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NOTES ON LATIN INSCRIPTIONS FOUND IN BRITAIN.

PART X.

BY THE REV. JOHN M'CAUL, LL.D.,

PRESIDENT OF UNIVERSITY COLLEGE, TORONTO, AND OF THE CANADIAN INSTITUTE.

In compliance with suggestions that it would be advantageous to resume the papers on "Latin Inscriptions found in Britain," I purpose continuing the series occasionally as time permits. My last article on this branch of Epigraphy appeared in the *Canadian Journal* for January, 1862, when I ceased contributing articles on the subject, as I was engaged in preparing for the Press the volume on "Britanno-Roman Inscriptions," in which all my published notes were collected, with the addition of others that had not appeared in print. In this and succeeding Parts, I shall not only use some materials that I then laid aside from a desire to limit the bulk of the book, but shall also give the results of subsequent investigation.

58. Horsley's n. cix. Northumberland, is an inscription found at Hexham. It stands thus in his copy:

IMP·CAES·L·SEP
PERTINAX ET IMP·C
AVRANTONIN
VSII
HORI
VEXILLATION
FE RVNT

The following is his expansion :

Imperator Cæsar Lucius Septimius Pertinax et Imperator Cæsar Marcus *Aurelius Antoninus pius* felix Augustus et Geta Cæsar *cohortium vexillationes fecerunt.*

Dr. Bruce, *Roman Wall,* p. 315, 2nd ed., figures the slab and offers the suggestion :

"If the word in the fifth line be intended for *horreum,* which it probably is, the stone records the building of a granary by a vexillation of some portion of the Roman forces."

In the "*Wallet-book of the Roman Wall,*" 1863, he strangely rejects this reading, and remarks :

"The third and fourth lines of the inscription probably stood thus :—

. . ET IMP·P·SEP·
GETA COHORTES.

Certain cohorts and vexillations seem to have been employed upon some work at this time ; what, does not appear."

I much prefer *horreum,* but would read the last three words—*horreum vexillationi fecerunt ; i.e.* The Emperors made the granary for the vexillation stationed at Hexham or in its neighbourhood.

On another slab, found at Great Chesters, *Æsica,* we have a record of the rebuilding of a granary in 225 A.D. See *Brit. Rom. Inscrip.* pp. 154—156. It is strange that so few commemorative tablets of this class have been found in the island, for there must have been many such buildings.

59. In the *Archæologia Æliana,* new series, i. p. 250, we have a fragment of an inscription from Carvoran, *Magna* :—

IVSAGRI
AMIORV

Dr. Bruce remarks :

"The name of Calpurnius Agricola occurs upon two or three inscriptions in connection with the Hamii at *Magna.* There can be no doubt that we have before us fragments of the words—

CALPVRNIVS AGRICOLA
HAMIORVM

The date of these inscriptions is unknown."

Every scrap of information relative to this cohort of Hamians is interesting and valuable, for the only notice that has been discovered of it, so far, is in inscriptions found in Britain. Mr. Roach

Smith, *Collectanea Antiqua*, vi. p. 39, identifies it with the *cohors prima Apamenorum* of the *Notitia*; but there is no ground for this identification, and Mr. S. seems to have strangely confused the towns *Apamea* and *Hamah*, from which latter, as Mr. Hodgson first suggested, the *cohors prima Hamiorum* probably derived its name. Dr. Bruce's reading of the few letters on the broken stone is both acute and satisfactory, but I cannot understand his remark—"The date of these inscriptions is unknown."

From an inscription, given in the same page in the *Arch. Æliana*, we may infer that this cohort was at *Magna* in 136 or 137 A.D., for Ælius Verus was not Cæsar until the first of these years, and he died on the 1st of January, 138. An inscription, found at Kilsyth, Scotland, suggests that this cohort was stationed there, perhaps during the construction of the northern barrier about 140, from which they seem to have been recalled and stationed again at *Magna*, in the reign of M. Aurelius Antoninus (*i.e.* 162—180), under whom Calpurnius Agricola was legate in Britain.

We have, I think, another memorial of their stay at *Magna*, in an altar, figured by Dr. Bruce, *Roman Wall*, p 399, 2nd Ed It was erected (as I read it) by *Julius Pastor Imag*[inifer] of the cohort of Hamians.

In the *Notitia*, the second cohort of Dalmatians is mentioned as stationed at *Magna*, but no traces* of this cohort have been found there.

60. One of the most perplexing inscriptions, found in Britain, is on a small altar, discovered in York, in 1752, and at present in the Museum of the Philosophical Society of that city. It may be represented thus :†

MAT·A ? ? IA· ? A
M ? I ? ? ? ? DE
MIL·LEG·VI VIC
GVBER·LEG·VI
V·S·L·M.

* A monumental slab, found there and now preserved in the Museum of the Society of Antiquaries, Newcastle-upon-Tyne, may, possibly, be a memorial of this cohort, although it is not named on it. The inscription is by a centurion to his wife, whose birth-place is stated as Salona, the city in Dalmatia. See *Archæol. Æliana*, new series, i. p. 256.

† The queried letters are not effaced, but only doubtful, some of them in a less degree than others. Thus in the first line, the third queried letter is certainly G or C; and in the second, the first five letters are most probably M·MINV.

The various explanations, that had been proposed up to 1842, were collected by Mr. Wellbeloved in his *Eboracum*, and are given in my "Britanno-Roman Inscriptions" in an extract from that work. To these I there added Mr. Kenrick's recent interpretation of GVBER as *Gubernator*, scil. pilot or steersman, "having charge of the vessels, by means of which the legion communicated with places on the Ouse, or the rivers that fall into it." The only suggestions, which I offered, were—the reading of the first line, as MAT·AFLIA·GAV, *i.e. Matribus Afliabus Gavadiis*, (see Henzen, nn. 5929, 5937), and the reading of the second line, as M·MINV·NANDE, instead of M·MINV·MVDE or M·MINV·ANDE, which had been proposed by others—with the remark that I regarded Mr. Kenrick's explanation of GUBER· as more satisfactory than any of which I was aware. I indicated, however, that I was not satisfied that the correct reading had been found. I have therefore occasionally made other attempts, and now submit the result of these efforts as more satisfactory than the explanations that have hitherto been proposed. As to the first line, I adhere to the reading which I suggested, MAT·AFLIA·GAV, as the most probable of which I am aware; although it has since occurred to me that the last letters may have been CA or CAM· for *Campestribus*. The second line I would read also as before—M·MINV·NANDE, but instead of taking *Nande* for the name of a place, I would separate the letters thus, NAN·DE. GVBER seems to me to be used in the same sense, as it is found in the *Fasti Antiatini*, ed. Henzen, n. 6445, on which* that able Epigraphist remarks: [GVBER·] "*Ita scriptum pro* gibber, *qui ut* pumilio (n. 5411,) *in familiis nobilium colebatur, ut ludicro ejus spectaculo delectaretur.*" My view then is that this altar was erected by the hunchback dwarf of the sixth legion, called by the soldiers in fun, from his size, *Minutius*† *Nanus*;‡ and hence we may explain the unusual

* Mommsen, however, takes GVBER in that passage for *gubernator*, for which, he observes, it is often placed.

† Similar applications of names were not uncommon amongst the Romans. It is well known that some of the *cognomina* were derived from personal characteristics, and we are not without examples of *nomina* given in jest, *e. gr. Censorinus*, as we learn from Trebellius *Pollio, Triginta Tyranni*, was called *Claudius*, with reference to his lameness, *Scurrarum joco*.

‡ The practice of having *pumiliones* or *nani* may be illustrated from Suetonius, *Tiberius*, c. 61:—*Interrogatum eum subito et clare a quodam* nano, *adstante mensæ inter copreas*; Juvenal, viii. 32. Nanum *cujusdam Atlanta vocamus*; and Lampridius, *Alexander Severus*, 34.—Nanos et Nanas, *et moriones populo donavit*. In addition to these, already cited by Facciolati, see Pliny, vii. 16; Suetonius, *Augustus*, 43; Propertius, iv. 8, 41; and compare Xiphilinus, lxvii. 8; Horace, *Sat.* ii. 3, 308; and Statius, *Silv.* i. 6, 57.

It may be that NAN was used in jest, as if it were the abbreviation of a tribe, *i.e.*, *Marcus Minutius Nania* tribu.

smallness of the altar, not more than "10 inches high, and 5 inches square." The only point, which remains to be noticed, is DE in the first line. It may be the preposition, *i.e. de militibus legionis sextæ victricis,* used purposely to avoid calling him a *miles;* or it may stand for *delicium, delicia,* or *deliciæ,* "the pet," MIL·, of course, if this be adopted, standing for *militum.*

61. In Dr. Bruce's *Roman Wall,* p. 209, 2nd Ed., a stone, bearing the following fragment of an inscription, is figured :—

ESTRA.A
RIANO
EGII

Dr. B. remarks :—

"The Milking Gap slab, to which it has a very close resemblance, enables us to supply the parts that are wanting. The only difference seems to be, that the emperor's name is in the dative case instead of the genitive as in the other example.

[IMP CA]ES TRAIA[NO]
[HAD]RIANO [AVG PP]
[L]EG II [AVG]
[A PLATORIO NEPOTE LEG PR PR]."

This restoration is justified by "the Milking Gab" slab, except in one point, and that an important one, *viz.,* the addition of the letters PP, which do not appear on that slab. This title, *Pater Patriæ,* cannot be introduced *ad libitum;* its presence or absence as a designation of Hadrian may make a difference of eleven years in the date, for it was not assumed by that emperor until 128 A.D. The two* slabs, given by Dr. Bruce, in pp. 202, 203, indicate a period between 117 and 128 A.D., about 124, in which year, as we know from the diploma found at Stannington, Aulus Platorius Nepos was Legate in Britain. The inscriptions, found at Great Chesters, *Æsica,* and Moresby, *Morbium?,* which have the addition of P·P· give a date between 128 and 138 A.D.

The Leicester mile-stone marks the year between August 11, 120, and August 11, 121, within which time Hadrian was probably in the island. The altar already noticed in 59, mentioning *L. Ælius Cæsar,* gives either 136 or 137 A.D.; and Horsley's, n. lxi. *Cumber-*

* I suspect that some pairs of slabs, bearing the same inscription, were set up to mark the beginning and the end of work done on the Southern barrier as there were on the Northern. See *Brit. Rom. Inscrip.* p. 235.

land, in which *M. Mænius Agrippa* is named, may be referred to a year between 120 or 121 A.D. and 138 A.D., probably at the beginning of this period. See *Monum. Hist. Brit.* nn. 11, 92.

62. In Mr. Lee's *Isca Silurum*, and "Delineation of Roman Antiquities found at Caerleon," a slab is figured, which bears the following inscription :—

IMPP·VALERIANVS ET GALLIENVS
AVGG·ET VALERIANVS NOBILISSIMVS
CAES·COHORTI VII·CENTV[illegible]AS·A SO
LO RESTITVERVNT·PER·DESTICIVM IVBAM
VC·LEGATVM AVGG·PR PR·ET
VITVLASIVM LAETINIANVM LEG·LEG
II·AVG·CVRANTE·DOMIT·POTENTINO
PRAEF·LEG·EIVSDEM

As the interpretation is fully discussed in my "Britanno-Roman Inscriptions," it is not my intention to take up this part of the subject again. There is a question, however, relative to the date, that I now desire to examine. In a review of Mr. Lee's *Isca Silurum*, in the *Gentleman's Magazine*, for August, 1862, the author remarked:

"As this [restoration] took place in the reign of Valerian and Gallienus, when Valerian, the son of Gallienus, was Cæsar, the date of the inscription must be between A.D. 253 and A.D. 259, just before the revolt of Postumus in Gaul, when the young Cæsar was murdered."

In *Brit. Rom. Inscrip.*, p. 125, I rejected these statements as erroneous, observing: "Gallienus was not associated in the empire until A.D. 254, nor was his son Saloninus, the 'young Cæsar,' killed until A.D. 260;" and I appended the note, with the object of doing justice to a previous enquirer,—"Mr. Newton, *Monum. Hist. Brit.*, gives the correct dates." The same critic, in reviewing my book in the *Gentleman's Magazine*, for April, 1863, notices my observation in the following terms:

"We are quite willing to rest upon the dates we have given, which are usually accepted; and refer Dr. McCaul to the elaborate paper on the family of the Emperor Valerian in the Baron Marchants' *Lettres sur le Numismatique et l'Histoire.*"

To this the note is appended :

"Paris, 1851. 'Comme il est positif que Salonin est mort in 259,' &c, p. 440. A.D. 253, is even more generally admitted as the year in which Valerian admitted Gallienus as his imperial associate."

The dates, given by the Reviewer, were, I believe, those "usually accepted," and are still received by some. Under ordinary circumstances, then, I should not have impugned their accuracy, but the object of my book being to correct received opinions, if they seemed to me to be unsatisfactory, I felt bound to notice them as in my judgment erroneous, especially as they seemed to be advanced as an emendation of those previously given in the *Monumenta Historica Britannica*.

I shall now give the grounds of my opinion. The question is whether the date of the inscription, as given above, is 253–259 A.D. or 254–260 A.D. The former is selected by the Reviewer, the latter by me. My reason for adopting 260 instead of 259 is, that it appears from mention of the name of the Cæsar Valerian (*i.e.* Saloninus) in the Code of Justinian, iv. 6, 4; v. 42, 2; and x. 16, 2, that he was alive when the first two of those laws were given, *scil.* on the 27th of April and the 15th of May, in the consulship of *Sæcularis* ii. and *Donatus*, *i.e.* 260 A.D. It is true that he is not mentioned in all the laws of this year, but neither is he in all of the preceding years, when he was unquestionably alive. As to the choice between 253 and 254, I preferred the latter, on the authority of Aurelius Victor, *de Cæsaribus*, c. 32; *Licinio Valeriano imperium deferunt.* * * *Ejus filium Gallienum Senatus Cæsarem creat, statimque Tiberis adulta æstate diluvii facie inundavit.* What summer is that mentioned here? Certainly not of a year before the death of the *Galli*. Now we have unquestionable evidence that they were not slain until their fourth tribunician year, and, as their first year cannot have commenced before the death of Decius, who was killed in 251, their death and the recognition of Gallienus by the senate cannot have taken place before 254. I do not question the assertion that Valerian assumed the imperial title and made Gallienus

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* As much confusion exists relative to this period of history, I subjoin an extract of the principal events of the years 251, 252, 253, and 254, that I drew up for my own use after a careful examination of all the ancient and the chief modern authorities.

251. Death of Decius in November. Accession of Gallus and Hostilianus, with Volusianus as Cæsar.

252. Death of Hostilianus in the autumn or winter, after the beginning of the pestilence.

253. Assumption of the Imperial power by Æmilianus in the summer, about the end of July. Valerian proclaimed Augustus by the army in the winter, about the time of the entrance of Æmilianus into Italy.

254. Deaths of the Galli (*scil.* Trebonianus and Volusianus) at Interamnæ, in February, and accession of Æmilianus. Death of Æmilianus in May, and recognition of Gallienus by the senate, in June. Valerian and Gallienus are substituted as Consuls for those who commenced the year.

his colleague in 253, but I think that this tablet, bearing, as it does, the name of an imperial legate of the *Augusti*, was not erected before the death of the *Galli*, and the recognition by the senate. But the Reviewer gives a modern authority in support of his view, the Baron Marchant. On the other side, I may be permitted to refer to Fynes Clinton, whose opinion on such subjects is justly held in the highest estimation. That learned investigator, in his *Fasti Romani*, A.D. 254, remarks:

"Gallienus is associated in the empire." "The son of Valerian [*i.e.* Gallienus] was acknowledged by the senate in June, A.D. 254."

In A.D. 260, he gives the following notes:

"Saloninus slain." "Saloninus was still living, August 29, A.D. 259, and is mentioned in *Cod. Justin.* at May 15, A.D. 260; see col. 3. His death may therefore be placed about June, A.D. 260."

The notices in the Justinian Code are the same which I have already mentioned. Clinton adds the remark: "The Cæsar Valerian is named in only three out of seventeen laws [of the year 260]. If he is rightly inserted, he was still living in May, 260." Here, it must be admitted, is the expression of a doubt as to the correctness of the insertion of the name in this year, but the author's estimation of the value of this doubt is manifest from his disregarding it, and placing the death of Saloninus, and giving the authorities, in 260.

In the 'Chronological Tables of Roman History,' subjoined to Dr. Smith's *Dictionary of Greek and Roman Biography and Mythology*, we have the following notices on the subject:—

"254. Valerianus emperor. His son Gallienus is made Augustus.
"260. Saloninus, the son of Valerian, put to death by Postumus."

The statement that "Gallienus was made Augustus" is correct, for he was in this year not only *Cæsar* but *Augustus*; but "Valerian," in the words "son of Valerian," is a mistake for "Gallienus."

63. In the Museum of the Society of Antiquaries, Newcastle-upon-Tyne, there is a "fragment of a rudely carved monumental stone," from Risingham, which bears an inscription of more than ordinary interest, if my view of it be correct. It is figured in the *Archæologia Æliana*, new series, i. p. 257; and "the letters which appeared [to Dr. Bruce] most probable when the stone was placed under a strong light, are:

SDECEF
ANNXXII
FALIVN
REIIITIA
TTCOSC
F
VPFIVVICT
VINCVLV"

When I first saw the copy of this inscription, it at once occurred to me that it was the memorial of a Christian. The notice of the day of the month—KAL·IVN, *i.e. Kalendis Juniis*—(for thus I read the third line)—and the indication of the year by the consul or consuls—characteristics so common in Christian, but so rare in Pagan epitaphs, produced the impression that this inscription was a record of Christianity in Britain during the Roman occupation of the island. There are also other peculiarities in it that appear to me to confirm my view, but I am reluctant to venture on conjectures, where the reading is so uncertain, and must defer further statement of my opinion until I have more accurate information relative to those letters that are still legible.

