known as the "Assiniboine and Saskatchewan expedition." Their object was to explore the region west of the Red River and Lake Winnipeg up to the Saskatchewan river. Before they arrived at Fort Garry, Dawson, Wells and Gaudet had already made some new surveys, around the Red River, Lake Winnipeg, and the lower Assiniboine, and had just left for the lake district. This latter party went by way of Lake Manitobah and Lake Winnipegosis, over Mossy Portage toward Cedar or Bourbon lake to the grand rapids of the Saskatchewan river. At Mossy Portage they separated; Wells went over Lake Winnipegosis, Lake Dauphin, Lake Manitobah, the Little Saskatchewan river, which he found to be 8 to 12 feet deep, 250 yards wide, free from rapids and throughout adapted for steam navigation, thence over Lake Winnipeg to the Red River. The rest of the party followed Swan river to Fort Pelly, and thence went down the Assiniboine river.

Dawson considers the whole alluvial plain east of the Pasquia and Porcupine hills and Dauphin mountains, where the large lakes are situated, well adapted for settlements. It is partly prairie land, for the most part, however, thickly wooded. North of Lake Dauphin wood predominates; south of it the country becomes more open, and toward the Assiniboine an apparently endless prairie commences. Wheat gives abundant harvests near Lake Manitobah and the Little Saskatchewan river, and near the latter even Indian corn may be cultivated. The valley of the Swan river is particularly fertile, and climate equals that of the Red River district. The Red Deer river district has also a good soil and fine climate, as its maple tree forests plainly show. Coal is said to be found in the Porcupine hills and the Duck mountain; Dawson himself found samples of lignite near Snow river. The great alluvial valley of the Assiniboine and its branches will, in his opinion, hereafter become one of the finest wheat growing districts upon earth.

Near Moss or Dauphin river, a fine navigable stream, the Indians grow maize, melons and potatoes. Vines, hops, and vetches grow naturally in abundance.

Hind and his companions went (June 14, 1858,) from Fort Garry in a westerly direction over Fort Ellis toward the missionary station near Qu' Appelle lake, (July 18) where he divided his corps into three parties: Dickinson travelled on the Qu' Appelle river up to its mouth, thence on horseback to Fort Pelly; Hine surveyed Long lake northwest of the Qu' Appelle mission, then went over land to Fort Pelly to meet Dickinson, and to explore with him the Dauphin mountains; Hind and Fleming followed the Qu' Appelle river up to its source, went over to the elbow of the southern arm of the Saskatchewan or Bow river, on which they travelled down until they reached Fort à la Corne (August 9.) The Qu'-Appelle and Bow rivers have no connections as Dr. Hector believes. The latter (southern arm of the Saskatchewan) has down from its elbow for a distance of about 100 miles, a width of 300 yards to half a mile, then it becomes narrower and straighter in its course, its sand and mud banks disappear, and finally it hurries through a narrow and deep valley, with a strong current toward the northern arm of the Saskatchewan, with which it unites, forming one river (Saskatchewan,) which now goes toward Fort à la Corne through Pine and Cedar lakes into Lake Winnipeg. Fleming followed this course from Fort à la Corne into Lake Winnipeg, along its western coast, until he reached the Red river. Hind made a land voyage along Long Creek, then turning southeast went over Touchwood hills to Fort Ellis, where he met Dickinson, with whom he returned over White Mud river to Fort Garry (September 4.)

But Hind and Fleming soon started on another excursion (September 18). They went in boats along the western shores of Lake Winnipeg, up to the mouth of the Little Saskatchewan, hence (September 29) into Lake Manitobah, and by means of Water Hen river and a lake of the same name reached Lake Winnipegosis where they examined the salt springs, which had been imprudently exhausted by the Indians. From thence they started for Lake Dauphin, ascended the Dauphin mountains (1700 feet high), and navigated Lake Manitobah in different directions. Hind stayed four days on a little island there, which was much revered by the Indians as the seat of the "Manitou," or fairies. On its northern side were limestone cliffs about fifteen feet high, which by the beating of the waves emitted sounds very similar to chimes from a number of church bells, ringing at a distance. From Oak Point, at the southern extremity of the lake, the party went over land to Fort Garry, where they arrived the 31st of October, 1858.

Hine, while sojourning on the Red River during the fall months, took photographic views of landscapes, churches, Indians, etc. Dickinson made excursions in the district east of the lower Red River, and in the regions between the Assiniboine and the U. S. boundary, but particularly along Rivière Sal through the Pembina mountains and Blue hills.

Some Canadian journals have blamed this Expedition for not having made any determination of points and for giving generally but little positive information, although $50,000 to $60,000 had been expended for the purpose. They said that the country had been much better explored by the late astronomer Thompson. This, however, is an unjust imputation. Astronomical observations of points,

although very valuable, cannot be the main object of explorers, who have to run through a great number of districts in a comparatively very short time, and who must give us the general features of the country; moreover, as here a great number of such fixed points already exist, a careful survey of routes by dead reckoning is perfectly sufficient. The reproach that the country had been much better explored by Thompson is most unjust. Thompson's reports where undoubtedly as little accessible to the members of the Canadian expedition as they were to the rest of the world; besides, if we compare Thompson's chart with that of the expedition of 1858, we perceive that our knowledge of the country between Lake Winnipeg and Bow river is more accurate and more complete than Thompson's.

The expedition has achieved much. They made very comprehensive levellings, effected numerous measurements of width, depth and rapidity of rivers and lakes, made geological observations, inquired into the climate, forests, quality of soil, etc, made surveys and discoveries between Lake of the Woods and the Red River, between the Assiniboine river the U. S. boundary, along the upper Assiniboine and Qu' Appelle rivers, in the district of the great lakes etc. A comparison of their charts with the older ones of these districts will at once show that the money was not thrown away.

This expedition has moreover excited the curiosity of the people more than that of Capt. Palliser. Thus a society was formed at St. Paul in Minnesota, who, under the direction of Col. Nobles, left this city in June, 1859, with the object to explore the valleys and sources of the Saskatchewan and Columbia rivers. Their plan was, to start from the elbow of Bow river toward the Rocky Mountains, to explore carefully the region of their eastern foot up to the Edmonton House, thence to go over Arthabaska Portage between Mount Hooker and Mount Brown toward the sources of Thompson's river, and here to disperse in different directions. Col. Nobles intended to start for the source of Columbia river, and to return over Lewis and Clarke's Passage, the Missouri Falls, the valley of the Milk river, Fort Mandan, Big Stone Lake, and Fort Ridgley to St. Paul. Dr. Goodrich accompanies them as physician, and the Smithsonian Institution sent Dr. C. L. Anderson, of Minneapolis, to make scientific observations and collections.

The "Board of Trade" in St. Paul offered a reward of $1000 for the first steamer that should ply on or before the first of June on the Red river, and the "Anson Northup" really commenced her voyages in June. She carries, besides passengers, 100 to 150 tons of cargo, and is intended to do the post service between the mouth of the Shagerme river and Fort Garry, and thus to connect St. Paul, (which sustains a post wagon up to the Shagerme River) directly with the Red River.

Another company in Canada intend to put four steamers on Rainy lake, Red River and Lake Winnipeg. Even the settlers on the Red River themselves show an active spirit of progress.

PUBLICATIONS RECEIVED.

Government Map of Canada, from Red River to the Gulf of St. Lawrence, compiled by THOMAS DEVINE, P. L. S., Head of Surveys, Upper Canada Branch. This is, without exception, the most useful map of the Province that has yet appeared. It is on a scale of thirty miles to the inch; and in addition to the ordinary topographical matter, it conveys much valuable information in the shape of lists of townships, distances, &c. All the new roads and townships are laid down; and the engraving and getting up of the map leave nothing to be desired.

Contributions to the Palæontology of Iowa, by JAMES HALL. This publication is in the form of a supplement to the author's Report on the Geology of Iowa. It contains descriptions and figures of various new crinoids from the Carboniferous formations of the West. The described species belong in great part to the genus *Actinocrinus;* but new forms of Poteriocrinus, Forbesiocrinus, &c., are also announced. A new genus is likewise instituted under the name of *Trematocrinus*. This belongs to the family of the CYATHOCRINIDÆ, and is more or less closely related to both the *Rhodocrinus* of Miller, and the *Acanthocrinus* of Rœmer. Probably, however, these allied genera, with some other near-lying forms, may eventually be united, by an extension of the type-characters of the older genus. The following is the generic formula of Trematocrinus, as given by Professor Hall:—Basal plates, 5; sub-radial plates, 5; Radial plates, 3×5; Supra radials, or Radials of the second order, 3 (or 4)×10. Anal plates, 12 to 17 or more. Inter-radials, 12 to 15 or more. Arms, five, bifurcating. Pores or ambulacral openings, 10. E J. C.

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST,—AUGUST, 1860.

Latitude—43 *deg.* 39.4 *min. North. Longitude*—5 *h.* 17 *m.* 33 *s. West. Elevation above Lake Ontario,* 108 *feet.*