64. In the *Archæologia Æliana*, iii. Pl. i. p. 153, an altar, found at Risingham, is figured. It bears the inscription—

FORTVNAE·REDVC
IVLIVS·SEVERINVS
TRIB EXPLICITO
BALINEO·V S L M

i.e. Fortunæ reduci Julius Severinus Tribunus explicito balineo votum solvit libens merito. In the *Archæologia Æliana*, new series, i. p. 258, Dr. Bruce translates it thus:—

"To Fortune the Restorer, Julius Severinus the Tribune, the Bath being opened, erected this altar in discharge of a vow freely and deservedly made."

Explicito does not mean "opened," but "finished." Thus Scævola, *Digest.* xxxiv. 1, 17, *eo tempore, quo templum* explicitum *fuerit:* and Orelli, n. 3817, explicito *quod promiserat.*

DESCRIPTIVE CATALOGUE OF COINS, ANCIENT AND MODERN, IN THE COLLECTION OF THE CANADIAN INSTITUTE.

(*Continued from No. L. page* 105.)

BY THE REV. DR. SCADDING,
LIBRARIAN TO THE INSTITUTE.

No. 2.

GREEK COINS.—(*Continued.*)

II. COPPER.

(A) OF AUTONOMOUS CITIES.

1. Abydos. Obv. Head wreathed to r. Rev. Eagle* Leg. ABY.† Weight—1½ dwts.

2. Abydos. Obv. Head. Rev. Amphora. Leg. AB (reversed.)‡ Weight—5 dwts.

3. Aegium.§ Obv. Head of Pallas to r. Rev. Victory with wreath. In the field a Tortoise,‖ and monogram AI repeated in reverse order. Weight—8½ dwts.

4. Ætnaea.¶ Obv. Head of Ceres to r. Rev. Cornu copiae.** Leg. AITNAIΩN. Weight—2 dwts.

5. Apamea on the Orontes.†† Obv. Head of Jove laureated, to l. Rev. A fulmen. Leg. AΠ. in a wreath of wheat-ears. Weight—3 dwts.

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* "Aquilæ causa incerta."—Eckhel .i. 478.

† "Qua per angustas vectae male virginis undas
Seston Abydena separat urbe fretum."—Trist. i. x. 28.

‡ This coin is very much worn. The AB may denote the *Aburia gens.*

§ "Achaiae nobilissima urbs quo non Achaei solum, sed universi Peloponnesii conveniebant, publicis de rebus consultaturi."—Rasche i 113.

‖ "Testudo reptat in numis Aegiorum, qui numi sunt antiquissimi."—Rasche ix. 973.

¶ "Stadiis lxxx. a Catana dissita."—*Vide* Strabo. vi. c. ii. 3.

** "Aetnae montis cineres regionem vicinam reddebant feracem."—Rasch i. 246.

†† Seleucus Nicator so named this place (previously called "Pella" by the Syro-Macedonians) after his wife Apamé, and built there a magnificent Temple to Jove, professing to be descended from him, B.C. 291.

6. Assus in Mysia. Obv. Head of Pallas helmeted, to r. Rev. A gryphon seated;* below, a tortoise. Leg. ΑΣΣ. Weight—5 dwts.

7. Athens. Obv. Head of Athené helmeted, to r. Rev. Warrior hurling a dart. Leg. ΑΘΕ.† Weight—3 dwts.

8. Athens. Obv. Head of Athené helmeted, to r. Rev. Warrior hurling a dart. Leg. ΑΘΕ. [Here the Ε stands between the Α and the Θ.] Weight—6 dwts.

9. Brutii.‡ Gr. Brettii. Obv. Head of Mars bearded and helmeted, to l. Rev. Pallas striding to r, holding a shield before her with both hands; a spear resting against the left shoulder; below the shield a tripod. Leg. ΒΡΕΤΤΙΩΝ. Weight—8 dwts.

10. Cales in Campania. Obv. Head of Pallas helmeted, to l. Rev. A cock crested and spurred;§ behind, a star. Leg. ΚΑΛΕΝΩΝ. Weight 4½ dwts.

11. Centoripa in Sicily || Obv. Head of Ceres, to r. Rev. A plough and bird.¶ In the field, one globule. Leg. ΚΕΝΤΟ. Weight—1½ dwts.

12. Cephaloedium in Sicily.** Obv. Head of Hercules bearded,

* "The Greek griffin is curiously like the Persepolitan, and both are apparently derived from the winged lion of the Assyrians, which was the emblem of the god *Nergal*, or Mars."—*Note in Rawlinson's Herodotus*, iii. 23. The story of the "gold-guarding griffins" (*vide* Herod, *loc cit.*), arose from the jealous care of the natives of the Siberian gold-regions, to prevent the intrusion of strangers.

† "In antiquissimis Atheniensium numis ΑΘΕ, pro ΑΘΗ, seu ΑΘΗΝΑΙΩΝ, atque ΘΕΒΗ pro ΘΗΒΗ, et in monetis Cretensis urbis Phaesti ΘΕΣΕΥΣ pro ΘΗΣΕΥΣ invenimus"—Rasche, iii. 495.

‡ "Populus in extremo Italiae angulo multas et præclaras urbes complexus, *quae ingente numero et rara elegantia numos dedere.*"—*Eckhel, i. 166.*

§ "Rationem sociati cum Pallade galli adfert Pausanias. Nam cum videret, gallum Minervae cassidi in ejus simulacro insidere, istud factum adfirmat, quod haec avis omnium est pugnacissima."—Eckhel, i. 101.

|| Centoripa (neut. plur.) and Centuripae. Κεντουρῖπαι *Ptol.* Quantity not given by Gesner in his Onomasticon; nor by Drisler, in his Ed. of Liddell and Scott. The modern name is Centorbe.

¶ "Cicero describes the Centuripini as *summi aratores*, and as farming largely in every part of Sicily."—Leake, *Numismata Hellenica, sub nom.*

** Cephaloedium is said to be derived from *cephalus*, the thunny-fish, an article of commerce in the Mediterranean. In the lines—

"Quaeque procelloso Cephaloedias ora profundo
Caeruleis horret campis pascentia cete,"

from Silius Italicus (xiv. 252), "horret" graphically describes a vast shoal of to r. Rev. Small human figure, club and quiver. Leg. ΚΕΦ. Weight—4 dwts.

13. Chalcis* in Euboea. Obv. Female head laureated, to r. Rev. An eagle with a kid in its talons. Weight—4 dwts.

14. Gela† in Sicily. Obv. A youthful head filleted, to r. Rev. A bull butting, to l. In exergue, three globules.‡ Weight—2 dwts.

15. Leucas in Acarnania. Obv. Head of Hercules, to r. Rev. An armed rostrum. In field .... Leg. .... Weight—3 dwts.

16. Messana. Obv. Head of Apollo laureated, to r. Rev Warrior with spear and shield, seated on rocks. Leg. ΜΑΜΕΡΤΙΝΩΝ.§ Weight—6½ dwts.

17. Messana.|| Obv. Veiled head, to l. Rev. Delphic tripod. Leg. ΜΕΣ. Weight—2½ dwts.

18. Pergamus in Mysia. Obv. A youthful head laureated, to r. Rev. In field ΕΡΥΦΙΛΩ ΗΡΟ ΤΟΥ .... ΠΕΡ.¶ Weight—1 dwt.

19. Rhegium. Obv. Head of Proserpine, to r. Rev. A lyre. Leg. in two lines: ΡΗΓΙΝΩΝ. A ligature of ΡΗΓ. Weight—4½ dwts.

20. Rhegium. Obv. Head of Proserpine, to r. Rev. A warrior with spear in left hand; in the r, an eagle or dove. Leg. ΡΗΓΙΝΩΝ. Weight—4¼ dwts.

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this fish as seen from an eminence on the Sicilian coast. The modern name of Cephaloedium is Cefalu.

* Situate where the bridge crossed the Euripus; now *Negroponte*, whence the whole island has its name.

† "Gela inter primores Siciliae urbes veteres fuit celeberrima."—Rasche, iii. 1338. *Terra Nuova* now stands on its site.

‡ "Globuli tres in numis Romanorum aereis quartam assis partem denotant, tres uncias valere quadrantem. Tria puncta seu globuli in Sicula moneta per aream obvii, pretium itidem vel pondus arguunt."—See Rasche, iii. 1459.

§ Messana was occupied in B.C. 270 by Mamertines, *i.e.* Mercenaries, discharged from the service of Syracuse.

|| Anciently *Dancle* and *Zancle*. In the 5th century B C., taken by emigrants from Messenia in Peloponnesus, and named the "City of the Messenii."

¶ On a coin described by Rasche (iii. 821), the orthography of the legend is different. It there reads, ΕΥΡΥΠΥΛΟΣ ΗΡΩΣ. This Eurypylus was the son of Telaphus, the founder of a colony at Pergamus. "Pausanias à Telepho ex Arcadia deductam Pergamum coloniam tradit; in cujus originis memoriam primi conditoris sui filius, Eurypylus, Telephi filius, seu Telephides, olim circa Pergamenum agrum dynasta, publico aere a Pergamenis signatus est."—Rasche, iii. 821.

21. Rhegium. Obv. Two heads to r. jugate.* Rev. A warrior leaning on a staff in left hand ; in the r. a palm branch : on the arm a dove or eagle. In field IIII. Leg. PHΓINΩN. Weight—1½ dwts.

22. Syracuse. Obv. Pallas helmeted, to l. Leg. ΣYPA. Rev. Two dolphins round a star. Weight 20½ dwts.

23. Syracuse. Obv. Head laureated, to l. Leg. .... Rev. A fulmen. Leg. ΣYPAKOΣIΩN. Weight—4½ dwts.

24. Syracuse. Obv. Head bearded and filleted, to r. Rev. A tripod with serpents below. Leg. ΣYPAKOΣIΩN. Weight—3 dwts.

25. Syracuse. Obv. Head of Pallas helmeted, to l. Leg. ΣYPAK ... Rev. A winged sea-horse.

26. Siculo-Punic. Obv. Head to r. ; the hair and beard crisped. In the field a caduceus. Rev. An augur's cap within a wreath. Weight—4¼ dwts.

27. Tauromenium in Sicily. Obv. Head of Apollo Archegetes.† Rev. A tripod. Leg. in two lines, TAYPOMENITAN.‡ Weight—7½ dwts.

28. Teanum Sidicinum.§ Obv. Female head laureated, to l. Leg. in Oscan characters RVNAET [*i.e.* TEANVR reversed.] Rev. Victory crowning a human-faced bull ; below, a star. Weight—3 dwts.

29. Panormus. Obv. A head full-faced. Rev. An archer kneeling.‖ Weight—1½ dwt.

30. Thespiae in Boeotia. Obv. Veiled head, to r. Rev. A lyre within a wreath. Leg. ΘEΣII. Weight—2 dwts.

31. Tyndaris in Sicily. Obv. Head (obliterated.) Rev. Two horsemen.¶ Leg. TYN .... PITAN.** Weight—4½ dwts.

* "Dianae forsan et fratris Apollinis sunt."—Rasche, vii. 989.

† Tauromenium was peopled from Naxus, a neighbouring colony of Chalcideans. These under Thucles, their conductor, going from Euboea, built Naxus, and the altar of Apollo Archegetes, now standing without the city, upon which the ambassadors employed to the oracles, as often as they launch from Sicily, are accustomed to offer their first sacrifice."—Thucyd. vi. 3, p. 341. Vol. ii. Hobbes' Transl.

‡ Doric for Ταυρομενίτων.

§ So called to distinguish it from another Teanum in Apulia.

‖ "Genuflexus sagittarius * * in veteri numo inter Panormitanos."—Rasche vii. 1549.

¶ The Dioscuri. "Clarum Tyndaridae sidus."—Hor. iv. 8. 31.

** Doric for Τυνδαρίτων.

32. Zacynthus (Zante). Obv. Head of Diana, to r. Rev. A quiver within a wreath. Leg. ZA. Weight—4⅓ dwts.

33. Leontini.* Obv. Lion's head, or lion-faced mask. Rev. A palm-tree with fruit. Weight—6½ dwts.

(B) MONARCHICAL.

1. Agathocles of Sicily. (Died B.C. 289.) Obv. Head of Proserpine or Artemis, to r. Leg. .... ΣΩΤΕΙΡ.... Rev. A winged fulmen. Leg. in two lines, ΑΓΑΘΟΚΛΕΟΣ ΒΑΣΙΛΕΟΣ.

2. Phintias of Agrigentum. (Lived B.C. 288.) Obv. Youthful head, to l. Rev. A boar.† Leg. ΒΑΣΙΛΕΟΣ.... Weight—4 dwts.

3. Ptolemaeus I. and Berenice. (Died B.C. 283.) Obv. Head of Ptolemaeus, to r. Rev. Head of Berenice, to r. Leg. ΒΑΣΙΛΕΟΣ ΠΤΟΛΕΜΑΙΟΥ. Weight—1 dwt.

4. Hieronymus of Syracuse. (Died B.C. 215.) Obv. Head of Hieronymus, filleted to l. Rev. A fulmen. Leg. ΒΑΣΙΛΕΟΣ ΙΕΡΟΝΥΜΟΥ.

5. Ptolemaeus IX. (B.C. 107.) Obv. Head of Ptolemaeus in Elephant-scalp, to r. Rev. An eagle standing on a fulmen. Leg. ΠΤΟΛΕΜΑΙΟΥ ΒΑΣΙΛΕΟΣ.

ON THE FAMILIES PROPERLY BELONGING TO THE FISSIROSTRAL SUBORDER OF INSESSORIAL BIRDS, AND THE REAL POSITION OF SOME WHICH HAVE BEEN REFERRED TO IT.

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

When I laid before the Institute my views respecting the family *Struthionidæ*, I stated my intention, should the opportunity be allowed me, of communicating my conclusions upon some other disputed questions relating to the arrangement of Birds, in pursuance

* In Sicily, south of Catana, five miles inland. Here, in the 5th century B.C., was born Gorgias, the celebrated statesman, orator, and sophist.

† "Apri typus non sine ratione conspicitur, quippe venationi deditus somnium vidit, exitum illi vitae repraesentans; dum scilicet aprum venatur (Phintias), sus in eum ruere, latus ejus ferire dentibus, et vulnere illato ipsum perimere visus. Non caruit somnium eventu."—Rasche vi. 1220.

of which intention I have selected my present subject. Persuaded that the group of Scansorial Birds is too well marked and important to rank only as a sub-order of Insessores, and in fact has as good a claim as Raptores to be accounted an order, I without hesitation assign to it that position; but I cannot follow Dr. George Gray in giving the same distinction to the families of *Columbidæ* and *Struthionidæ*: I have then before me six Orders of the Class AVES, one of which, the Perching-birds, called *Insessores*, exhibits the special bird type most completely, and is vastly more numerous than any of the others. In accordance with views of the classification of the animal kingdom which I have on other occasions endeavoured to explain, defend and apply, and which amount to an attempt to revive with considerable modifications the ideas of McLeay and Swainson, I place the *Insessores* in the centre, with the five other orders placed around them, and I am led to expect to find five sub-orders or great sections of *Insessores*, manifesting certain analogies with the other five orders. The sub-orders of Cuvier, founded on the beak and feet, at once invite attentive examination, and we cannot fail to observe that the *Dentirostres* represent the *Raptores*; the *Conirostres* the *Rasores*; the *Tenuirostres* the *Grallatores* [picking out food from obscure places, with an elongated, generally pointed beak, and in a manner sometimes almost suctorial], whilst the *Fissirostres* [darting at their prey whilst moving in their appropriate element] represent the *Natatores*. If, however, we should be tempted by these analogies to compare Cuvier's remaining sub-order *Syndactyli* with the *Scansores*, we are encountered by difficulties seemingly insurmountable. I was at first disposed to try the effect of this method, but the more I put it to the test, the more evident it became that it completely failed. Still, not readily abandoning principles which seemed to give such beautiful results in a great variety of instances. I returned again and again to the inquiries how the Syndactyli of Cuvier ought to be disposed of, and whether among Insessorial birds, without disturbing the other sub-orders, there really exists any group exhibiting an analogy with the order *Scansores*. These questions soon brought before me the proper limits of the sub-order *Fissirostres*, and having satisfied my own mind by a scheme which, as far as I know, is novel, I submit it to the candid judgment of my fellow-students of nature with no other desire than that it may be considered and fairly judged. It could not fail to be observed that, great as is the authority of Cuvier, and very generally as his other sub-orders have been acknowledged, his Syndactyles are far from having been received with the same favour, both because the principle upon which they are separated is different in kind from that applied in the other groups, and because there has been a strong feeling that the Syndactyle families find proper places among the other sub-orders. Cuvier's Syndactyli are the Bee-eaters (Meropidæ), the Motmots (Prionitidæ), the Kingfishers (Alcedinidæ) the Todties (Todidæ) and the Hornbills (Bucerotidæ). But there are other birds with syndactyle feet not here included (manikins, for instance), and the character is possessed less perfectly by many birds. If we take the most remarkable cases of syndactyle feet, as the Bee-eaters and the Kingfishers, and consider the effect of the structure, we find that it unfits the bird for walking on branches of trees or on the ground, and is connected with the habit of resting quietly on a branch when not on the wing, and taking prey whilst flying; hence it is a fissirostral character—not constantly, since small feeble feet with short tarsi may be equally connected with this mode of life, but sufficiently to justify the opinion entertained by so many eminent ornithologists that the families first named belong to the Fissirostral group, in which Cuvier, limiting its characters too closely as to the figure of the beak, had only placed the Swallows and Goatsuckers. The small family of Todidæ seems to be best treated as a sub-family of Kingfishers. Another family, nearly related to the Bee-eaters, which is certainly Fissirostral, though with a tendency to the Conirostres, is *Coraciadæ*, the Rollers. Setting aside, then, the Syndactyles by referring their principal families to the Fissirostres, and considering the others as disposable elsewhere, in a way that I shall explain before I conclude, our next object will be to determine the proper limits of the Fissirostral sub-order by reviewing the families which have been by good authorities referred to it. Besides all those which we have already placed in it, and rightly as I think connecting the Jacamars as a sub-family with the Kingfishers, Dr. George Gray adds the Trogons (Trogonidæ) and the Motmots (Prionitidæ). The latter are very deficient in fissirostral characters, and are apparently placed in this position from their supposed (but I think not real) relation to the Bee-eaters. I shall venture an opinion as to their real affinities as we proceed. The beautiful family of the *Trogonidæ* certainly does exhibit fissirostral characters, but they seem to be overbalanced by others of a different kind—the arched beak being finely dentated, and the feet exhibiting such an approach to the scansorial structure that many have referred the family to the order Scansores; and I believe that it expresses the fissirostral tendency in the sub-order, not yet determined, which represents the Scansores in the great order Insessores. Mr. A. R. Wallace, whose opinions on these subjects always deserve attention, adds the Humming-birds (Trochilidæ), the Puff-birds (Capitonidæ), which he agrees with most recent ornithologists in separating from the Scansorial Bucconidæ, and the Hornbills (Bucerotidæ). The Humming-birds, in their power of flight, their feeding on the wing, and their small and feeble feet, undoubtedly exhibit Fissorial characters, but the slender pointed beak, adapted for extracting food from flowers, is most strikingly Tenuirostral, and though the one family has a foot suited for moving on branches, whilst the other relies chiefly on its wings, the relationship between Promeropidæ and Trochilidæ is too close to be disturbed. Regarding Trochilidæ as expressing the Fissirostral tendency among Tenuirostres, we perhaps avoid all real difficulty. Capitonidæ had been also included among the Fissirostres by Dr. G. R. Gray, who treated them as a sub-family of Kingfishers. Mr. Wallace elevates them into a family, and I must think rightly, if we grant their separation from Bucconidæ; but I have hitherto failed to appreciate the reasons for this separation, excepting as sub-families of *Bucconidæ*—the family of Scansores which expresses the Fissirostral tendency. As to Bucerotidæ, their foot, though the two toes are partially united, is not characteristically syndactyle, the expansion of the toes beneath allowing of walking or hopping on branches, and there can hardly be said to be any other fissirostral character. I readily admit that the Hornbills have no real or close affinity with the crows, near which they have been often placed, and their relations with the Toucans, though striking, are more of analogy than immediate affinity. Their mode of life, according to Mr. Wallace's own interesting account, is far removed from that of any Fissirostral family.

Having now decided upon the families which in my judgment can be admitted as truly Fissirostral, it only remains to point out how they severally express the tendencies towards the sub-orders of Insessores, or the five other admitted orders of Birds, in the centre of which we suppose Insessores to be placed. Alcedinidæ, the Kingfishers, manifestly express the Raptorial tendency; the second, the active tendency, shows itself sometimes in arboreal, sometimes in aerial habits, and seems here to belong to the Swallows (Hirundinidæ), who have most in common with the general body of Insessorial birds. The Rollers (Coraciadæ) display Conirostral affinities, and as far as the essential nature of this group will admit, manifest the Rasorial tendency. The somewhat larger tarsi and the narrow elongated beak, prove the *Meropidæ* (Bee-eater) to look towards the Tenuirostres, and express the Grallatorial tendency. The Caprimulgidæ alone remain, which by their nocturnal habits may be known as the lowest group, and are altogether an exaggeration of whatever is most peculiar to the Fissirostres.

In the course of my examination of Fissirostral birds, I have had occasion to show the reasons which compel me to give up Cuvier's section of Syndactyli, which, indeed, has been abandoned by most recent ornithologists, and from the habits of life arising from the structure being nearly similar to those ascribed to the Fissirostres, could hardly lead to a truly natural grouping. We have now, then, five orders of birds, expressing their remarkable deviations in form and mode of life from the general type, and one much larger order of specially typical birds, in which latter we observe four sub-orders or great sections analogous with four of the other orders, but one of them, the *Scansores*, is without a representative. It surely needs no general theory on the subject to make us feel that something is wanting, and incite us to seek a fifth sub-order of Insessores, bearing a similar relation to Scansores to that which the four received sub-orders do to the other four orders. We should anticipate their possessing some common remarkable character in the beak or feet, or both, with a habit of life imitating in a lower degree that of Scansores; and we might expect to find a series of families bound together by the common characters so as to form a sub-order, though now lying neglected among the other orders of birds. I believe I am in a position to determine this unnoticed sub-order, and point out the families which should be referred to it; and I flatter myself with the hope of thus contributing something towards the improvement of ornithological classification. I name this sub-order *Serratirostres*. They have almost uniformly the margin of the beak serrated or dentated, a character belonging to the Scansorial family Ramphastidæ (Toucans); several of the families, all, indeed, excepting the analogues of the ground birds, whose feet are very peculiar, may be said to have semi-scansorial feet. They all chiefly live on trees. I will name the families thus brought together, and add a very few remarks in justification of what I propose: Musophagidæ, Coliidæ, Bucerotidæ, Prionitidæ, Trogonidæ, form the group. That the Coliidæ, Musophagidæ and Trogonidæ are nearly related to each other, and exhibit strong Scansorial tendencies, yet not sufficient to place them in the order Scansores, may perhaps be conceded. In the case of the Trogons, which have been placed with Fissirostres, the question is whether Scansorial or Fissirostral tendencies predominate, both being admitted to exist, and looking at the arched—not at all depressed—dentated beak, and the feet with the third toe turned so as to assume some appearance of the true scansorial foot, we ought, I think, to regard the Fissirostral characters of these birds as marking their place in their own circle, not as carrying them amongst the true Fissirostres. More difficulty may be felt respecting the other two families, but the agreement in the serrated beak, and generally arboreal habits, and the comparison as to the beak and mode of swallowing, of Bucerotidæ with the Scansorial Ramphastidæ, will go far towards removing difficulty, and possibly among the various stations assigned to the small but distinct family of Prionitidæ none is more probable than that here suggested. I take the fine family of Musophagidæ as the most perfect representative of the Serratirostral type. Since the birds have become better known, the idea of their having any relationship with the Rasores has been abandoned, and they certainly do not present truly Scansorial characters, though a tendency in that direction is unmistakeable. The character of the beak is by no means conirostral, unless we give a very vague extension to that division, and altogether I believe that making this family the foundation of a new sub-order will be felt to remove considerable difficulties. The family of *Coliidæ* is evidently near to Musophagidæ, though abundantly distinguished from it; and the beak, though not precisely serrated is so curiously toothed, and is used so much like a parrot's, that the representation of the Psittacidæ must be readily admitted. The Bucerotidæ occupy the next place, and their analogy with Ramphastidæ with the departure of the feet from the Scansorial tendency, whilst the curved beak, strongly serrated on its margin, and the arboreal mode of life, preserve the connection with the preceding families, may afford good reasons for their position. I cannot but think at least that the common supposition of their near relationship to Crows, and Mr. Wallace's of their belonging to the Fissirostres, will appear to most ornithologists far less tenable than what is now proposed. The Prionitidæ, which I place next, have probably been approximated to Meropidæ from a general resemblance of figure and elongation of beak, each amongst its own allies representing the Tenuirostral tendency. I have already explained my view of Trogonidæ as in some striking points approaching Musophagidæ, and having well marked the characters of our new sub-order, yet by their power of flight, their feeding on the wing, and their peculiar plumage, sufficiently showing their Fissirostral tendency.

In Mr. Wallace's valuable paper on the natural arrangement of birds, which contains his suggestions respecting the Fissirostral and Scansorial groups, he takes occasion to make an attack on the system of definite numbers in nature, to which I shall take the present opportunity of offering some reply, since, though he immediately refers to Mr. Swainson's system, his arguments, granting their sufficiency, would undoubtedly apply to all schemes which suppose definite tendencies as to number. I might, perhaps, not improperly begin by observing that definite numbers of parts in certain series of organisms being indubitable facts, and yet being fully exposed to one of Mr. Wallace's objections—setting bounds to the variety of Nature —we must receive the fact in preference to a theory, and it perhaps seems to us quite as certain a fact, that the best arrangements in Natural History always show a tendency to the recurrence of the same number of divisions of each great type which can only be accounted for by its occurrence in Nature. Mr. Wallace's first great objection to definite numbers is thus stated by himself:—"Geological investigations prove that the animals now existing in the earth are probably not one-tenth, perhaps not one-hundredth, of those which have existed; for all before the tertiary epoch were of different species and mostly of different genera, and thousands of other genera, families, and whole orders must have existed of which we are absolutely in ignorance. If therefore this regular system were true of the whole, it must be quite imperceptible in the mere fragment we have an acquaintance with. Instead of complete circles being the rule, they should scarcely ever exist; in fact the gaps left in the system by its authors do not leave room enough for all the forms that must have become extinct." Now we believe nobody supposes that if we knew the whole animal creation, past as well as present, we should find all types of structure developed to the same extent, with the same number of families and sub-families, genera and species; and setting this notion aside as altogether preposterous, what is it which is assumed by the advocates of definite number? It is just this, that under each distinct type of structure the minor divisions will all conform to one or another of a certain set of plans of development, which set of plans or tendencies will equally be found to regulate the variations of every other known type, thus indicating a general order in nature and a certain uniformity in the methods by which the most varied results are produced. Not only does the variety to be called forth under each type or sub-type remain as a subject for observation, but we soon learn that a general type of structure being given, we may have the several plans of development, which give the definite number, repeated in several different grades or degrees of development, for the number of which we know of no definite law, so as in many cases greatly to increase the number of organic forms. Now we believe it is generally agreed that all the organisms of which the remains have been recognized in the strata of the globe conform to the grand types of animal and vegetable structure now known upon the earth. It is therefore the wildest conjecture to suppose that those we do not know may exhibit altogether new and distinct general plans of structure, and as to minor differences they find their place in perfect consistency with regularity of plan. We cannot help regarding Mr. Wallace's estimate of the numbers of extinct creatures as considerably exaggerated, but whatever may be thought on this subject, we must judge of the successive extinct races by the traces of them which remain, and these as clearly indicate a definite plan in Nature, and as certainly prove the uniformity of that plan as a whole, through all periods, as could be desired by the most scrupulous weigher of evidence.

Mr. Wallace's second argument is thus stated: "This system absolutely places limits to the variety and extent of creation; for it is said that every group can only contain five sub-groups, and the number of gradations of groups is fixed. For instance, in a family there can be only five true genera, and again in each group, five sub-genera. In the *Psittacidæ*, therefore, there can be but twenty-five generic forms, and when those are all known, not only is it declared impossible to discover a new one, but it is also asserted that no other can possibly ever have existed and become extinct. This is the logical deduction from any system of definite number in Natural History, and it is one that should convince every person of the false basis on which all such systems rest." I do not know how far this reasoning may apply against Mr. Swainson's system, or some modes of stating it, but I feel very confident that it does not apply to all theories of classification implying the occurrence of definite numbers, nor specially to the view of the subject which I am myself recommending. We do not prescribe either through how many steps the subdivision of secondary types needs to be carried, nor how many grades of development a type shall admit. We lay down a general law as founded on observation that under each more general plan of structure the secondary divisions are five, each indicating development in a particular direction, or according to a particular idea, and therefore each having a certain more or less distinctly perceived analogy with the corresponding division under a different type. Such a law indicates a regular natural relation among the members of the animal kingdom, and a definite plan in the mode of adapting different creatures to their different positions; but it places no limit that we can perceive to the extent of creation, and it only opens to us some imperfect view of the means by which the union of order with variety is accomplished. Mr. Wallace takes the example of a particular family (the Parrots) to show that our system exactly fixes how many forms of Parrots can possibly exist in Nature, so that our work is merely to find them and assign to them their places; that we are masters of the limits of nature, and anything out of our scheme is inconceivable. Suppose, then, that we have a definite idea of what constitutes a member of the family of Psittacidæ. If our views be correct, the members of this family will readily fall into five sub-families, each distinctly exhibiting a certain tendency. If those demand further subdivision, the same tendencies will be again manifested within a more limited field of variation, and this will go on to any required extent, the groups next to the species being genera, or possibly sub-genera, but the number of the intermediate divisions depending on the extent and variability of the family. Would a botanist insist on as many intermediate steps in classification in the order Violaceæ as in Fabaceæ? We have here, then, ample means of disposing of numerous species, provided they all exhibit the kind of relations implied in the sub-families; but suppose even that our researches should bring to our knowledge some birds manifestly not conforming to any of the five sub-families, our law would lead us to expect that they would each still imitate one of the sub-families in its tendency of development, but must belong to a higher or lower grade of development; in either case we extend our actual knowledge of birds, without placing any limit to the variety of creation, yet with a constant sense of the relation of the new object to those previously known, and to a plan which pervades living nature. If we met with the remains of a species in deposits of as old a date as any in which birds were known to exist, we might be the less surprised if that species exhibited a lower grade of development than living species, and required to be so placed as to direct attention to that fact; but such a circumstance would cause no more difficulty under our system than under any other, and it is evident that Mr. Wallace has been reasoning from a misconception, so far at least as any system of definite numbers is at present maintained.

The law we have proposed may be well defended simply as the general expression of a sufficient number of observed facts, but its interest and value are greatly increased if we are able to trace it to a general principle, and show a connection between it and great truths respecting the structure of the animal kingdom. The living functions of animals are usually reduced under two great divisions, those of animal life which are concerned with sense and motion, and those of vegetative life which include nutrition and reproduction, and which are common to the vegetable with the animal kingdom. The development of the animal functions may be manifested by a high condition of the organs of sense, and a general perfection of the faculties as far as the character of the type will admit, or by a more special development of the motory powers with the other qualities in immediate connection with them, thus forming two distinct plans of development connected with the higher attributes of animal life. In reference to the vegetative life, we may have a higher and a lower grade—the latter being the lowest condition consistent with the type; and also a case for anomalous modes of obtaining and appropriating nourishment, usually accompanied by elongated forms and peculiar habits. These five distinct plans of development may all be worked out in connection with each different type of structure, and the effect is, that whilst the common type establishes affinity, with variations which are commonly expressed by a circular arrangement, a relationship is also perceived between each form and the corresponding mode of development of every other type, producing that complex network of relations which is recognized in nature, and showing how the most marvellous variety is consistent with harmonious order and the prevalence of fixed law. To affirm that there is no other conceivable mode of development of a type of structure than will readily come under one of the five tendencies above enumerated might be rash; but to affirm that these are really manifested, are sufficient for the purpose, and consistently explain the facts observed in the relations of organised beings, may be no more than observation will justify, and reason sanction. For myself, at least, I find such increasing satisfaction in these views of classification that I cannot but hope that as attention is directed to them their value will be perceived. It is, at least to my mind, abundantly evident that the prevalent feeling against anything of definite numbers in classification is either founded on a misunderstanding of what is proposed, or arises from a belief in the origin of species *by accident* which is unsupported by evidence, and unphilosophical in its real character.

ON THE RELATIVE DURATIONS OF THE DIFFERENT WINDS DURING RAIN OR SNOW, DERIVED FROM THE TORONTO OBSERVATIONS, IN THE YEARS 1853 TO 1859, INCLUSIVE.

BY G. T. KINGSTON, M.A.
DIRECTOR OF THE PROVINCIAL MAGNETIC OBSERVATORY, TORONTO.

The relations between rain or snow and the direction of the wind may be viewed either with reference to the winds that precede, to the winds that accompany, or to those that succeed the fall. In this paper it is proposed to consider the second of these questions only.

A comparison will be made of the relative durations of the winds, from the sixteen principal points, *throughout days* of rain or snow, including the hours in which no rain or snow fell, as well as the actual time of falling; and a similar and separate comparison will also be made of the relative durations of the winds whose occurrence was limited to the *hours* in any part of which a fall took place.

As some winds have a greater general prevalency than others, it is requisite that the absolute duration of each wind during rain should be divided by its absolute duration, with and without rain, in the same series of years. The quotients form what may be termed the *relative durations* of the several winds during rain, and constitute the proper quantities for intercomparison.

As it is probable that the lighter showers may give a greater prominence to certain winds than is their due, and may also diminish, in some degree, the preponderance of those which are properly the rainy winds, the distribution of the winds, when no regard is had to the amount of rain that fell in the day, and the distribution of the winds when the total fall in the day was equal to or exceeded half an inch, have been shewn separately.

Table I. shews the distribution of the winds among the different points of the compass *throughout days* of rain. The process employed in the computation will be understood by referring to the table itself.