Day.	Barom. at temp. of 32°. 6 A.M.	2 P.M.	10 P.M.	Mean.	Temp. of the Air. 6 A.M	2 P.M	10 P.M	M'E'N	Excess of mean above Average	Tens. of Vapour. 6 A.M	2 P.M.	10 P.M.	M'N	Humidity of Air. 6 A.M	2 P.M.	10 P.M.	M'N	Direction of Wind. 6 A. M.	2 P. M.	10 P. M.	Resul't. Direction.	Velocity of Wind. 6 AM.	2 PM.	10 P.M. Result.	M'E'N	Rain in inches.	Snow in inches.
1	29.743	29.749	29.737	29.7382	50.4	65.4	59.0	59.98	— 6.98	.299	.307	.380	.333	.81	.49	.76	.69	N N W	s b w	s w b s	S 10 W	4.6	8.0	2.8	3.67	4.90	...	...
2	.762	.731	.700	.7280	52.6	70.2	60.9	62.67	— 4.18	.342	.552	.441	.461	.86	.75	.82	.81	N w b w	s w	E b N	N 81 E	2.0	5.6	4.2	1.47	4.16	...	...
3	.638	.516	.458	.5290	60.9	65.9	67.0	65.08	— 1.77	.465	.581	.588	.543	.87	.91	.88	.87	N E	s E b E	s w	S 25 E	5.4	9.4	2.6	1.79	4.58	0.125	...
4	.446	.497	.603	.5332	68.4	81 8	65.2	71.85	+ 5.05	.646	.483	.510	.522	.93	.41	.81	.70	s w b w	w b s	N W b N	N 74 W	5.4	15.0	3.4	7.79	8.85	...	...
5	.681	.701	—	—	63.0	71.0	—	—	—	.500	.406	—	—	.86	.54	—	—	N b w	E	E	N 81 E	4.1	7.5	3.0	4.01	4.62	...	...
6	.673	.642	.521	.6038	63.4	73.1	65.9	67.83	+ 1.07	.457	.612	.581	.560	.78	.75	.91	.82	N b E	s E b E	Calm.	S 88 E	2.5	3.8	0.0	2.25	2.36	...	...
7	.513	.422	.478	.4640	67.4	77.8	71.1	73.82	+ 7.13	.589	.822	.676	.698	.88	.86	.89	.84	N b w	s s w	Calm.	N 74 W	2.0	4.5	0.0	2.74	4.39	Inp.	...
8	.477	.456	.432	.4555	68.4	71.6	69.1	72.08	+ 5.42	.494	.410	.530	.476	.71	.43	.81	.62	N w b	s b w	N N W	N 83 W	3.8	5.5	5.5	3.56	6.16	0.265	...
9	.443	.487	.508	.4852	62.1	74 6	65.6	67.87	+ 1.32	.539	.564	.454	.529	.96	.65	.72	.78	s E	s s w	w	S 43 W	7.0	8.0	2.6	3.56	4.27	0.035	...
10	.480	.417	.615	.5133	60.9	79.2	58 0	65.08	— 1.48	.465	.596	.233	.464	.87	.60	.58	.72	w	s w	N w b N	N 65 W	0.8	11.6	14.2	7.14	10.41	...	...
11	.712	.693	.669	.6907	52.9	62.7	54.4	58.42	— 8.0	.296	.354	.341	.330	.74	.62	.80	.69	N N W	s b E	E b s	S 22 E	8.0	8.0	5.0	1.55	6.09	...	...
12	.603	.553	—	—	60.9	69.9	—	—	—	.388	.541	—	—	.73	.74	—	—	N W b w	s E b E	N b w	N 9 W	4.5	5.5	2.0	2.60	6.39	0.675	...
13	.525	.558	.677	.5963	54.0	64.5	53.3	57.32	— 8.92	.390	.355	.323	.356	.93	.58	.79	.75	N b w	N w b N	N w b N	N 36 W	8.1	11.8	11.0	10.22	10.28	0.185	...
14	.777	.706	.831	.8047	52.9	63.4	53.3	56.47	— 9.77	.327	.457	.323	.369	.82	.78	.79	.79	N N W	s b w	N N W	N 21 W	4.0	7.2	7.5	4.56	6.33	...	...
15	.881	.882	.834	.8792	51.1	66.3	56.5	59.23	— 6.92	.320	.456	.356	.384	.85	.70	.78	.76	N b w	s b E	s b E	S 18 E	9.8	8.0	3.0	3.14	4.49	...	...
16	.841	.795	.717	.7802	52.6	64.8	58.3	60.07	— 5.97	.353	.386	.436	.403	.89	.62	.90	.78	s s E	E b s	E	S 68 E	5.8	7.0	4.0	3.48	4.34	...	...
17	.693	.614	.533	.6033	57.2	73.8	65.5	66.03	+ 0.07	.415	.382	.506	.461	.88	.46	.80	.73	N N E	s s w	E	N 82 W	2.0	6.5	2.0	0.69	3.93	0.127	...
18	.495	.473	.527	.4990	64.6	75 3	63.7	68.73	+ 2.90	.479	.663	.428	.535	.78	.76	.72	.75	N b w	s b w	N w b N	N 47 W	7.8	5.5	4.2	3.15	5.53	...	...
19	.573	.585	—	—	60.5	67.0	—	—	—	.389	.526	—	—	.74	.80	—	—	N b w	w s w	w b s	S 70 W	1.2	0.5	5.0	2.45	3.04	0.303	...
20	.548	.548	.625	.5760	64.8	77.4	62.7	68.85	+ 3.30	.582	.681	.466	.551	.95	.72	.82	.79	s b w	s b w	N N W	N 85 W	1 8	7.2	0.5	1.99	4.20	...	...
21	.673	.650	.673	.6697	60.1	73.1	66.3	67.47	+ 2.03	.461	.599	.508	.529	.89	.74	.78	.79	N N W	s	N b w	S 86 W	3.0	7.2	8.0	1.27	4.66	...	...
22	.713	.679	.640	.6705	59.4	71.0	65 2	65.08	+ 0.63	.410	.432	.510	.453	.81	.57	.81	.71	N b w	E	E	N 79 E	3.2	6.0	3.8	3.33	4.66	...	...
23	.587	.538	.496	.5327	66 6	77.1	69.5	71.02	+ 5.88	.557	.639	.642	.601	.86	.69	.88	.80	E b N	E b s	N b w	N 71 E	4.2	6.4	5.5	3.96	6.37	0.390	...
24	.441	.408	.401	.4223	64.1	72.0	62.7	66.03	+ 1.13	.551	.613	.517	.557	.92	.78	.90	.87	N b E	E	N w b w	N 15 w	2.2	6.5	5.5	0.87	4.91	1.350	...
25	.367	.369	.469	.4087	61.9	70.1	62.7	64.80	+ 0.07	.515	.466	.466	.478	.93	.62	.82	.78	N w b w	N w b w	w N w	N 53 W	3.8	19.0	12.8	11.58	11.67	..	...
26	.516	.485	—	—	56.2	72.8	—	—	—	.406	.517	—	—	.90	.61	—	—	N w	s	s w	S 50 W	0.7	9.2	4.5	3.24	4.55	Inp.	...
27	.493	.445	.561	.4997	54.7	66.6	52.9	58.80	— 5.52	.358	.491	.306	.365	.84	.75	.76	.74	N W	s w	w b N	N 81 w	1.4	12.5	8.2	8.28	9.20	0.062	...
28	.598	.582	.620	.6032	47.1	64.3	53.6	58.67	— 7.47	.269	.345	.276	.306	.81	.57	.67	.67	N w b w	s s w	N w b N	N 53 W	4.0	5.8	2.8	2.96	4.13	...	...
29	.648	.657	.626	.6482	52 2	67.4	58.3	60.58	— 3.23	.295	.385	.367	.353	.75	.57	.75	.68	N w b N	s	s w b w	S 20 W	2.8	9.5	2.5	3.70	4.26	...	...
30	.582	.430	.211	.4007	53.6	72.4	63.6	64.83	+ 1.22	.351	.523	.505	.459	.85	.65	.79	.79	Calm.	s b w	w b N	S 49 W	0.0	15.5	5.5	4.98	7.82	0.375	...
31	.324	.387	.460	.3902	58 0	71.7	59.0	62.78	— 0.53	.416	.374	.403	.403	.86	.48	.81	.72	w b N	W N W	N W	N 63 W	11.0	10.8	5.4	C.93	8.29	0.013	...
M	29.5960	29.5711	29.5804	29.5825	58.60	71.18	61.68	64.46	— 1.30	.431	.502	.450	.463	.85	.65	.80	.76	.....	.....	.....	.....	4.09	8.21	4.74	.....	5.80	3.405	...

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR AUGUST, 1860.

Highest Barometer . . . . . 29.903 at 9 a. m. on 15th. } Monthly range
Lowest Barometer . . . . . 29.211 at 10 p. m. on 30th, } 0.692 inches.

Self-registering Ther.:
- Maximum temperature . . . . 87°0 on p.m. of 8th } Monthly range=
- Minimum temperature . . . . 46°8 on a.m. of 28th } 40°2
- Mean maximum temperature . . 73°973 } Mean daily range = 17°46.
- Mean minimum temperature . . 56°27 }
- Greatest daily range . . . . . 24°4 from a. m. to p. m. of 11th.
- Least daily range . . . . . 8.5 from a. m. to p. m. of 3rd.

Warmest day . . 7th ... Mean Temperature . . . . 73°82 } Difference=17°35.
Coldest day . . . 14th ... Mean Temperature . . . 56°47 }
Maximum Solar Radiation } Monthly range=
- Solar . . . . . 101°8 on p. m. of 7th
- Terrestrial . . . . . 36.8 on a. m. of 28th } 65°0.

Aurora observed on 8 nights, viz.: on 6th, 8th, 9th. 10th, 11th, 13th, 18th and 22nd; possible to see Aurora on 19 nights; impossible on 12 nights.

Raining on 14 days; depth, 3.405 inches; duration of fall, 40.4 hours.

Mean of cloudiness=0.43; most cloudy hour observed, 2 p. m., mean=0.50: least cloudy hour observed, 8 a. m.; mean=0.30.

Sums of the components of the Atmospheric Current, expressed in Miles.

North.	South.	East.	West.
1659.14	1185.64	698 76	1977.24

Resultant direction, N 70° W; Resultant Velocity, 1.83 miles per hour.

Mean velocity 5.80 miles per hour.

Maximum velocity . . . 22.2 miles per hour, from 4 to 5 p.m. on the 25th.

Most windy day . . 25th—Mean velocity, 11.67 miles per hour. } Difference 9.31

Least windy day . . 6th—Mean velocity, 2.36 do } miles.

Most windy hour, 2 to 3 p. m.—Mean velocity, 8.56 miles per hour. } Difference

Least windy hour, 6 to 7 a. m.—Mean velocity, 3.93 do. } 4.63 miles.

3rd. Sheet lightnir in S. E. at 10 p. m. and midnight. 4th. Fog to 6.45 a. m. 7th. Thunderstorm and slight rain 1.50 to 11 p. m. 8th. Sheet lightning in N. W. and N at midnight. 9th. Thunderstorm, vivid lightning and heavy rain 4.30 to 6.20 a. m. 12th. Slight thunderstorm from 9 p. m.; heavy rain during the night. 15th. Large and remarkable meteor fell from zenith to N. W. horizon at 9 p. m. 16th. Very large meteor fell in a S S. W. direction, emitting sparks and a long train at 8.35 p. m. 17th. Thunderstorm, lightning and heavy rain at intervals from 6 p. m. to 2 a. m. of 18th; rainbow at 7 p m. 19th Severe thunderstorm, vivid lightning and moderate rain from 11 p m. to 9 a. m. of 20th. 21st. Sheet lightning round horizon from 7 p. m. 23rd. Sheet lightning from 6 p. m. to midnight. 24th. Severe thunderstorm, intensely vivid lightning, heavy rain, and large hailstones, from 1.45 to 4 a. m.; another thunderstorm passing from N. to S., 4.30 to 6 p. m. 30th. Thunderstorm, incessant lightning, and moderate rain, from 10.30 p. m., continuing during a portion of the night.