Column (1) contains the absolute number of hours that each wind blew during the days in any part of which either heavy or light rain occurred during the years 1853 to 1859. Column (2) contains the duration of each wind on days wherein the rain was equal to or exceeded half an inch. Column (3) gives the absolute number of hours that each wind blew during the same seven years.*

From the quotients, which are given in column (4), we learn that of 1000 hours in which the wind blew from E.N.E. as many as 545 hours belonged to days during some part of which rain fell; but that of 1000 hours of north wind, only 248 were included in days of rain. Also from column (5), obtained in a similar manner from columns (2) and (3), it appears that of 1000 hours of wind from E.N.E., 126 hours were comprised in days on which the rain that fell was not less than half an inch, and that only 14 hours in 1000 of W.S.W. winds occurred on days wherein the rain reached that amount.

The comparative magnitudes of the numbers in column (4) are better seen by aid of the ratios which they severally bear to their arithmetic mean. These ratios, and the ratios similarly obtained from column (5), are given in columns (6) and (7).

From column (6) it appears that during days in which rain fell to a greater or less amount, the winds from N.E. through south to S.W. had a duration above or not below the average duration of all winds, and that winds from N.N.E through north to W.S.W. had a less than average duration. It is also seen that the wind of most frequent occurrence is from E.N.E., and that of least frequent occurrence from either north or N.N.W.

When the heavier rains only are taken into account, the winds whose relative durations are above the average, lie between N.E. and S.S.E.;

* The entries in these three columns are furnished from the hourly records made by Robinson's Anemometer.

the maximum continues at E.N.E., but the minimum is transferred to W.S.W. The range between the durations for the different points is also greatly increased; the E.N.E. wind being nearly nine times as frequent as the wind from W.S.W., during days of heavy rain; whereas when days of light as well as heavy rain are considered, the range is little more than 2 to 1. The progression in column (6) is determined chiefly by the rains under half an inch; for if the heavier rains be excluded by subtracting column (5) from column (4), the positions of the maximum and minimum in the resulting series of numbers remain the same as in column (6), and the winds that have a more than average duration lie, as in column (6) between N.E. through south to S.W. The predominance of the E.N.E. wind will be still less than in column (6); the ratio to the mean being only 1.41, and the range less than 2 to 1.

During the year 1857 to 1859 a record was made each day of the *hours* during any part of which rain or snow was seen to fall, or was believed to have fallen, from the best evidence that could be procured at the time when the entries were made. The want of any instrument for recording the hours in which a fall took place, precluded any more certain mode of procuring the requisite facts; but although the entries do not claim the same confidence as those made at the regular observation hours, or by aid of self-registering instruments, it is believed that they furnish very fair data for determining approximately the relative frequency of the winds that blew during the same hours with rain or snow.

The distribution of the winds among the several points of the compass during the hours in which rain fell is shewn by Table II.

Column (1) gives the number of hours during any part of which rain fell, arranged according to the direction of the wind during the same hour. Column (2) gives the corresponding numbers when rain amounting to less than half an inch in the day is excluded. Column (3) gives the total duration of each wind within the same period, namely, the years 1857 to 1859, inclusive.

The quotients arising from the division of the numbers in (1) and (2) by those in (3), and which are entered in columns (4) and (5), are measures of the frequency of rain for each wind. Thus, of 1000 hours in which the wind was from E.N.E. it rained during some part of each of 219 hours; but it rained in 39 hours only of 1000 hours of a N.W. wind.

From column (6) it appears that during hours of rain, winds between N.N.E. through east to S.S.W., with an interruption at south, have a relative duration above the average relative duration of all winds, and winds from north through west to S.W. have a duration below the same average. The wind that most frequently occurs during hours of rain is from E.N.E ; and the N.W. wind is that which is most rarely accompanied by rain.

For the heavier rains we see from column (7) that the winds whose duration is above the average are limited to the four points N.N.E. to East. The range is also greatly increased, the E.N.E. wind being 18 times as frequent as the N.W. wind; whereas when lighter rains are included, the E.N.E. wind is less than 6 times as frequent as the N.W. wind.

The increase of the ranges in Table II. as compared with those in Table I. is explained by the circumstance that westerly and northwesterly winds, though blowing seldom during the actual fall of the rain, frequently occur during some part of the days in which rain falls, particularly after the rain has ceased, and thus tend to conceal or diminish the predominance of the E.N.E. winds that is so conspicuous in Table II.

The distribution of the winds throughout days of snow is exhibited in Table III.

With the view of examining whether the distribution of the winds is affected by the magnitude of the snow storm, the method employed in computing Table I. has been applied in Table III. to the following four classes, whereof each class is taken so as to include all the higher classes:

Class I. includes every instance in which snow was recorded.

Class II. is limited to those cases wherein the snow in twenty-four hours was equal to or exceeded one inch.

Class III. is limited to falls of three inches and upwards.

Class IV. is limited to falls of six inches and upwards.

From column (6) it appears, when light falls and the heaviest snow storms are ranked together indiscriminately, that 291 hours in 1000 hours of N.E. winds, 330 hours in 1000 of west winds, and 86 hours in 1000 of south winds are included in days of snow. Also, from column (10), the winds whose duration during days of snow are above the average for all winds, lie between N.E. through north and west to

S.W., all inclusive, the duration of the other winds being below the average. The progression is double, the chief maximum being at west and the principal minimum at about south or S.S.W., with a second maximum at N.E. and a second minimum at or near N.W.

This apparent predominance in the relative frequency of west winds is due to the lighter falls of snow. By subtracting the numbers in (7) from those in (6) and taking the average of the remainders, it is found that the winds above the average lie between N.N.E. through west to S.W., all inclusive, the N.E. wind being slightly *below* the average and the west wind occurring more than twice as frequently as the N.E. wind. The progression becomes single, the maximum being at west, and the minimum about S.S.W., with a sudden drop between S.W. and S.S.W., as well as another between N.E. and E.N.E.

Comparing the four final columns of Table III. we find that the second maximum at N.E. in column (10) becomes very decidedly the principal maximum in column (11), wherein snow amounting to less than one inch in the day is excluded, and increases greatly as the storm becomes more heavy. The west wind also, which was the principal maximum when light snow was included, is now decidedly below the average, and rapidly decreases in frequency in columns (12) and (13). The north wind maintains a more than average frequency till the falls of snow are limited to those of six inches and upwards.

The progressive increase in the predominance of winds from the five points N.N.E. through east to E.S.E., in passing from Class I. to Class IV., and the diminished frequency of other winds, are made apparent by the averages of the ratios for the former five points, and for the remaining eleven points.

	AVERAGE RATIOS.			
	Class I.	Class II.	Class III.	Class IV.
Five winds from N.N.E. to E.S.E.	1.00	1.70	2.10	2.55
Eleven remaining winds, -	1.04	0.74	0.57	0.35

In Table IV. the distribution of the winds is shewn during the *hours* in any part of which snow fell.

When no distinction is made between falls of widely different amount, it is seen by column (10) that the winds from north to E.N.E. are decidedly above the average, the most prevalent wind being from N.E. For the other points of the compass the winds are mostly below the average; but there is a trace of a second maximum between W.N.W. and W.S.W.

The distribution of the winds during falls of which the amount is less than one inch, will be found by subtracting the relative durations in column (7) from those in column (6). The progression in the resulting series, omitting minor irregularities, becomes single; the maximum is decidedly between the three points W.N.W., west, and W.S.W., and the minimum is in the S.E. quadrant, the winds from N.E. being well below the average.

On comparing the four final columns in Table IV. we find that the principal maximum at N.E., in column (10), increases rapidly in the higher classes, and that the second maximum at or near west in column (10), disappears when the snow amounts to one inch. The north wind continues above the average during falls of snow equal to or exceeding one inch, but falls below the average when snow amounting to less than three inches is excluded, and is wholly absent when the storms included are only those of six inches and upwards. It appears further, by comparing Tables III. and IV., that although during some part of the day in which a snow storm of the heaviest class takes place, the wind may blow more or less from any point of the compass; during the actual fall of the snow the directions of the wind are limited to the four points N.N.E., N.E., E.N.E., and east.

The increasing frequency in the easterly group of winds from N.N.E. through east to E.S.E., *during the actual fall of snow,* as more and more of the lighter falls are excluded, and the diminishing frequency of all other winds, are shewn by the averages of the corresponding ratios, in the manner already employed with reference to Table III.

	AVERAGE RATIOS.			
	Class I.	Class II.	Class III.	Class IV.
Five winds from N.N.E. to E.S.E.	1.41	2.16	2.59	3.22
Eleven remaining winds, -	0.84	0.52	0.33	0.00

TABLE I.

Comparative duration of the several winds during days in any part of which rain fell, from observations in the years 1853 to 1859 inclusive, the falls that include heavy or light rain indiscriminately, and such as are limited to half an inch or upwards in the day being considered separately.

Direction of the wind.	Absolute duration of the several winds expressed in hours.			Relative duration of each wind during the days in which rain fell as compared with its whole duration for the seven years.		Ratios of the numbers in (4) and (5) to their respective means for all winds.	
	During days of heavy or light rain. (1)	Rain ½ inch and upwards during the day. (2)	During days with and without rain (3)	Ratios of (1) to (3). (4)	Ratios of (2) to (3). (5)	Rain generally. (6)	Rain ½ an inch and upwards. (7)
N	969	118	3908	0.248	0.030	0.72	0.64
N N E	687	107	2579	.266	.041	0.77	0.88
N E	961	171	2635	.365	.065	1.06	1.40
E N E	2142	497	3929	.545	.126	1.58	2.71
E	2375	515	4572	.519	.113	1.50	2.43
E S E	977	173	2298	.425	.075	1.23	1.61
S E	606	85	1647	.368	.052	1.07	1.12
S S E	681	102	1818	.375	.056	1.09	1.20
S	965	94	2795	.345	.034	1.00	0.73
S S W	1538	163	4021	.382	.041	1.11	0.88
S W	1421	147	4000	.355	.037	1.03	0.80
W S W	1297	62	4415	.294	.014	0.85	0.30
W	1249	73	4571	.273	.016	0.79	0.34
W N W	1157	100	4455	.260	.022	0.76	0.47
N W	1160	88	4426	.262	.020	0.76	0.43
N N W	1258	106	5061	.249	.021	0.72	0.45
Calms.	1283	115	3921	.327	.029	0.95	0.62

TABLE II.

Comparative duration of the several winds during the hours in any part of which rain fell, from observations in the years 1857 to 1859, rains generally and the falls amounting to half an inch and upwards in the day being considered separately.

Direction of the wind.	Absolute duration of the several winds expressed in hours.			Relative duration of each wind during the hours in which rain fell as compared with its whole duration for the three years.		Ratios of the numbers in (4) and (5) to their respective means for all winds.	
	Rain generally. (1)	Rain ½ inch and upwards. (2)	During hours with and without rain (3)	Ratios of (1) to (3) (4)	Ratios of (2) to (3). (5)	Rain generally. (6)	Rain ½ an inch and upwards. (7)
N	92	26	1489	0.062	0.017	0.68	0.67
N N E	118	42	770	.153	.055	1.68	2.18
N E	102	40	1022	.100	.039	1.10	1.55
E N E	471	236	2140	.219	.110	2.41	4.37
E	288	94	2192	.131	.043	1.44	1.71
E S E	116	18	876	.132	.021	1.45	0.83
S E	68	11	661	.102	.017	1.12	0.67
S S E	75	15	781	.096	.019	1.05	0.75
S	94	18	1166	.081	.015	0.89	0.60
S S W	172	31	1799	.096	.017	1.05	0.67
S W	129	37	1760	.073	.021	0.80	0.83
W S W	103	21	1945	.053	.011	0.58	0.43
W	107	17	1975	.054	.009	0.59	0.36
W N W	92	14	2044	.045	.007	0.49	0.28
N W	80	12	2027	.039	.006	0.43	0.24
N N W	115	22	2213	.052	.010	0.57	0.39
Calms.	85	16	1388	.061	.012	0.67	0.48

TABLE III.

Comparative duration of the several winds during the days in any part of which snow fell, from observations in the years 1853 to 1859, inclusive, the snow storms being arranged in four classes, according to the amount of snow, and each class being taken to include all the higher classes.

	Absolute duration of the several winds in hours.					Relative duration of each wind on days of snow as compared with its duration in all days.				Ratios of the numbers in (6) (7) (8) and (9) to their respective means for all winds.			
	Snow generally.	Snow 1 inch and upwards.	Snow 3 inches and upwards.	Snow 6 inches and upwards.	During days with and without Snow.	Ratios of (1) to (5).	Ratios of (2) to (5).	Ratios of (3) to (5).	Ratios of (4) to (5).	Snow generally.	1 inch and upwards.	3 inches and upwards.	6 inches and upwards.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
N	909	236	97	11	3908	0.233	0.060	0.025	0.003	1.21	1.15	1.18	0.83
N N E	705	294	119	19	2579	.273	.114	.046	.007	1.41	2.19	2.17	1.94
N E	766	403	190	38	2635	.291	.153	.072	.014	1.51	2.94	3.40	3.89
E N E	533	269	171	34	3929	.136	.068	.044	.009	0.70	1.31	2.08	2.50
E	526	236	128	27	4572	.115	.052	.028	.006	0.60	1.00	1.32	1.67
E S E	330	125	74	22	2298	.144	.054	.032	.010	0.75	1.04	1.51	2.78
S E	212	75	27	4	1647	.129	.046	.017	.002	0.67	0.88	0.80	0.56
S S E	165	43	12	1	1818	.091	.024	.007	.001	0.47	0.46	0.33	0.28
S	239	62	15	0	2795	.086	.022	.005	.000	0.45	0.42	0.24	0.00
S S W	350	102	14	4	4021	.087	.025	.003	.001	0.45	0.48	0.14	0 28
S W	800	147	27	7	4000	.200	.037	.007	.002	1.04	0.71	0.33	0.56
W S W	1372	161	50	10	4415	.311	.036	.011	.002	1.61	0.69	0.52	0.56
W	1509	212	56	3	4571	.330	.046	.012	.001	1.71	0.88	0.57	0.28
W N W	1161	165	45	3	4455	.261	.037	.010	.001	1.35	0.71	0.47	0.28
N W	1000	176	64	5	4426	.226	.040	.014	.001	1.17	0.77	0.66	0.28
N N W	1223	261	107	2	5061	.241	.052	.021	.000	1.25	1.00	0.99	0.00
Calms.	504	81	28	2	3921	.129	.021	.007	.001	0.67	0.40	0.33	0.28

TABLE IV.

Comparative duration of the several winds during the *hours* in any part of which snow fell, from observations in the years 1857 to 1859, inclusive, the snow storms being arranged in four classes, according to the amount of snow, and each class being taken to include all the higher classes.

	Absolute duration of the several winds expressed in hours.					Relative duration of each wind during the hours in which snow fell, as compared with its duration in all hours.				Ratios of the numbers in (6) (7) (8) and (9) to their respective means for all winds.			
	Snow generally. (1)	Snow 1 inch and upwards. (2)	Snow 3 inches and upwards. (3)	Snow 6 inches and upwards. (4)	During days with and without Snow. (5)	Ratios of (1) to (5). (6)	Ratios of (2) to (5). (7)	Ratios of (3) to (5). (8)	Ratios of (4) to (5). (9)	Snow generally. (10)	1 inch and upwards. (11)	3 inches and upwards. (12)	6 inches and upwards. (13)
N	105	43	9	0	1489	0.071	0.029	0.006	0.000	1.24	1.07	0.59	0.00
N N E	100	72	10	2	770	.130	.094	.013	.003	2.27	3.48	1.29	2.04
N E	143	117	60	11	1022	.140	.114	.059	.011	2.45	4.22	5.84	7.48
E N E	139	89	64	14	2149	.065	.041	.030	.007	1.14	1.52	2.97	4.76
E	82	58	34	8	2192	.037	.026	.016	.003	0.65	0.96	1.58	2.04
E S E	28	15	11	0	876	.032	.017	.013	.000	0.56	0.63	1.29	.00
S E	31	14	2	0	661	.047	.021	.003	.000	0.82	0.78	0.29	.00
S S E	36	9	4	0	781	.046	.012	.005	.000	0.80	0.44	0.49	.00
S	21	7	3	0	1166	.018	.006	.003	.000	0.32	0.22	0.29	.00
S S W	49	20	7	0	1799	.027	.011	.004	.000	0.47	0.41	0.39	.00
S W	85	26	5	0	1760	.048	.015	.003	.000	0.84	0.56	0.29	.00
W S W	113	19	6	0	1945	.058	.010	.003	.000	1·01	0.37	0.29	.00
W	110	16	5	0	1975	.056	.008	.003	.000	0.98	0.30	0.29	.00
W N W	125	21	2	0	2044	.061	.010	.001	.000	1.07	0.37	0.10	.00
N W	91	25	2	0	2027	.045	.012	.001	.000	0.79	0.44	0.10	.00
N N W	125	47	10	0	2213	.056	.021	.005	.000	0.98	0.78	0.49	.00
Calms.	48	13	6	1	1388	.035	.010	.004	.001	0.61	0.37	0.39	0.68

NOTE ON TRILINEARS.

1. *The property of transversals.*

With the usual notation, let the sides c, a, b of the triangle of reference ABC, taken in order, be divided by the points F, D, E, respectively in the ratios $p:q$, $q:r$, $r:p$. Then the equations to the lines CF, AD, BE respectively are

$$\begin{aligned} pa\alpha - qb\beta &= 0, \\ qb\beta - rc\gamma &= 0, \\ rc\gamma - pa\alpha &= 0, \end{aligned}$$

and the three lines meet in the point

$$pa\alpha = qb\beta = rc\gamma.$$

Again, the equations to the lines DE, EF, FD are

$$\begin{aligned} pa\alpha + qb\beta - rc\gamma &= 0, \\ qb\beta + rc\gamma - pa\alpha &= 0, \\ rc\gamma + pa\alpha - qb\beta &= 0, \end{aligned}$$

and if these lines be produced to meet each the remaining side of the triangle, the three points of section lie in the line

$$pa\alpha + qb\beta + rc\gamma = 0.$$

Also, the equations to the lines joining these points of section each to the remaining vertex of the triangle, are

$$\begin{aligned} pa\alpha + qb\beta &= 0, \\ qb\beta + rc\gamma &= 0, \\ rc\gamma + pa\alpha &= 0, \end{aligned}$$

and these with the sides of the triangle and the three first-mentioned lines form harmonic pencils at the vertexes of the triangle.

Cor. 1. This includes the following well-known cases:

(1) If $p=1$, $q=1$, $r=1$, we have the bisecters of the sides.

(2) If $p=b\cos A$, &c, we have the perpendiculars from the angles on the sides.

(3) If $p=b$, $q=c$, $r=a$, we have the bisecters of the angles.

(4) If $p=\cot\frac{A}{2}$, &c, we have the lines from the angles to the points of contact of the inscribed circle.

COR. 2. The case of a dividing point lying in a side produced is included by making the ratio negative.

2. *The equations to a line.*

Let (α, β, γ) be the coordinates of some arbitrary point in the line, $(\alpha', \beta', \gamma')$ current coordinates; r the distance between these points: then we have

$$\frac{\alpha'-\alpha}{l} = \frac{\beta'-\beta}{m} = \frac{\gamma'-\gamma}{n} = r,$$

where l, m, n, are constants connected by the relation

$$al + bm + cn = 0.$$

This is obvious, because the numerators of the above ratios are the projections of r on lines perpendicular to the sides of the triangle. Also since

$$a\alpha' + b\beta' + c\gamma' = 2 \text{ Area of triangle},$$
$$a\alpha + b\beta + c\gamma = \text{same},$$

it follows that

$$a(\alpha'-\alpha) + b(\beta'-\beta) + c(\gamma'-\gamma) = 0,$$

and therefore

$$al + bm + cn = 0.$$

Hence also the equations to a line which passes through two points (α, β, γ), $(\alpha_1, \beta_1, \gamma_1)$, are

$$\frac{\alpha'-\alpha}{\alpha-\alpha_1} = \frac{\beta'-\beta}{\beta-\beta_1} = \frac{\gamma'-\gamma}{\gamma-\gamma_1}.$$

3. *The tangent to a conic.*

Let $\phi(\alpha, \beta, \gamma) = 0$, be the general equation to the conic, ϕ being homogeneous and of the second order. The tangent to this at the point (α, β, γ) being the line through the points (α, β, γ) and $(\alpha + d\alpha, \beta + d\beta, \gamma + d\gamma)$, its equations will be

$$\frac{\alpha'-\alpha}{d\alpha} = \frac{\beta'-\beta}{d\beta} = \frac{\gamma'-\gamma}{d\gamma}.$$

But, from the equation to the curve,

$$\frac{d\phi}{d\alpha}\cdot d\alpha + \frac{d\phi}{d\beta}\cdot d\beta + \frac{d\phi}{d\gamma}\cdot d\gamma = 0,$$

therefore the equation to the tangent becomes

$$(\alpha'-\alpha)\frac{d\phi}{d\alpha} + (\beta'-\beta)\frac{d\phi}{d\beta} + (\gamma'-\gamma)\frac{d\phi}{d\gamma} = 0,$$

and since, by the property of homogeneous functions,

$$\alpha \frac{d\phi}{d\alpha} + \beta \frac{d\phi}{d\beta} + \gamma \frac{d\phi}{d\gamma} = 0,$$

the equation finally reduces to

$$\alpha' \frac{d\phi}{d\alpha} + \beta' \frac{d\phi}{d\beta} + \gamma' \frac{d\phi}{d\gamma} = 0.$$

4. *The polar of a point.*

Let (α, β, γ) be the point; $(\alpha_1, \beta_1, \gamma_1)$, $(\alpha_2, \beta_2, \gamma_2)$ the points of contact of the two (real or imaginary) tangents drawn from it to the conic.

The equations to these tangents are

$$\alpha' \frac{d\phi}{d\alpha_1} + \beta' \frac{d\phi}{d\beta_1} + \gamma' \frac{d\phi}{d\gamma_1} = 0,$$

$$\alpha' \frac{d\phi}{d\alpha_2} + \beta' \frac{d\phi}{d\beta_2} + \gamma' \frac{d\phi}{d\gamma_2} = 0,$$

and since (α, β, γ) lies in each of these, we have the relations,

$$\alpha \frac{d\phi}{d\alpha_1} + \beta \frac{d\phi}{d\beta_1} + \gamma \frac{d\phi}{d\gamma_1} = 0,$$

$$\alpha \frac{d\phi}{d\alpha_2} + \beta \frac{d\phi}{d\beta_2} + \gamma \frac{d\phi}{d\gamma_2} = 0,$$

and these, by the property of homogeneous functions, are equivalent to

$$\alpha_1 \frac{d\phi}{d\alpha} + \beta_1 \frac{d\phi}{d\beta} + \gamma_1 \frac{d\phi}{d\gamma} = 0,$$

$$\alpha_2 \frac{d\phi}{d\alpha} + \beta_2 \frac{d\phi}{d\beta} + \gamma_2 \frac{d\phi}{d\gamma} = 0,$$

and the points $(\alpha_1, \beta_1, \gamma_1)$, $(\alpha_2, \beta_2, \gamma_2)$ therefore lie in the line

$$\alpha' \frac{d\phi}{d\alpha} + \beta' \frac{d\phi}{d\beta} + \gamma' \frac{d\phi}{d\gamma} = 0,$$

which is therefore the equation to the polar of (α, β, γ).

Cor. Since the centre is the pole of the line at infinity, the equation

$$\alpha' \frac{d\phi}{d\alpha} + \beta' \frac{d\phi}{d\beta} + \gamma' \frac{d\phi}{d\gamma} = 0$$

will, when the centre is pole, be identical with

$$a\alpha' + b\beta' + c\gamma' = 0,$$

and therefore

$$\frac{1}{a}\frac{d\phi}{d\alpha} = \frac{1}{b}\frac{d\phi}{d\beta} = \frac{1}{c}\frac{d\phi}{d\gamma}$$

determine the coordinates of the centre.

This result may be obtained independently as follows:

4. *The centre of a conic.*

Let the conic $\phi(\alpha, \beta, \gamma) = 0$ be cut by the line

$$\frac{\alpha'-\alpha}{l} = \frac{\beta'-\beta}{m} = \frac{\gamma'-\gamma}{n} = r.$$

Then for the points of section

$$\phi(\alpha, \beta, \gamma) + \left(l\frac{d\phi}{d\alpha} + m\frac{d\phi}{d\beta} + n\frac{d\phi}{d\gamma}\right) r + Rr^2 = 0,$$

and, if l

$$\frac{d\phi}{d\alpha} + m\frac{d\phi}{d\beta} + n\frac{d\phi}{d\gamma} = 0,$$

the two values of r are equal and opposite, and the point (α, β, γ) is the centre of the chord. If then the above condition be satisfied for *all* values of l, m, n, consistently with the condition

$$al + bm + cn = 0,$$

all the chords through (α, β, γ) are bisected by it, and (α, β, γ) is the centre. Comparing the two conditions, we have

$$\frac{1}{a}\frac{d\phi}{d\alpha} = \frac{1}{b}\frac{d\phi}{d\beta} = \frac{1}{c}\frac{d\phi}{d\gamma}$$

for determining the centre.

Cor. If the conic be such that the triangle of reference is self-conjugate with regard to it, its equation is

$$u\alpha^2 + v\beta^2 + w\gamma^2 = 0,$$

and the centre is given by

$$\frac{u}{a}\alpha = \frac{v}{b}\beta = \frac{w}{c}\gamma.$$

If the conic be a circle, then

$$\frac{u}{a\cos A} = \frac{v}{b\cos B} = \frac{w}{c\cos C},$$

and the centre is given by

$$\alpha \cos A = \beta \cos B = \gamma \cos C,$$

that is, it is the intersection of the perpendiculars from the angles on the sides of the triangle.

If the conic be an equilateral hyperbola, then

$$u + v + w = 0,$$

and the coordinates of the centre satisfy the condition

$$\frac{a}{\alpha} + \frac{b}{\beta} + \frac{c}{\gamma} = 0;$$

that is, the locus of the centre is the circumscribing circle of the triangle.

Univ. Coll. J. B. C.
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OBSERVATIONS ON SUPPOSED GLACIAL DRIFT IN THE LABRADOR PENINSULA, WESTERN CANADA, AND ON THE SOUTH BRANCH OF THE SASKATCHEWAN.

BY HENRY YOULE HIND, ESQ., M.A., F.R.G.S.,
PROFESSOR OF GEOLOGY IN TRINITY COLLEGE, TORONTO.

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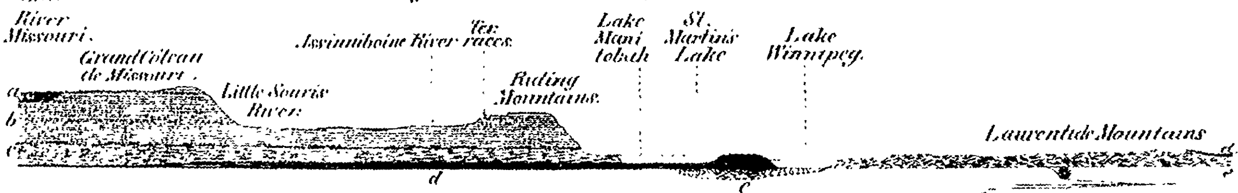
7. Conclusion.

§ 1. *The Boulders on the flanks of the Table-land of the Labrador Peninsula.*

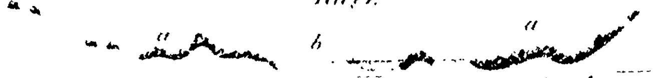
During an exploration of a part of the interior of the Labrador Peninsula in 1861, I had an opportunity of observing the extraordinary number, magnitude, and distribution of the erratics in the valley of the Moisie River and some of its tributaries, as far north as the

Profile of country from Lake Winnipeg to the Grand Côteau de Missouri.



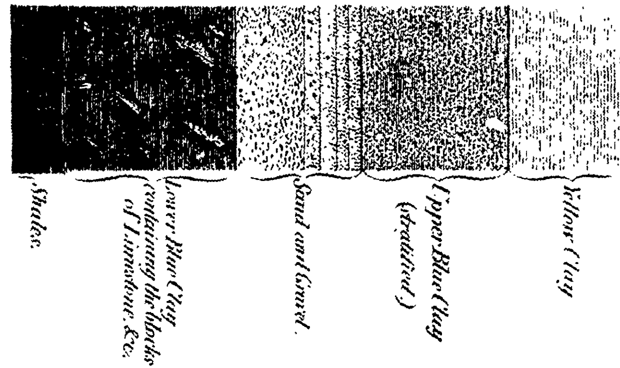
a Tertiary.
b Cretaceous.
c Devonian.
d Silurian.
c Laurentian
* Niagara escarpment, 600 to 1400 ft. above the sea level.

Section of the Valley of the East Branch of the Moisie, in the Burnt Country (3 miles.)

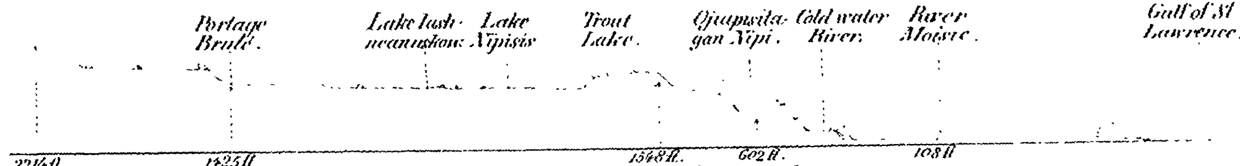


a Boulders of Gneiss and Labradorite.
b Coarse sand.

Section showing the forced arrangement of Blocks of Limestone &c. in Boulder-Clay.



Section of the Canoe-route from the Portage Brulé to the Gulf of St. Lawrence.



Vertical scale five times the horizontal.

south edge of the table-land of the Labrador Peninsula (lat. 51° 50′ N., long. 66° W.), and about 110 miles due north of the Gulf of St. Lawrence. Boulders of large dimensions, 10 to 20 feet in diameter, began to be numerous at the Mountain Portage, 1460 feet above the sea, and 60 miles in an air-line from the mouth of the Moisie River. They were perched upon the summits of peaks estimated to be 1500 feet above the point of view, or nearly 3000 feet above the sea-level, and were observed to occupy the edges of cliffs, to be scattered over the slopes of mountain-ranges, and to be massed in great numbers in the intervening valleys.

At the "Burnt Portage" on the north-east branch of the Moisie, nearly 100 miles in an air-line from the Gulf of St. Lawrence, and 1850 feet above the ocean, the low gneissoid hills for many miles round were seen to be strewed with erratics wherever a lodgment for them could be found. The valleys (one to two miles broad) were not only floored with them, but they lay there in tiers, three or more deep. Close to the banks of the rivers and lakes near the "Burnt Portage," where the mosses and lichens have been destroyed by fire, very coarse sand conceals the rocks beneath, but on ascending an eminence away from the immediate banks of the river the true character of the country becomes apparent. At the base of the gneissoid hills which limit the valley of the east branch (about three miles broad) at this point, they are observed to lie two or three deep, and although of large dimensions, that is from 5 to 20 feet in diameter, they are nearly all ice or water-worn, with rounded edges, and generally polished or smoothed. These accumulations of erratics frequently form tongues, or spots, at the termination of small projecting promontories in the hill-ranges. I have several times counted three tiers of these travelled rocks where the mosses, which once covered them with a uniform mantle of green, had been burnt; and occasionally, before reaching the sandy area which is sometimes found on the banks of the river, I have been in danger of slipping through the crevices between the boulders, which were concealed by mosses, a foot and more deep, both before and after passing through the "Burnt Country," which has a length of about 30 miles where I crossed it. I extract the following note from my journal of the appearance of these travelled rocks in the "Burnt Country":—

"Huge blocks of gneiss and labradorite lie in the channel of the river, or on the gneissoid domes which here and there pierce the sandy tract through which the river flows. On the summit of the mountains, and along the crest of the hill-ranges, about a mile off on either side, they seem as if they had been dropped like hail. It is not difficult to see that many of these rock-fragments are of local origin, but others have evidently travelled far, on account of their smooth outline. From a gneissoid dome, I see that they are piled to a considerable height between hills 300 and 400 feet high; and from the comparatively sharp edges of many around me, the parent rock cannot be far distant."

On all sides of Cariboo Lake, 110 miles in an air-line from the Gulf, and 1870 feet above it, a conflagration had swept away trees, grasses, and mosses, with the exception of a point of forest which came down to the water's edge and formed the western limit of the living woods. The long lines of enormous unworn boulders, or fragments of rocks, skirting the east branch of the Moisie at this point were no doubt lateral glacial moraines. The coarse sand in the broad valley of the river was blown into low dunes, and the surrounding hills were covered with millions of erratics. No glacial striæ were observed here, but the gneissoid hills were rounded and smoothed at their summit; and the flanks were frequently seen to present a rough surface, as if they had been recently exposed by land-slides, which were frequently observed, and the cause which produced them, namely, frozen waterfalls.

No clay or gravel was seen after passing the mouth of Cold-water River, 40 miles from the Gulf, and 320 feet above it. The soil, where trees grew, was always shallow as far as observed; and although a very luxuriant vegetation existed in secluded valleys, yet it appeared to depend upon the presence of labradorite-rock or a very coarse gneissoid rock, in which flesh-coloured felspar was the prevailing ingredient.

Observers in other parts of the Labrador Peninsula have recorded the vast profusion in which erratics are distributed over its surface. There is one observer, however, well known in another branch of science, who has left a most interesting record of his journey in the Mistassinni country, between the St. Lawrence, at the mouth of the Saguenay and Rupert's River, in Hudson's Bay. André Michaux, the distinguished botanist, traversed the country between the St. Lawrence and Hudson's Bay in 1792. He passed through Lake Mistassinni; and in his manuscript notes, which were first printed in 1861, for private circulation, at Quebec, a brief description of the journey is given. "The whole Mistassinni country," says Michaux, "is cut up by thousands of lakes, and covered with enormous rocks, piled one on the top of the other, which are often carpeted with large lichens of a black colour, and which increase the sombre aspect of these desert and almost uninhabitable regions. It is in the spaces between the rocks that one finds a few pines (*Pinus rupestris*), which attain an altitude of three feet; and even at this small height showed signs of decay."

The remarkable absence of erratics in the Moisie, until an altitude of about 1000 feet above the sea is attained, may be explained by the supposition that they may have been carried away by icebergs and coast-ice during a period of submergence, to the extent of about 1000 feet. I am not aware that any traces of marine Shells or marine drift have been recognized, north of the Labrador Peninsula, at a greater elevation than 1000 or 1100 feet. In the valley of the St. Lawrence marine drift has not been observed higher than 600 feet above the sea. Glacial striæ were seen on the "gneiss-terraces" at the "Level Portage," 700 to 1000 feet above the sea. The sloping sides of these terraces are polished and furrowed by glacial action. Grooves half an inch deep, and an inch or more broad, go down slope and over level continuously. It is on the edge of the highest terrace here that the first large boulders were observed.