Heavy dew recorded on 18 mornings during this month.

The Resultant Direction and Velocity of the Wind for the month of August, from 1848 to 1860 inclusive, were respectively N. 61° W., and 0.90 miles.

The month of August, 1860, was cold, wet and windy—the mean temperature having been 1°59 below, the rain 0.455 inches above, and the mean velocity of the wind 0.56 miles per hour above their respective averages.

COMPARATIVE TABLE FOR AUGUST.

YEAR.	TEMPERATURE. Mean.	Difference from Average.	Maximum observed.	Minimum observed.	Range.	RAIN. No. of days.	Inches.	SNOW. No. of days.	Inches.	WIND. Resultant Direction.	Resultant Velocity.	Mean Velocity
	°	°	°	°	°					°		
1840	64.7	— 1.3	80.1	47.4	32.7	12	2.905	...	..	...	...	...
1841	64.4	— 1.6	83.5	46.7	36.8	9	6.170	...	...	...	...	0.19 lbs
1842	65.7	— 0.3	80.7	45.3	35.4	6	2.300	...	...	...	...	0.30 "
1843	66.4	+ 0.4	85.5	44.4	41.1	4	4.850	...	...	...	...	0.12 "
1844	64.3	— 1.7	82.5	44.3	38.2	17	imp.	...	...	...	...	0.16 "
1845	67.9	+ 1.9	82.5	44.4	38.1	9	1.725	...	...	...	...	0.19 "
1846	68.4	+ 2.4	86.3	50.4	35.9	9	1.770	...	...	...	...	0.17 "
1847	65.1	— 0.9	83.1	44.9	38.2	10	2.140	...	...	...	...	0.19 "
1848	69.2	+ 3.2	87.5	49.3	38.2	8	0.855	...	...	S 21 E	0.98	4.55ms.
1849	66.3	+ 0.3	79.5	51.4	28.1	10	4.970	...	...	N 71 W	0.60	3.76 "
1850	66.8	+ 0.8	84.2	43.0	41.2	13	4.355	...	...	N 15 E	0.35	4.46 "
1851	63.6	— 2.4	79.8	43.6	36.2	10	1.360	...	...	N 63 W	0.40	4.63 "
1852	65.9	— 0.1	81.2	46.7	34.5	9	2.695	...	...	N 70 E	0.56	3.30 "
1853	68.6	+ 2.6	91.6	47.6	44.0	11	2.575	...	...	S 36 E	0.39	4.26 "
1854	68.0	+ 2.0	98.1	47.0	51.1	5	0.455	...	...	N 64 W	1.76	4.60 "
1855	64.1	— 1 9	82.1	44.9	37.2	7	1.455	...	...	N 63 W	1.04	6.97 "
1856	63.6	— 2.4	81.3	44.0	37.3	12	1.680	...	...	N 50 W	2.88	7.03 "
1857	65.3	— 0.7	85.3	50.1	35.2	13	5.265	...	...	N 77 W	1.51	6.36 "
1858	67.6	+ 1.6	83.4	45.4	38.0	11	3 890	...	...	N 69 W	1.57	6.50 "
1859	66.6	+ 0.6	81.4	46.2	35.2	11	3.990	...	...	N 36 W	1.62	5.96 "
1860	64.5	— 1.5	81.8	47.1	34.7	14	3.405	...	...	N 70 W	1.83	5.80 "
Mean	66.05	...	83.88	46.39	37.49	10.0	2.950	...	...	...	...	5.24

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST—SEPTEMBER, 1860.

Latitude—43 *deg.* 39.4 *min. North.* *Longitude*—5 *h.* 17 *min.* 33 *sec. West.* *Elevation above Lake Ontario*, 108 *feet.*

Days.	Barom. at temp. of 32°. 6 A.M.	2 P.M.	10 P.M.	MEAN.	Temp of the Air. 6 A.M.	2 P.M.	10 P.M.	ME'N	Excess of mean above Average	Tens. of Vapour. 6 A.M.	2 P.M.	10 P.M.	M'N	Humidity of Air. 6 A.M.	2 P.M.	10 P.M.	M'N	Direction of Wind. 6 A.M.	2 P.M.	10 P. M.	Resultant Direction.	Velocity of Wind. 6 A.M.	2 P.M.	10 P.M.	Result.	ME'N	Rain in Inches.	Snow in Inches.
1	29.557	29.630	29.745	29.6502	50 8	63.4	48.2	54.43	— 8.60	.293	.243	.245	.255	.78	.42	.72	.62	NWbW	NWbW	NWb N	N 36 W	6.0	15.5	4.0	7.86	8.06	...	...
2	.829	.881	—	—	48.2	64.1	—	—	—	.226	.313	—	—	.66	.53	—	—	NW bN	S	Calm.	S 27 W	3.6	8.2	0.0	1.73	2.64	...	...
3	.935	.917	.808	.8813	49.7	65.9	59.4	59.47	— 2.97	.308	.449	.363	.336	.86	.70	.71	.76	W N W	E b N	N E	N 65 E	0.5	8.0	3.0	4.65	4.93	...	...
4	.815	.782	.672	.7345	59.5	69.2	65.2	65.07	+ 2.91	.356	.593	.577	.532	.78	.83	.92	.84	N N E	S b E	S b E	S 23 E	2.0	8.0	0.5	2.63	2.83	Inp.	...
5	.681	.691	.666	.6787	64.5	74.2	70.2	69.75	+ 7.92	.573	.642	.651	.617	.94	.77	.88	.85	S b E	S b W	S WbW	N 48 W	1.8	4.5	1.5	2.21	5.45	Inp.	...
6	.719	.728	.743	.7248	64.5	72 2	62.3	66.15	+ 4.72	.342	.440	.459	.420	.56	.62	.82	.67	N b W	S b W	N b W	N 35 W	8.0	5.5	8.6	1.45	4.33	..	...
7	.693	.576	.531	.5915	55.8	72.0	66.6	66.57	+ 5.42	.343	.556	.536	.492	.78	.70	.90	.75	N b W	S E	S S W	N 43 E	4 2	1.5	1.2	1.37	3 45	0.020	...
8	.643	.631	.777	.6335	60.1	52.2	50.8	54.13	— 6.60	.488	.337	.272	.360	.91	.86	.73	.83	N E b N	N N E	N	N 9 E	6.5	11.0	3.2	6.77	7.03	0.520	...
9	.849	.857	—	—	45 7	60.5	—	—	—	.249	.227	—	—	.81	.43	—	—	N b W	N WbW	N b W	N 24 W	10.0	5.0	8.0	4.54	5.77	...	...
10	.718	.622	.648	.6537	47.5	60.1	52.2	53.93	— 6.12	.255	.331	.305	.293	.77	.63	.78	.71	N W	S b W	W b N	S 64 W	4.9	8.0	2.5	3.32	4.92	...	...
11	.539	.438	.565	.5223	46.4	55.1	44.6	49.60	—10 05	.249	.389	.199	.284	.76	.89	.61	.77	W b N	SW bW	NWb N	N 59 W	1.0	9.0	10.2	8.39	10.92	0.170	...
12	.694	.724	812	.752	44.3	52.6	41.7	46.37	—12.87	.194	.196	.218	.191	.67	.48	.82	.62	N W	N W	Calm.	N 9 W	8.8	17.5	0.0	10.47	10.55	...	...
13	.856	.836	.855	.8513	43.5	64 8	49.3	54.09	— 4.85	.211	.314	.270	.270	.82	.51	.77	.67	NWbW	W b N	Calm.	N 67 W	8.0	9.6	0.0	3.80	3.91	...	...
14	.902	.865	.836	.8565	45.7	63.8	53.0	59.62	+ 1.23	.283	.371	.394	.378	.94	.53	.82	.76	Calm.	S	S	S 3 W	0 0	8.4	0.4	3.59	3.67	...	...
15	.795	.694	.671	.7118	49.3	70.2	65.2	63.92	+ 6.00	.313	.510	.497	.473	.88	.69	.79	.79	Calm.	S b W	S W b S	S 18 W	0.0	10.6	0.5	5.54	5 64	0.610	...
16	.631	.548	—	—	62.3	64.1	—	—	—	.522	.499	—	—	.94	.83	—	—	S S W	S	S W b S	S 29 W	4.2	9.5	5.0	4.30	4 65	0.057	...
17	.562	.532	.668	.6163	51.5	66.6	56 5	57.85	+ 0.85	.336	.441	.390	.386	.87	.67	.85	.80	Calm	S S W	N N W	S 80 W	0.0	3.8	0.5	1 63	1.8.	...	...
18	.724	.706	.681	.7032	48.9	64.1	55.8	57.07	+ 0.45	.319	.423	.365	.372	.91	.70	.82	.80	N b W	E S E	Calm.	S 79 E	1.0	2.8	0.0	0.75	1 05	...	...
19	.627	.578	.553	.5788	54.0	67.7	59.8	60.98	+ 4.87	.401	.529	.428	.462	.96	.78	.83	.86	Calm.	S S E	N N W	N 16 W	0.0	2.0	7.5	2.13	2.59	...	...
20	.459	.294	.431	.3942	57.2	56.2	47.7	53.42	— 2.18	.404	.428	.283	.363	.86	.95	.86	.88	NWb N	N W	W S W	N 73 W	4.4	11.0	5.2	6.20	7.76	0.060	...
21	.433	.431	.624	.5262	42.8	58.3	42.1	47.80	— 7.32	.251	.223	.233	.239	.90	.46	.80	.74	W S W	W	Calm.	S 80 W	6.0	17.5	0.0	7.96	8.46	Inp.	...
22	.473	.455	.604	.5 12	52.2	65.5	51.8	55.98	+ 1.35	.315	.317	.311	.321	.80	.50	.80	.73	S S W	S WbW	N b W	S 60 W	15.5	16.2	2.5	7.36	8.77	0.017	...
23	.791	.693	—	—	39.6	54.4	—	—	—	.227	.318	—	—	.94	.7.	—	—	Calm.	E b S	E N E	N 81 E	0.0	8.8	5.5	4.21	4.57	.	...
24	.390	.387	.344	.3667	56.2	60.1	60 1	58.63	+ 4.93	.393	.448	.372	.384	.87	.86	.71	.78	S S W	S W b S	W	S 48 W	7.0	7.6	16.2	5.72	6.20	0.130	...
25	.254	.233	.490	.3432	51.1	61.6	46.8	53.32	+ 0.08	.353	.269	.234	.279	.91	.48	.74	.69	Calm.	W	W b N	N 86 W	0.0	18.0	15.5	11.82	12.29	0.005	...
26	.644	.760	.885	.7718	41.6	56.2	41.4	47.08	— 5.63	.219	.169	.214	.204	.83	.35	.81	.66	W b S	NWbW	W N W	N 76 W	1.2	25.0	0.5	8.89	8.96	...	...
27	.910	.806	.621	.7692	43.5	49.7	41.0	43.00	— 6.22	.240	.255	.227	.244	.85	.61	.88	.79	NWbW	S E b S	Calm.	N 74 W	3.4	2.0	0.0	3.05	4.70	0.080	...
28	.738	.843	30.041	.8902	41.4	47.9	38.5	42.47	— 9.37	.232	.183	.120	.175	.89	.54	.52	.64	W b N	NW bN	N WbN	N 44 W	7.0	18.8	2.8	10.49	10.68	..	...
29	30.038	30.044	30.042	30.0307	35 2	43.7	40.7	39 90	—11.42	.128	.147	.196	.151	.62	.51	.77	.61	N N W	S b W	Calm.	S 12 W	0.5	5.0	0.0	1.69	1.88	...	...
30	30.134	30.106	—	—	28.7	40.3	—	—	—	.103	.140	—	—	.69	.56	—	—	N N E	E b S	N E	N 74 E	2.8	8.2	5.0	4.75	5.13	0.230	..
M	29.6744	29.6503	29.6923	29.6733	50.17	61.53	52.64	55.34	— 2.15	.313	.369	.336	342	.83	.64	.79	.74	.....	.....	.....	.....	3.94	9.55	3.66	.....	5.79	1.959	...