The entire absence of clay, and the extraordinary profusion of both worn and rugged masses of rock piled one above the other in the valley of the east branch of the Moisie (fig. 1), as we approach the table-land, lead me to attribute their origin to local glacial action, as well as the excavation of a large part of the great valley in which the river flows. Its tributary, the Cold-water River, flows in the strike of the rocks through a gorge 2000 feet deep, excavated in the comparatively soft labradorite of the Labrador series.*

The descriptions which have recently been published† of different parts of the Labrador Peninsula not visited by me, favour the supposition that the origin of the surface-features of the areas described

* See Sir William Logan's 'Geology of Canada' (1863), on the Division of the Laurentian Rocks into "two formations":

1st. The Labrador series.

2nd. The Laurentian.

The Labrador series, I have been recently informed by Sir William Logan, has been ascertained by him to rest unconformably upon the older Laurentian, and will be distinguished by a separate colour on his new Map of Canada. See also Mr. Sterry Hunt on the Chemistry of Metamorphic Rocks.

† See my 'Explorations in the Interior of the Labrador Peninsula.' Longmans, 1863.

may be due to glacial action, similar to that observed in the valley of the Moisie River.

§ 2. *The Forced Arrangement of Blocks of Limestone, &c., in Boulder-Clay.*

The forced arrangement of blocks of limestone, slabs of shale, and boulders of the Laurentian rocks, in the Blue Clay at Toronto, formed the subject of a paper which I read before the Canadian Institute seven years ago. A minute description of this arrangement was published in my Report of the Assinniboine and Saskatchewan Exploring Expedition in 1859,* to illustrate a similar arrangement of blocks of limestone and gneissoid rocks in the clay on the south branch of the Saskatchewan observed in 1858.

I concluded the description of this remarkable arrangement with the following hint at their origin :—" May not the plastic and irresistible agent which picked up the materials composing the Blue Clay, and then melting, left them in their present position, have been largely instrumental in excavating the basins of the great Canadian lakes ? "†

And, in 1860, in a ' Narrative of the Canadian Expeditions," I remarked, "The widespread phenomena exhibiting the greater or less action of ice, such as grooved, polished, and embossed rocks, *the excavation of the deep lakes of the St. Lawrence basin*, the forced arrangement of drift, the ploughing-up of large areas, and the extraordinary amount of denudation *at different levels*, without the evidence of beaches, all point to the action of glacial ice previous to the operations of floating ice in the grand phenomena of the Drift."‡

§ 3. *The Driftless Area in Wisconsin.*

In a recent Report on the Geological Survey of the State of Wisconsin, by the distinguished American geologists, Professors James Hall and J. D. Whitney, the remarkable view is advanced by the latter, that there is an area of more than 3000 square miles in extent (long. 90° W., lat. 42° 50' N.) which has never been overflowed since the Upper Silurian epoch. Mr. Whitney says‡, "If we consider the magnitude and universality of the drift-deposits in

* Report on the Assinniboine and Saskatchewan Exploring Expedition. By Henry Youle Hind, M.A. Toronto, 1859. Eyre and Spottiswoode, London, 1860 (Blue Books.)

† *Op. cit.* (Toronto), p. 122.

‡ Narrative of the Canadian Expeditions of 1847 and 1858, vol. ii. p. 254. Longman's 1860.

the Northern United States, and especially in Northern Wisconsin, we shall be the more astonished to learn that throughout nearly the whole Lead-region, and over a considerable extent of territory to the north of it, no trace of transported materials, boulders, or drift can be found; and what is more curious, to the east, south, and west, the limit of the productive Lead-region is almost exactly the limit of the area thus marked by the absence of Drift."

The conclusions to which Mr. Whitney has been led by the study of this driftless region are briefly as follow :—

1. That since the Upper Silurian period this portion of Wisconsin has not been submerged, and that its surface has, consequently, never been covered by Drift.

2. That the denudation it has undergone has been effected by the simple agency of rain and frost.

3. That a large portion of the superficial detritus of the West must have had its origin in the subaërial destruction of the rocks, the soluble portion of them having been gradually removed by the percolating water.

4. The entire absence of terraces indicates that the region in question has not been submerged in recent times. No organic remains other than those belonging to palæozoic times, except those of land animals and plants, have been found in the Lead-region.

On the railway between Milwaukie (Lake Michigan) and Prairie du Chien on the Mississippi, there is no point which rises higher than 950 feet above the sea-level; and the towns of Galena, Menomonee, and Dunlieth, in the Lead-region, are below the level of Lake Michigan.

§ 4. *Beaches and Terraces.*

In connexion with this driftless area, the beaches and terraces which form so distinguishing a feature in North America acquire particular interest.

Confining myself to those terraces which have come under my own observation, I shall notice first the vast bank of sand, 55 miles west of Lake Superior, commonly called the Great Dog Portage.* The altitude of the summit of this terrace is 835 feet above Lake Superior, more than 800 feet above Lake Michigan, and 1435 feet above the sea.

* For a description of the Great Dog Portage, see 'Narrative of Canadian Exploring Expeditions of 1857 and 1858.' Also Reports on the North-west Territory, 1859. By the Author.

One hundred and twenty miles west of Lake Winnipeg the successive steps or terraces of the Riding and Duck Mountains rise in well-defined succession on the south and south-western slopes; but on the north-east and north sides they present a precipitous escarpment more than 900 feet in altitude, or 1000 feet above Lake Winnipeg, or 1600 feet above the sea; while Lake Traverse, which sends water during floods to the Red River of the north as well as to the Mississippi, is only 966 feet above the same level; and from 10 to 15 miles west of Lake Traverse and Big Stone Lake (966 feet above the sea) is the abrupt escarpment of the Côteaux des Prairies, whose summit is 1000 feet above them.

Illustrations of a precipitous escarpment on one face, with gentle sloping plateaux separated by terraces on the other side, might be greatly multiplied; they are indeed the common feature in the scenery of the basin of Lake Winnipeg, west of that lake; and, with a single known exception, mentioned by Dr. Hector*, the precipitous escarpment faces the north-east or the north, and the terraces and plateaux the south or south-west. This feature is also observed in all the outliers in the great prairies and plains of the basin of Lake Winnipeg. The terraces of Lake Superior and the escarpments, with their corresponding terraces in the Lake Winnipeg basin, considered in relation to the driftless area in Wisconsin, point to the former existence of great glacial lakes, as suggested by Mr. Jamieson to explain the origin of the Parallel Roads of Glen Roy. The clean-swept floor of the level country at the foot of the great escarpment of the Riding, Duck, and Porcupine Mountains, in which Lake Winnipeg and its associated lakes lie, indicates the boundary of a vast glacier, which excavated their basins and left its dirt-beds on the prairie country even as far as the south branch of the Saskatchewan, where I observed the forced arrangement of slabs in *unstratified clay* in 1858.

§ 5. *Anchor-ice—Excavation of Lake-basins.*

It has been frequently stated that a difficulty arises as to the *modus operandi* by which a moving glacier can excavate lake-basins. May not the manner in which stratified rocks, at least, over which a glacier may be moving, be involved in its mass in the form of slabs or mud, constituting dirt-beds, be partially explained by the phenomena attending the formation of 'anchor-ice'? It is no

* The Cyprès Hills. Quart. Journ. Geol. Soc. vol. xvii. p. 399.

uncommon occurrence for the anchors of the nets of a "seal-fishery" on the north shore of the Gulf of St. Lawrence to be frozen to the bottom at the depth of from 30 to 60 feet; and when anchors are then raised, they bring with them frozen masses of sand. But it is in rapid rivers that the formation of anchor-ice is most remarkable, and most effective in excavating these beds. It forms on the beds of rivers above the head of a rapid, and frequently bursts up with a load of frozen mud or shingle, or slabs of rock, which it has torn from the bottom. This phenomenon is witnessed every winter in the valley of the St. Lawrence, but it is best observed after a prolonged term of cold, when the thermometer indicates a temperature considerably below zero. Anchor-ice has only been observed, as far as my knowledge of the subject goes, in rapid currents in open water; and the sudden and apparently inexplicable rise of the St. Lawrence during extreme cold is most probably due to this cause.* It is not difficult to see how the rivers issuing from beneath the precipitous walls of glaciers, as described by Dr. Rink, may rapidly excavate deep channels by means of anchor-ice, to be widened by the subsequent operations of the glacier itself. Nor is it improbable that by this means a glacier in very cold climates may increase from the bottom upwards with a load of frozen mud and fragments of rock, particularly near its base, when that does not meet the open sea. The great lakes of North America, including Lake Winnipeg, are excavated on the edges of the fossiliferous rock-basins; and these lakes may represent the boundary of a glacial mass similar to that which now covers Greenland.

§ 6. *Parallelism of Escarpments in America.*

In 1860† I described the remarkable parallelism which exists between great escarpments in America north of the 40th parallel of latitude.

1st. The Niagara escarpment.

2nd. The Riding, Duck, and Porcupine Hill escarpment, west of Lake Winnipeg.

3rd. The escarpment of the Grand Côteau de Missouri.

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* See "Notes on Anchor-ice," by C. T. Keefer, C E, Canadian Journal, New Series, vol. vii. p. 173 (1862)

† See my 'Narrative of the Canadian Exploring Expeditions of 1857 and 1858,' vol. ii. p. 266, for a notice of these escarpments.

These are all roughly parallel to one another, and are many hundred miles in length. The lowest, the Niagara, varies from 600 feet to 1300 feet above the sea; the second, west of Lake Winnipeg, from 1600 feet to 2000; the third, the Grand Côteau de Missouri, from 2000 to 3000 feet and more above the ocean (see fig. 3.) They have all easterly, north-easterly, or northerly aspects, in relatively different parts of their lengths,* and appear to have a common origin. If it can be shown conclusively, as Mr. Whitney believes, that the driftless area in Wisconsin has never been overflowed, these escarpments, as well as those of their great outliers in the "far West," can only be due to the same agent which excavated the basins of the great American lakes.

The symmetrical escarpments of the Grand Côteau de Missouri, the Riding Mountain and its prolongations, and portions of the Niagara escarpments, are probably the result, to a large extent, of the action of glacial rivers undermining and washing away the soft strata of the sedimentary rocks, and excavating *in advance* of the glacial mass itself; and they represent different and closely succeeding glacial periods (the Missouri escarpment being older than that of the Riding Mountain), with, however, a distinct geological interval between them. The close proximity of the isothermal curves in these latitudes to the general direction of the escarpments of the Grand Côteau and Riding Mountain is a very interesting and important feature in connexion with the cause which produced them.

§ 7. *Conclusion.*

The opinion that many of the phenomena attending the surface-geology of a large portion of North America were caused by glacial ice, appears to be gradually gaining ground among American geologists. First enunciated by Professor Louis Agassiz,† it received the sanction, wholly or in part, of some well-known geologists. In a recent paper by Dr. Newberry, it is stated that "in this 'glacial epoch' all the Lake-country was covered with ice, by which the rocky surface was planed down and furrowed, and left precisely in the condition of that beneath modern moving glaciers in mountain-valleys"‡.

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* The western exception at Cyprès Hills has been already noticed. Here the flanks of the Rocky Mountains are approached.

† Lake Superior: its Physical Character, Vegetation, and Animals, &c. 1850.

‡ Notes on the Surface-geology of the Basin of the Great Lakes.

Dana considers "the glacial theory the most satisfactory, but the iceberg-theory required, in some cases, for the borders of continents."*

Sir William Logan, when speaking of the innumerable lakes scattered over the Laurentian region of Canada, says, in his 'Geology of Canada,' just published, "The rock which is most characteristic of the depressions is the comparatively soft crystalline limestones of the series; and it appears probable that one of the main erosive forces has been *glacial action*."

Also, with reference to the great Lake-basins, he says, "These great Lake-basins are depressions, not of geological structure, but of denudation; and the grooves on the surfaces of the rocks, which descend under the water, appear to point to glacial action as one of the great causes which have produced these depressions."†

I have great satisfaction in observing that the views which I published in 1859,‡ respecting the origin of the great American lakes and other glacial phenomena in North America, are continually receiving additional support from various sources; and I venture to think that it is not unreasonable to suppose that we shall find in North America the parallel of that widespread work of ancient glaciers in Europe, which has been so ably described before the Society by its distinguished President, Professor Ramsay.

PALÆONTOLOGY.

(*Translated from the Comptes Rendus, Feb.* 29, 1864.)

Upon some new Observations of Messrs. Lartet and Christy, relative to the existence of Man in the centre of France, at a period when that country was inhabited by the Reindeer and other animals, which do not live there at the present day.

BY M. MILNE EDWARDS.

THE interest which surrounds all facts calculated to enlighten us upon the characteristics of the Gallic Fauna at the period when man

* Dana's 'Manual of Geology,' 1863, p. 546.
† Geological Survey of Canada, 1863, page 889.
‡ See Reports of the Assinniboine and Saskatchewan Expedition. In 1855 I read a paper before the Canadian Institute, Toronto, "On the Origin of the Basins of the Great Lakes, advocating the view that they had been excavated by means of ice.

began to inhabit this part of Europe, has made me resolve to submit, for the inspection of the Academy, some of the specimens recently discovered by Messrs. Lartet and Christy, in one of the numerous ossiferous caverns of the centre of France. These objects are remarkable for more than one reason; and to exemplify their importance, I cannot do better than present here a letter, which has just been addressed to me by the former of these able and zealous explorers:

Sir,—In support of the remarks which you have communicated at one of the late sittings of the Academy, on the subject of animal figures carved on bone, and found in the cavern of Bruniquel, I come in my own name and also in that of Mr. H. Christy, a member of the London Geological Society, to cite to you many other facts of the same nature. For the present we shall confine ourselves wholly to mentioning the discoveries we made during the five last months of the year 1863, in that part of ancient Périgord which now constitutes the district of Sarlat.

One of the grottoes of that region—that of Eyzies, in the parish of Tayac—has exhibited to us in a conglomerate covering the soil like one continuous floor, an amalgam of broken bones, cinders, fragments of charcoal, and splinters and laminæ of flint cut upon different plans, but invariably in definite and oft-repeated forms, accompanied by other utensils and arms worked in the bones or horns of the reindeer. The whole of this must have been taken up and solidified into a conglomerate in the original condition of deposit, and before any geological change, because series of many vertebrae of the reindeer and assemblages of joints in multiple pieces are found remaining in their exact anatomical connections; the long and hollow marrow-bones are alone detached, and split or broken according to a uniform plan, that is to say, evidently with the intention of thence extracting the marrow. This proposition of ours can, moreover, be confirmed by all competent observers, for we were careful to have this conglomerate extracted in large plates, and after having deposited the finest specimens in the Museum of Périgueux and in the collection of the Jardin des Plantes at Paris, we have addressed to different French and foreign museums, blocks of sufficient size to enable any one to verify the exactness of the observations which we here record.

This grotto of Eyzies, the mouth of which is 35 metres above the level of the nearest watercourse, the Beune, contained also many pebbles and fragments of rocks foreign to the basin of that little stream, and which must have been introduced there by human agency. Some of those pebbles of considerable bulk, principally those of granite, are flattened on one side, rounded in their contour, and scooped out on the top, with a cavity of greater or less depth, which presents traces of repeated rubbing.

There were also in the grotto of Eyzies numerous fragments of a schistoid rock of considerable hardness, and upon two plates of this rock we could discern partial representations of animal forms engraved in outline. We suppose that these are the first observed examples of engraving upon stone in that ancient phase of the human epoch, when the reindeer still inhabited the temperate regions of the Europe of our day. Upon one of those plates, which has come to our hands in an imperfect state in consequence of an ancient fracture, may be distinguished the fore part of a quadruped—probably of a herbivorous species—and the head of which must have been armed with horns, so far at least as one can judge from lines of engraving undecided in their character, and penetrating but slightly into this rock, which is relatively so hard. On the other plate we recognize more readily a head, with clearly defined nostrils, and half open mouth; but the outlines are interrupted in the frontal region by a sort of erasure, resulting from a fracture, apparently artificial, and subsequent to the engraving. Beside, and a little in advance of this, we distinguish the design of a large palm-like figure, which, if it really belongs to this head, would lead us, as you were the first to suggest, to assign it to the elk. Besides the ossiferous deposits of the interior of the caverns, which are so numerous in Périgord, we can also study there analogous accumulations of organic remains, leaning against the large escarpments of the cretaceous limestones of this district, and sometimes simply sheltered by projections of rocks more or less overhanging. These external deposits are equally rich in cut flints and in the broken bones of animals,—the horse, the ox, the wild goat, the chamois, the reindeer, birds, fish, &c.,—which evidently served as food for the indigenous tribes during this ancient period of the stone age. The remains of the common stag are here very rare, as well as those of the wild boar and the hare. We found there some isolated teeth of the gigantic stag of Ireland (*Megaceros Hibernicus*), and some detached laminæ of molars of the elephant (*E. primigenius*) precisely as we have observed them at the scenes of the funeral entertainments of the ancient burial-places of Aurignac, without being any better able to explain for what actual use these laminæ of teeth thus isolated were intended.

It is also in the external deposits that we have collected the finest cut flints, especially at that of Laugerie-Haute, which seems to have been the site of a manufactory of those spear-heads cut to little splinters upon both faces, and slightly undulating upon the edges. But it is probable we found there only the refuse of this manufacture, for few specimens presented themselves in a perfect state among more than a hundred fragments which we have taken out.

At Laugerie-Basse, half a league down the stream, and still upon the banks of the Vezère, there was probably another workshop for arms and implements of reindeer's horn, to judge from the enormous quantity of remains of horns of that animal which are found accumulated there, and which almost without exception bear marks of a sawing, by means of which the pieces intended to be worked up were detached. There in particular we were able to procure,—in addition to arrows and barbed harpoons, which are found in nearly all the deposits of this age,—that great variety of utensils which will be submitted for the inspection of the Academy, and some of which are ornamented with elegant carvings of a workmanship truly astonishing, when we consider the means of execution which these tribes could have possessed, unacquainted as they were with the use of metals. You will remark among them those needles of reindeer's horn, finely pointed at one end, and pierced at the other with a hole or eye, intended to receive a thread of some kind.

There are also tools raised at the extremity with blunt notches, which would permit of the conjecture that they were used for making nets. Teeth of sundry animals—the wolf and the ox—pierced at their root, must have served for ornaments, as well as other objects fashioned like ear-drops, sometimes from the ivory part of the ear-bones of the horse or the ox.

Another object already found by one of us in the vault of Aurignac, respecting which he thought he ought to maintain silence, in spite of the value of an observation as yet unique, is represented at both the stations of Laugerie, and at that of Eyzies. It is a first hollow *phalanx* of certain herbivorous ruminants, which is pierced artificially beneath, a little in front of its metacarpal or metatarsal joint. On applying the lower lip to the articular hollow, and then blowing into the hole, you obtain a sound resembling that which is produced by a hollow key of moderate size. It cannot be doubted that it was a call-whistle in common use among these tribes of hunters, for up to the present we have observed four examples of it,—three of which are made of *phalanges* of the reindeer and the fourth of a *phalanx* of the chamois.

At Laugerie-Basse, moreover, thanks to the intelligent superintendence and minute precautions of M. A. Laganne, who was charged with the direction of our excavations, we have obtained many bits of reindeer's horn, which despite the alterations made by time, still preserve, in whole or in part, very distinct representations of animal forms. Some are simply traced in outline upon the branch or terminal expansion of the frontal prolongations of the reindeer; others are truly sculptured either in bas-relief, or even in round embossment, or full relief upon the shanks of the same animal, prepared for that effect.

One of these branches, from which an old breakage has obliterated a part of the design, still gives us the exact outlines of the hind quarters of a large herbivorous animal, traced by a sure hand. The thinness of the tail, the slight curvature of the hams, and especially the very advanced position of the sign of the male sex, do not permit us to consider it meant for a horse; we should rather recognize it as a bovine form, and the abrupt rise of the line of the back near the shoulder would seem to point to the ure-ox. Unfortunately, the interruption of the design by the fracture of the piece occurs just at the point where the tufted hair or characteristic bristles of the bison family should commence.

On a second branch of greater size, we discover another form, evidently bovine in its character, to judge by the hams and the spurs placed behind the divided hoof.

In this, the thicker tail, the greater horizontality of the line of the back, and a smooth dewlap hanging between the forelegs, indicate a nearer approach towards the ox properly so called (Query—*Bos primigenius?*) A fracture has once more removed the region of the head to which the horns were attached, and the artist—in order to make use of the divisions of the antlers—must have given to the animal a twisted attitude, which injures the general effect of the sketch. A third branch, on which the graving is preserved a little more perfectly, shows us an animal whose head is armed with two horns rising vertically at first, and then bending back towards their point. Behind these horns, a faintly defined trace of ears is perceived; and beneath the chin, that of a tuft of hair or a beard, peculiarities which would suggest readily enough a female wild goat, if they were not contradicted by a perceptible curving of the forehead and a swelling of the neck behind the ears, which would seem to forbid this conjecture. In this figure, moreover, the designer has, without any apparent necessity, folded back the hind extremities under the animal's belly, in such a way that its finely divided hoofs touch the abdomen.

Among the carved specimens coming from this same locality of Laugerie-Basse, we may quote a rounded staff made of the shank of a reindeer's horn, and terminated at one end by a spear-point with a lateral recurrent hook. Was this a utensil, a weapon, or a symbol of authority? We cannot say. Immediately above the hook we perceived carved in half relief upon three of its faces a horse's head, with ears lying down, and a little long for the species, but not sufficiently so to permit of our assigning this figure to the ass. Farther on, but still in the continuation of the staff, we meet with a second head with delicate snout and armed with branching horns. The basilary antlers are carved in front upon the horizontal prolongation of the staff, while the butt and the neck and shoulders are projected in a reverse direction behind; the slender shape of the head, where no trace of a muzzle is perceptible, the apparent lengthening of one of the basilary antlers, and the entire physiognomy of this figure would induce us to attribute it to the reindeer rather than the elephant stag. In front of the snout of this head, we find still another figure simply engraved in outline, and which might be well enough accepted as the form of a fish.

There is another capital specimen in which the art sentiment is specially revealed by the skill which the artist has displayed in adopting animal forms to the necessities of common use, without doing them too much violence. It is a dagger or short sword of reindeer's horn, of which the whole handle is formed of the body of an animal; the hind legs are lying down in the direction of the blade; the head, which has the snout elevated, forms with the back and rump a hollow intended to facilitate the grasping of this weapon by a hand necessarily much smaller than those of our European races. The head is armed with branching horns, which are united to the sides of the neck and shoulders, without interfering in the slightest degree with the grasp; but the basilary antlers must have been suppressed. The ear is much smaller than that of the stag, and in its position also approaches more closely to that of the reindeer; lastly, the artist has left under the shoulder a projection, slight and jagged upon its edges, which presents a fair imitation of the tuft of hair often found in this position in the male reindeer. It is to be regretted that this specimen should have come to us in the state of a mere rough outline, as we may judge by the unfinished workmanship of the blade, and certain faintly indicated details of carving.

Now, if it were necessary to adduce fresh evidence in addition to that already furnished to prove the co-existence of man and the reindeer in those regions which have become our central and meridional France, we might mention pretty numerous horns of that animal, at the root of which we distinguish gashes made in detaching them from the skin. We would also direct attention to other transverse gashes or incisions which we frequently observe at the base of the hoofs of the reindeer of our caverns, and which have been produced by the cutting of the tendons, made, as the Esquimaux still do at the present day with the intention of splitting these tendons, and dividing them into threads which were used to stitch the skins of animals, and also to plait cords of great strength. Lastly, we could further shew a vertebra of the back of the reindeer, pierced through and through by a flint weapon which has remained fixed in the bone, where it is retained by a calcareous incrustation. After that, as archæological circumstances fitted to characterize the era of the reindeer in France, we confine ourselves to mentioning this one, viz., that of seventeen stations where we have discovered the presence of this animal in a state of subjection to human agency, there is not one in which we have observed traces of polish upon the stone weapons; and, nevertheless, it is by many thousands that we have there collected flints, cut in all varieties of types, and passing through all gradations of perfection of workmanship, from the roughly sketched forms of the hatchets of the drift of Abbeville and Saint-Acheul to the heads of spears with multiplied faces and with the elegant waving edges of the finest periods of the stone age in Denmark.

As to the epoch at which the reindeer ceased to inhabit our temperate Europe we have not upon this point any historical data or positive chronology. The reindeer was not seen or clearly described by any writer of antiquity. Cæsar has only spoken of it by hearsay, and as of an animal still existing somewhere in a forest of which the extreme boundaries could not be reached even after a march of sixty days. We have not recognized the reindeer among the animals represented upon the ancient coins of Gaul. We have not found its bones in the dolmens and other vaults styled Celtic in which are frequently found associated the remains of wild and domesticated animals, and in which we have observed on two occasions in the neighbourhood of Paris the bones of the beaver. The reindeer has not, as far as we know, been yet found in the peat mosses of France. Messrs. Garignon and H. Tilhol have not recorded its presence in certain caverns of the Ariége which they have justly assimilated by their zoological characteristics and also by the presence of instruments of polished stone to the most ancient lake-dwellings of Switzerland. We know that up to the present the reindeer is missed among the fauna of this marine crib-work, and yet we have been able to study its remains coming from a cavern of the neighbourhood (that of Mont-Salève) where the association of flints simply cut, and of mammals belonging to the same period, is shewn under the same condition as in our grottoes of Perigord.

Thus, let the disappearance of the reindeer from our temperate Europe be the result of the local extinction of this species, or of its being driven back by the progressive development of human societies, or, if you choose, of its gradual and voluntary retreat in consequence of changes in the climatic conditions, it is not less probable that this disappearance dates back to a phase of the pre-historic times prior to the introduction of the domesticated races and the employment of the metals in our Western Europe.

The Academy will remark that in the letter of Messrs. Lartet and Christy, as well as in the communication which I had the honor of recently making on the subject of the cavern of Bruniquel, no mention has been made of human bones found as well in this latter locality as in the grotto of Eyzies.

This silence is explained by the fact that the epoch of the burial of these remains seems to us possibly less ancient than that from which dates the accumulation of reindeer bones and instruments of flint or wrought bone.

Note upon some new proofs of the Existence of Man in the Centre of France, at an epoch when certain animals were found there which do not inhabit that country at the present day.

BY M. DE VIBRAYE.

The history of the human family in its cradle still presents some points of obscurity which it is highly important to set about the task of removing. I think, therefore, that I may advance the interests of science, by briefly communicating some of the observations, which numerous tours, undertaken in the course of the year 1863, have enabled me to collect, while exploring caverns, bone-bearing fissures, and land slides.

I will repeat the expression which I used before the Geological Society of France in 1860, that my evidence cannot be suspected, because I have shared in the doubts that have been entertained with respect to the co-existence of man and animals, some belonging to extinct species, and others that have migrated to other quarters of the globe in consequence probably of a modification of climate and of conditions—a modification of which the cause is still undetermined.

I considered it my duty to extend my investigations to the monuments pertaining to that age, which by common consent is termed the celtic era. I shall not here describe the flint instruments and the specimens of pottery which I have succeeded in collecting; it is enough for me to invite attention to the obscurities which surround this epoch. In view of the difficulties that beset us, it is of use, I think, to take every opportunity of making comparisons, and to prepare a classification of the age of stone, that shall be in some measure chronological.

According to the generally accepted opinion, the time has not yet come for attributing without criticism to the first ages of mankind, certain polished instruments found alongside of flints bearing traces of a ruder workmanship. Would the diluvial gravels present us with any specimens, as well as the monuments reputed to be celtic? All that I can vouch for is what the beds of caverns characterized by the presence of numerous bones of the reindeer, notched, fractured, or even wrought, supplied me with:

1. In the Fairies' Cave (Arcy-sur-Eure, Yonne) a hatchet or rather a tomahawk of amphibolite of which the workmanship would not

disgrace the celtic age; on the other side a saccharoid limestone evidently worn away by friction.

2. The deposits of Tayac and of Tursac (Dordogne) have furnished under the same conditions specimens of granite, squared or rounded at the edges, and hollowed in the centre, intended beyond doubt for grinding grain. In presence of these authentic facts the most philosophical course is to refuse our consent to the systematic elimination of these objects from the reputed diluvial beds, and for my own part I cannot *a priori* reject the theory of their antiquity.

But before pronouncing an opinion it will be well to recur to the stratigraphic study of caverns and bone-bearing fissures, and all the land-slides—a study which furnishes a powerful test that perhaps has been too frequently neglected.

I have, like many other persons, explored the valley of the Somme; this served for a starting point, but it was necessary to proceed in search of new facts, and to correct the observations made in some localities that had been too superficially explored.

The department of Loir-et-Cher has furnished at a great number of points flint instruments: *nuclei*, knives, hatchets, spear-points, round or kidney-shaped balls which had served as hammers for making splinters. These different implements are found in the sub-soil, or even at the surface, when they have been turned up by the plough. They invariably accompany the drift so generally seen in Sologne on the table-lands, and are always met with at points where the underlying geological formations crop out; at some points, gravels or shell-marl grits, at others the upper limestone beaches of the system of Beauer, and at others chalk layers.

On the 19th of July, our colleague, M. De Verneuil drew my attention to the same facts near Sacy-le-Grand, at 120 yards below the level of the Oise. A diluvium covers the lignite-clays of Soisonnais. Here flint splinters bestrew the soil, many of them characterized by workmanship of considerable fineness of execution. Here, as every where else, (not even excepting the banks of the Somme and the caverns) the traces of a natural polish upon the flints seem to me to deserve a minute examination. Should these traces be attributed to the pressure of blocks driven along by the currents? The fact is general and demands an explanation.

The most useful study to undertake is the establishment of a correlation between the flint-stones and the animal remains which accompany them, when destructive agencies, and especially the dissolvent action of carbonic acid upon bones, permit the recognition of traces of the fauna of the ancient world. Thus at Vallières (Loir-et-Cher) in a cave nearly dried up, as well as in an osseous breccia which surrounds it, filling fissures of cretaceous rocks, there have been found bones of the *Hyaena Spelaea*, the *Rhinoceros Tichorhinus*, the *Cervus Megaceros*, the *Bos Primigenius*, the *Equus Adamiticus*, &c., accompanied by hatchets analogous to the specimens collected in the Valley of the Somme.*

Thrice during the year 1863 I have extended my investigations over the departments of Dordogne and Charento; at Bourdeille, Tayac and Tursac, in the former of these departments; at Combe-de-Rolland, La Roche-Andry, Montgaudier, and La Chaise, in the latter.

In most of these localities we can prove the existence of hearth-stones, where upon layers of calcareous formations (oolitic or cretaceous) have been placed, as better calculated to resist the action of heat, various chrystalline rocks foreign to the country. Upon these hearth-stones we find mixed with cinders and fragments of coal, or even imbedded in a pretty tough conglomerate, thousands of flint instruments, and a multitude of articles worked in bone, needles of great fineness artistically bored, awls, fish-hooks, barbed arrows, spoons which from their shape might have served for the extraction of marrow, daggers manufactured from the horns of the reindeer, ornaments in intaglio or worked in relief upon the bones. Nay, further, the representation of the stag and the hind, the dog and the ox, an otter or a beaver, of an animal with a thick mane wanting the head, and lastly of many birds and fish. A reindeer's head pro ...s from the handle of a dagger; thus we recognize the first rudimentary attempts at carving—I would even venture to add, at statuary. The excavations of Tayac have furnished me with some fragments of the molars and tusks of the elephant, and I think we must assign to the spoils of this monster the reproduction of a human type—the statuette of a woman.

No doubt two observers of the highest authority will favor the learned world with their fruitful discoveries. I shall not anticipate the valuable communications of Mr. Christy of London, and M. Lartet, the kind guide of my earliest palæontological studies, the

* I may here observe that the flint-knives of Vallières are more highly finished, and display more after-touch than those which, in the lower bed of the cave of Arcy, are associated with the fauna of extinct species.

master whom I shall always consult in the numerous cases where prudence requires me to hesitate.

If the existence of hearth-stones at somewhat numerous points, but most frequently at the bottom of valleys, as, for instance, on the brink of water courses, and the revelation of a civilization which it would be erroneous at the present day to term rudimentary, should be urged as objections to the *relative* antiquity of these first inhabitants of the globe, I will reply that wrought flints, split by fire, are met with in the gravels of the table-lands, but the objects which accompanied them have without doubt been dispersed, swept away by the waters. The siliceous matter, from the double advantage of its specific gravity and of its indestructability, has alone been strong enough to resist the great currents, while bony and gelatinous substances have disappeared, as I before indicated, under the destructive influence of atmospheric agents. But, on the other hand, it is necessary to examine the fauna of these hearth-stones: it is identical with those of the bone-bearing conglomerates which surround and cover them; the remains of the reindeer, the urus, the ox and the horse, are found associated with numerous flint-stones of a workmanship of sufficient finish at a certain number of points to be compared to instruments of the same nature attributed to the Celtic epoch. It is especially at Combe-de-Rolland, near Angoulême, and at Bourdeilles (in the grotto of the Ass and Devil's Furnace) that the finest types are met with. In the parishes of Tayac and Tursac the instruments are less perfect, but, in return, bones adapted for use abound.* The hearth-stone of Roccoutteux at Bourdeilles; the grottoes of La Chaise and of Montgaudier, near Montbron, have furnished analogous specimens, but in smaller number. At Bourdeilles wrought flints are met with in the valley, but they are again found at all heights, and in the defiles.† They were undoubtedly carried along by the impetuosity of the same currents as have worn away the rocks not only in the sloping parts of the valley of erosion, but up to the summit of the table lands. If we were tempted to attribute to some convulsion the deposition of the Ass' Cave at Bourdeilles, I would observe that the calcareous sediments are found even in the upper part of this cave, and that they contain

* Utensils, arms, or designs, 252; reindeer horns, notched or sawed, 2 0; stag horns in the same state, 9.

† The exploration of this defile has led to the discovery of a human molar, which I succeeded in taking out with my own hands.

imbedded in them the finely wrought flints which I have mentioned above. It must be admitted on the other hand, that in order to have been precipitated through a fissure, the presence of which can be clearly traced to its summit, animals such as the reindeer, the wolf, &c., must have dwelt at more elevated levels. At some points of these human stations, these hearth-stones, the spoils of animals belonging to extinct races are found; at Montgaudier some rare relics of the *Hyæna-spelæa* : at La Chaise, the *Rhinoceros tichorhinus*, in the hearth.stone of Laugerie, the elephant is represented by some fragments of molars and a certain number of instruments. Already, in preceding years, I had collected in the Fairies' grotto some molars of the *Elephas Primigenius* and objects in wrought ivory, which a preconceived idea made me eliminate too arbitrarily from the middle bed, more or less properly termed the red or upper drift.