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR SEPTEMBER, 1860.

Highest Barometer ..... 30.170 at 10 a. m., on 30th } Monthly range=
Lowest Barometer ..... 29.233 at 2 p. m. on 25th } 0.937 inches

Self-registering Thermom.
- Maximum Temperature ..... 75°8 on p. m. of 5th } Monthly range=
- Minimum Temperature ..... 28°7 on a. m. of 30th } 47°1
- Mean maximum Temperature ..... 63°12 } Mean daily range=
- Mean minimum Temperature ..... 47°29 } 15°83
- Greatest daily range ..... 28°2 from a. m. to p. m. of 13th.
- Least daily range..... 3°2 from a. m. to p. m. of 16th.

Warmest day..... 5th ... Mean temperature..... 69.75 } Difference = 29°85.
Coldest day..... 29th... Mean temperature..... 39°90 }

Maximum } Solar..... 96°0 on p. m. of 5th } Monthly range=
Radiation. } Terrestrial..... 22°8 on a. m. of 30th } 73°2.

Aurora observed on 6 nights, viz., on 6th, 8th, 10th, 15th, 19th and 25th.
Possible to see Aurora on 22 nights; impossible on 8 nights.
Raining on 14 days,—depth 1.959 inches; duration of fall 36.2 hours.
Mean of cloudiness = 0.48.
Most cloudy hour observed, 4 p. m., mean = 0.60; least cloudy hour observed, 10 p. m., mean, = 0.35.

Sums of the components of the Atmospheric Current, expressed in miles.

North.	South.	East.	West.
1587.41	972.69	456.31	2246.36

Resultant direction N. 71° W.; Resultant Velocity 2.63 miles per hour.
Mean velocity..... 5.79 miles per hour.
Maximum velocity ..... 29.2 miles, from 5 to 6 p. m. on 25th.
Most windy day ..... 25th.....Mean velocity 12.29 miles per hour. } Difference=
Least windy day ..... 18th.....Mean velocity 1.05 ditto. } 11.24 miles.
Most windy hour... 1 to 2 p. m.....Mean velocity 9.84 ditto. } Difference
Least windy hour... 2 to 3 a. m. .....Mean velocity 2.96 ditto. } 6.88 miles.

5th. Distinct Solar Halo at noon. 8th. Imperfect rainbow at 5.30 p. m. 14th. Ground fog 6 to 7 a. m. 15th. Ground fog 6 to 7.30 a. m. 16th. Heavy thunderstorm 3 to 5.30 a. m. 19th. Dense fog from 5 a. m.; sheet lightning in S. E. at 7 p. m. 21st. Thin ice on shallow pools at 6 a. m. (*first of season.*) 22nd. Perfect solar rainbow 5.35 to 5.55 a. m. 23rd. Hoar frost and thin ice, 6 a. m. 24th. Slight thunderstorm, noon to 1 p. m.; halo round the moon 6.30 p. m. 25th. Very perfect double rainbow, 5.15 to 5.45 p. m. 26th. Hoar frost 5.30 a. m., very perfect Lunar Halo from 7.30 p. m. 27th. Sheet lightning in N. W. at 8 p. m. 28th. Thin ice at 6 a. m. 30th. Hoar frost and ice one-eighth inch thick: this frost was very destructive to tender vegetables and fruit.

Heavy Dew recorded on 7 mornings during this month.

The Resultant Direction and Velocity of the Wind for the month of September, from 1848 to 1860 inclusive, were respectively N 61° W, and 1.11 miles.

The month of September, 1860, was cold, dry and windy.

The Mean Temperature was 2°51 below the average of 21 years. The depth of rain recorded was 2.032 inches below the average of 20 years, which is less than half the mean amount; and the mean velocity of the wind was 0.35 miles per hour above the average of 13 years.

COMPARATIVE TABLE FOR SEPTEMBER.

Year.	Temperature. M'n.	Diff. from Aver.	Max ob'd.	Min. ob'd.	Range.	Rain. No. of days.	Rain. Inch's.	Snow. No. of days.	Snow. Inch's.	Wind. Resultant Direction.	Wind. Resultant V'y.	Wind. Mean Force or Velocity.
	°	°	°	°	°							
1840	54.0	—3.9	70.2	29.4	40.8	4	1.380	...	...	...	...	.....
1841	61.3	+3.4	79.9	37.5	42.4	9	3.340	...	...	...	...	0.26 lbs.
1842	55.7	—2.2	83.5	28.3	55.2	12	6.160	...	...	...	...	0.45
1843	59.1	+1.2	87.8	33.1	54.7	10	9 760	...	...	...	...	0.57
1844	58.6	+0.7	81.5	29.6	51.9	4	Imp.	...	...	...	...	0.26
1845	59.0	—1.9	78.8	35.3	43.5	16	6.245	...	...	...	...	0.34
1846	63.6	+5.7	84.0	39.0	45.0	11	4.595	...	...	...	...	0.33
1847	55.6	—2.3	74.8	38.1	36.7	15	6.665	...	...	...	...	0 33
1848	54.2	—3.7	80.9	29.5	51 4	11	3.115	...	...	N 71° W	2.38	5.81 mls.
1849	58.2	+0.3	80.6	33.5	47.1	9	1 480	...	...	N 75° W	0.69	4.23
1850	56.5	—1.4	76.0	31.7	44.3	11	1.735	...	...	S 65° W	1.03	4.78
1851	60.0	+2.1	86.3	33.4	52.9	9	2.665	...	...	N 14° E	1.03	5.45
1852	57.5	—0.4	81.8	36.1	45.7	10	3.630	...	...	N 77° W	0.53	4.60
1853	58.8	+0.9	85 4	36.1	42.3	12	5.140	...	...	N	1.06	4.33
1854	61.0	+3 1	93.1	36.3	56.8	14	5.375	...	...	N 22° W	1.33	4.04
1855	59.5	+1.6	81.7	36.1	45.6	12	5.585	...	...	N 20° E	1.29	7.61
1856	57.1	—0.8	77.3	37.4	39.9	13	4.105	...	...	S 79° W	1.98	6.53
1857	58 6	+0.7	81.4	34.1	47.3	11	2.610	...	...	N 63° W	1.61	5.55
1858	59.1	+1.2	80.1	36.8	43.3	8	0.735	...	...	S 74° W	1.53	5.69
1859	55.2	—2.7	73.8	35.7	38.1	15	3.525	...	...	N 44° W	1.60	6.36
1860	55.3	—2.3	74.2	28.7	45.5	14	1.959	...	...	N 71° W	2.63	5.79
M	57.85	...	80.62	34.08	46.54	11.0	3.991	...	...	.....	...	5.44 Ml.

INDEX.

ERRATA AND ADDENDA TO VOL. V.

Page 171, line 6 in foot-note, *for* our ordinary pea, *read* an ordinary pea.
" 175. *To* localities of *Chromic Iron Ore, add* Mount Albert in Gaspé.
" 178, line 5, *for* Addington Co., *read* Argenteuil Co.
" 294, line 16, *for* 1849, *read* 1859.
" 307 (in note on Calceola), *for* Prof. Stafford, *read* Prof. Safford.
" 320, line 2 from bottom, make the same correction; and *for* identified, *read* identical.
" 388, line 15, *for* palumbarius, *read* columbarius.
" 389, line 15, *for* Musicapa, *read* Muscicapa.
" 389, line 17, *for* crenita, *read* crinita.
" 389, line 27, *for* Mylodoctes, FLYCATCHER, *read* Myiodioctes,—FLYCATCHING.
" 389, line 41, *for* vinus—Vine-, *read* pinus—Pine-.
" 389, line 43. *for* Varus, *read* Parus.
" 390, line 15, *after* Philadelphia, *insert Mourning Warbler.*
" 390, line 21, *for* Minotilta, *read* Mniotilta.
" 390, line 28, *for* hymenalis, *read* hyemalis.
" 392, line 26, *for* roots, *read* roost.
" 392, in foot-note, *for excurbitoroides. read excubitoroides.*
" 393, line 42, *for* CROKI, *read* CRAKE.
" 393, line 36, *for Ruffled, read Ruffed.*
" 394, line 24, *for Red-headed, read Red-breasted.*
" 394, *after* Genus Scolopax, *insert* Genus Microptera, WOODCOCK.
" 471, line 6 from bottom, *for* north-west, *read* north-east.
" 519, line 7, *for Cornelian, read Carnelian.*
" 520, line 1 from bottom, *for Condrodite, read Chondrodite.*
" 540, line 6 from bottom, *for Thiels, read Theils.*

See also pages 22 and 237.

LOVELL AND GIBSON, PRINTERS, TORONTO.