Last year I thought I ought to examine still more minutely the Fairies' grotto. The principal point was to establish incontestably the co-existence of man with extinct races and with species that have migrated towards the north. My late excavations have furnished me with corroborative proof of the first of these two facts. When I began in 1858, I had, like all inexperienced explorers, proceeded by the tentative method, and I saw myself compelled, in the presence of numerous obscurities, to suspend my judgment. The most efficacious method of dispelling the reasons for my hesitation, was to explore in succession the superposition of the beds, and especially to exhaust the upper strata with a view to the study of the lower drift. It was under these conditions, and when the intermediate stratum (the red drift) had entirely disappeared, that an intelligent and learned coadjutor, M. Franchet, who accompanied me to the caverns, drew out with his own hands at the base of the lower stratum, and almost on the very rock, a human *Atlas* associated with numerous bones of the bear and the hyæna of the caverns. The very aspect of this human relic, even apart from the circumstances in which it was found, would serve to indicate its origin. This is the fifth example in six years of human bones obtained from this lower stratum, and collected at diverse points, but *always* in direct relation with extinct races, and under the same conditions of burial, without any trace of a later convulsion. The floor of the Fairies' Cave has fallen into decay at a certain number of points, and separates the inferior layer from the middle stratum. After having laboriously raised, by means of iron-pincers, the flag-stones belonging to the lower oolite, and sometimes to the coral rag, the excavations change in character, and it is no longer with the reindeer, but with the bear and the hyæna, the elephant and the rhinoceros, that I have myself extracted from this lower layer the wrought flints and the fractured bones, which the workmen could not discover in the middle of the moist and sticky substances of clay, in which the flints ana bones are imbedded. In presence of these layers, separated by a sinking of the surface, I asked myself whether it was possible to separate chronologically the two stages. Does the superposition of the strata in this connection belong to the geological order? Do not the existence of cinders and coal, and of wrought bones, and the wrought flints accumulated in such numbers in the upper stratum, as well as the scarcity of intact bones, seem to denote here the exclusive intervention of man for the formation of these depositaries as the *kjœkkenmoeddinger* of Norway, and certain accumulations of remains accompanying the lake deposits. Up to the time when the extinct races had seemed confined to the lower stratum, that hypothesis might have been absolutely rejected; but if, on the one hand, still existing, though migrated, races, are found to belong to both stages, and if, on the other hand, the relics of extinct races are associated with existing species in the bosom of the workshops of primitive human industry, what are we to think of this double association?

In any case the artificial, or if you will, the natural layer, where the bones of the reindeer abound, and where hearthstones are met, has preceded one of the convulsions of the globe, as is proved by the presence of numerous angular fragments of the surrounding rocks, and by the rolled pebbles derived from crystalline rocks, mixed into a perfect conglomerate with flint implements and wrought bones. This layer is very different, it may be remarked by the way, from the lake deposits, in which the animal remains without exception belong to the modern and local fauna, which no change in the earth's condition warrants our separating from our own epoch. I should note here the discovery of crude metals associated with the bones of the caverns. The negative fact of their absence in the bosom of the drift layers had led to the *a priori* admission that the men of these remote times were completely ignorant of their use, when they were perhaps only deprived of the means of using them, although they had preserved the traditional notion of their value.* I picked up in the lower bed of the caverns of Arcy (the stratum of the *Ursus Spelæus*), a kidney shaped piece of hydrated geodic iron, analogous to a specimen of the same nature which I procured from the excavation of a dolmen at Birochère, near Pornic; the same bed likewise contained a substance which I think should be attributed to the peroxyde of manganese. Two analogous specimens came from the Devil's Furnace at Bourdeilles (the stratum of the Reindeer). Lastly, the hearthstone of Laugerie, parish of Tayac, has made me the possessor of a little mass of copper, almost completely covered with a coating of a green carbonate of copper, and cubic crystals of protoxide of copper. The aspect of this mineral, which, however, I think natural, is analogous to that of the Roman-French *fibulæ* in bronze, enclosing in a cavity similar crystals of oxydized copper. Beyond all doubt the primitive tribes had foreign relations, as is established by the remains of sea-shells found among wrought articles; at Bourdeilles the *Patella* and *Dentalium;* at Montgaudier, the *Buccinum* and *Dentalium*; at Eyzies, the *Cassis.* In the same way M. Lartet had discovered at Aurignac certain perforated disks, fashioned from the valves of the Cardium. Similar disks, taken out of the excavation of a dolmen, four miles from Mende, form part of my collection.

I do not wish to conclude this note without mentioning the presence of splinters of glass quartz among the flint instruments accompanying wrought bones. I collected the first specimen in the lower structure of the caves of Arcy (1862). The same fact is reproduced in 1863 at Montgaudier, and still later at Eyzies. This last fragment of rock crystal, slightly smoked, seems retouched at the edges.

To add a new fact to my own observations, I shall mention the interesting researches of two generations of Savants. While exploring the banks of the Charente, Messrs. de Rochebrune, father and son, succeeded in rescuing from the vandalism of the workmen some magnificent molars of the *Elephas Antiquus*, accompanied by molars of the *Elephas Primigenius*, a remarkable fragment of a tusk, and some bones of the limbs, unfortunately too few. Upon one of these last the most evident trace of an incision was recognizable. Among the rolled pebbles and the remains of crystalline rocks accompanying these bones,

* The tribes who undoubtedly bored the horns of the reindeer, the incisors of the horse and ox, the canines of the wolf, the reindeer, the *Ursus Arctos*, and the *Ursus Spelæus*, in order to suspend them by way of ornament or amulet, might equally well attribute to the metals some healing, or even supernatural, virtue.

I have established the fact of the presence of a flint instrument, characterised by workmanship of considerable finish.

To sum up: three principal facts are at the present day registered and grouped together, as the fruits of long and persevering researches, carried on by a great number of observers. The man of the earliest ages reveals himself by his works; man is associated by his relics with extinct races; lastly, man makes himself the revealer of his own existence by himself reproducing his own image.

For a long time people pretended to deny the presence of human skill in the rude efforts of the first stone instruments; at a later date they were forced to disparage the value of the intentional fractures and incisions observed in so large a number of bones belonging to the horse, the ox, or the reindeer. But now the bones are turned into numerous instruments; animal figures are found reproduced from the spoil of themselves; the living reindeer has served as a model for the carving of a dagger handle stuck fast in an osseous breccia. Nay, still further, the statuary of the first ages has reproduced the human species in a sort of lewd idol, the material of which belongs to the skeleton of the elephant.

I have attempted to retrace here the most conclusive facts; to my eyes the decision is manifest. I wish to propose one last question which I shadowed forth before. Should we separate the epoch of the reindeer, which I take here as the type of the migration of species, from the fauna of extinct races, with which on the other hand the reindeer is now found associated? In the double hypothesis of the association or the superposition of the fauna, man is revealed by his presence or by his work. The future is not far distant which shall teach us the more or less intimate correlation of these two stages. It is to my mind the only really serious difficulty which at the present day surrounds this interesting question.

T. M.

ON THE PERMEABILITY OF HIGHLY-HEATED IRON BY GASES.

Translated from the 'Comptes Rendus,' Feb. 15th, 1864.

NOTE, BY M. L. CAILLETET.

In a late communication to the Academy, MM. Sainte Claire and Troost made known the very curious phenomenon that iron at a high temperature is permeable by oxygen. It will also be remembered, that an iron tube, filled with hydrogen and heated in a furnace, permits this gas to escape so thoroughly as to produce an almost perfect vacuum in the interior of the tube. These curious experiments will serve to explain many phenomena which present themselves in metallurgic operations, and which have never yet, I think, received satisfactory explanation. I have the honour to submit to the Academy the result of some researches I have made in this subject, and which it is my design to carry on and complete.

I caused some lengths of gun-barrels to be rolled flat, and then soldered the two ends, so that I thus obtained long rectangles formed of two plates in contact, soldered at the edges. On heating a lamina thus prepared to the high temperature of a smelting furnace, it was soon observed that the portions not soldered began to separate, and regained their cylindrical shape and original volume. This could doubtless only have been caused by the gases of the furnace penetrating the mass of iron, and producing the distension of the portions at first in contact. To this penetration of the gases we may attribute the blisters which frequently cover large pieces of cast-metal, especially those used for blinding, at the instant when they are extracted from the welding furnace. If one of these blisters is pierced on withdrawing the piece rough from the furnace, a jet of combustible gas is seen to escape, having been doubtless accumulated during the heating, in the cavities that occur in a piece which has been incompletely wrought.

It has been long observed that iron heated with coal-dust in the cementing-boxes, was covered, after its change to steel, with a quantity of bubbles, more or less numerous according to the nature of the metal employed, and it is easy to convince ourselves, by examination, that each of these bubbles corresponds to a point where the junction of the metallic sponge has been imperfect, whether owing to the presence of some infusible matter, as lime or the ash of the combustible used, or to the imperfection of the mechanical working. We may therefore suppose, after the experiments of Messrs. H. Deville and Troost, that the gases contained in the cementing-boxes traverse the pores of the iron, and accumulating in hollows of the red-hot metal, form the bubbles of which we are speaking. A rather simple experiment confirms this hypothesis. In fusing together the iron-plates which commonly occur in commerce, and are not of uniform texture, we always obtain the *poule* steel (as the steel covered with blisters is called); whereas if we work with the perfectly homogeneous iron, which is obtained by exposing cast-steel for many hours to a high temperature, it is then seen that the plates of this homogeneous iron return to the condition of steel, but without a single blister on their surface.

We may conclude from these experiments, that in order to procure steel with a smooth surface, we should employ iron as homogeneous as possible, and have recourse to a rapid process of cementation. Also, to avoid in castings the production of blisters, it is necessary to prevent the formation of hollows in the rough material, for, as we have tried to demonstrate, these blisters are caused by the gases of the furnace condensing in the cavities of the metal.

Remarks on the preceding by M. H. SAINTE-CLAIRE DEVILLE.

I have nothing to add to the very interesting and conclusive note of M. Cailletet. I wish merely to call his attention to another phenomenon which is frequently observed in metallurgic operations, namely, the disengagement at a high temperature of gases held in solution by liquids. The ebullition of silver and of litharge, so thoroughly investigated by M. Le Blanc, and the disengagement of bubbles of inflammable gas from the interior of vitreous masses, are phenomena which can be generalised with certainty. White iron and steel, at the moment of cooling, allow the escape of a gas (doubtless carbonic oxyde or hydrogen) which is highly injurious to the perfection of pieces run into cast-steel; and with this phenomenon we may connect some very curious observations of Messrs. Résal and Minari, on the production of scoriæ caused by bubbles of inflammable gas on the surface of white iron in fusion (or rather in the process of solidification), while it is very curious that the grey iron has nothing of the kind. It is easy to trace the origin of these combustible gases to the heating furnace, the walls of the crucibles permitting the surrounding gases by endosmose to concentrate upon the included materials. It would be very desirable that experiments should be made in the large metallurgic establishments where engineers have at their disposal scientific instruments, which become more precious in proportion as they know how to avail themselves of them, as M. Cailletet has well shown.

The experiment of M. Cailletet, combined with that which M. Troost and myself have published on the porosity of platinum, explains the formation of bubbles which often injure the quality of that metal, for these bubbles are formed only when platinum in plates is raised to a high temperature, and their development does not depend on the expansion of the air which we might suppose interposed between the metallic leaves which form the boundaries.

Note on the preceding communications, by M. CH. SAINTE-CLAIRE DEVILLE.

The curious experiment of M. Cailletet, as well as those recorded in the memoirs presented recently to the Academy by my brother and M. Troost, prove incontestably that the metals, platinum and iron, possess the property of permeability by gases when raised to bright incandesence. On the other hand, the researches of the two last-named philosophers prove that, while hydrogen traverses easily a tube of porcelain highly heated but not modified in structure, this is no longer the case when the temperature of the tube is raised to the point capable of softening or vitrifying its exterior wall. In this case, not only does the gas cease to traverse the tube, but it is stopped and partly absorbed by the vitrified surface, which again sets it free on recovering its porous structure. These different facts are connected with the antagonistic properties which distinguish the crystalline from the vitreous or amorphous condition. I have discussed the subject several times since the year 1845, and propose shortly to recur to it with some detail, attaching it to the more general fact of allotropy, of which it is only a particular case. At present I desire merely to call attention to the geological interest of the question, following out the train of reflection my brother has presented, and remarking some complimentary expressions to myself with which he has accompanied his last communication.

The oldest fact known of gas held in solution by substances in a state of igneous fusion, is that which occurs in the ebullition of silver. The similar phenomena which litharge gives at the instant of melting, were explained in the same way by M Thenard, and the admirable researches of M Félix Le Blanc, left no doubt in this respect. Lastly, the curious experiments which my brother brought forward at the meeting on Dec. 14, give a most direct proof that vitreous bodies in fusion possess the property of absorbing and of subsequently disengaging gaseous substances, obtained from the surrounding medium, and in that case, the gas was of a combustible na ure. It was natural, and long ago it occurred to me, to connect with this sin~ular property of lithoid substances in fusion many facts which have been observed in recent lavas and volcanic eruptions. The lavas which issue from volcanoes form two distinct varieties, from our present point of view. The first, being rich in silica and very readily fusible, easily assume the vitreous condition on cooling, and then form obsidian; the others, which are of more common occurrence (dolerites, amphigenites, basalts) contain generally not more than 50 per cent of silica, and most of them are rich in lime. To fix our ideas by an example, the neighbourhood of Naples presents both these varieties of rocks,—the old trachytes and the pumiceous tu. of the Phlegræan plains on the one hand, and the amphigenitic masses of the Somme and Vesuvius on the other. The lavas of the volcano, whatever may have been their rate of cooling, are always crystalline, with some very rare exceptions of very small extent, which are subvitreous or imperfectly crystalline. The volatile matters, such as steam, metallic chlorides, hydro-sulphuric acid, &c, which they contain, and which must have been dissolved in the highly-heated medium where they were fused, disengage themselves successively in the order I have explained, in proportion as the interior work of crystallisation went slowly on; precisely as at the instant of the ebullition of silver there is an escape of oxygen, or, as in another class of phenomena, the air held in solution in water is separated from it at the instant of freezing. The act of crystallising causing a large and sudden increase of density, there results at that instant a corresponding disengagement of latent heat, and I do not hesitate to assign to this cause the subsequent heating of the lava of 1855, observed by M. Scacchi, and verified by M. Albert Gaudry and myself. Similar facts did not escape older observers, for Serrao, after having proved the occurrence of this in the lava of 1737, remarks, that "the lavas must contain within themselves some cause which develops heat, and brings them back to incandescence when they have been already completely cooled (on the surface)."

The flames which have been often observed in Vesuvius, and in particular by Leopoldo Pilla, could be attributed only to the combustion of gases given out during the eruption; but, at the last eruption of December, 1861, I was fortunate enough to put beyond doubt the fact that combustible gases are disengaged from the incandescent lava in the act of cooling, and the exact analyses made on my return, by MM. Le Blanc, Fouqué, and myself, have proved that they consisted of a mixture of light carburetted hydrogen and hydrogen It is then natural to admit that the incandescent matter was surrounded, in the furnace from which it proceeds, by an atmosphere of this nature, that it became impregnated with it while in a liquid state, and again set it free in its progressive passage to the crystalline condition. The subsequent heating which I have mentioned in the gases escaping from the lava is doubtless also an indication of the heat rendered sensible by the act of crystallising.

When the eruptive matter, instead of having, like the lavas above spoken of, a great tendency to crystallise, offers on the contrary, along with an excess of silica, a tendency to solidify in the vitreous form, it constitutes obsidian. It then imprisons and solidifies in some way the volatile substances held in solution by it, and at the same time it retains a certain quantity of latent heat (which I propose to call the *latent heat of fusion*) which gives it a minimum of density; But it is remarkable, that if we proceed to heat this obsidian nearly up to its melting point, it puffs up so that its volume increases enormously; and yet, this extreme porosity of substance, rendering it everywhere of excessive friability, and, as it were, papyraceous in texture, corresponds only to an insignificant loss—some thousandths—of its original weight. When thus once transformed into pumice, it requires a very intense heat to soften it anew and melt it. Is it not natural to suppose that the temperature to which the obsidian was at first subjected, and which was relatively low, has only brought this glass to a particular molecular state, which by permitting the stored-up heat to be disengaged, has furnished the rest of the supply of caloric necessary to resoften the substance and facilitate the expulsion of the gases? Just as in the well-known experiment of M. Regnault, the soft sulphur (that is, the vitreous sulphur, the obsidian of sulphur) when raised to 92 or 93 degrees, suddenly sets free a certain quantity of heat, and raises the temperature of the thermometer in contact with it to 110°.

However this may be, let us revert to the Phlegræan plains which surround Vesuvius. We shall find them to consist entirely of trachytes, obsidian, and pumice, all which are beyond compare vitreous or vitrifiable substances. We may therefore conceive that a relatively small elevation of temperature, much inferior to that observed at each eruption of Vesuvius, on being applied in the interior of the soil to the masses of obsidian, changes them into pumice, with a large increase of volume; and from this there would result an immense force which, breaking the overlying crust, would lift it up in a bubble-shaped heap, projecting its fragments in all directions. Thus would be accounted for, as I have already remarked, both the facts observed at Monte Nuovo in 1538, and the production of the numerous craters of the Campagna.

Lastly (and I need not say that I offer this conjecture with reserve), if we notice the resemblance that exists between the map of the Phlegræan plains and that of the moon's surface, it is natural enough to believe that this latter owes its form to action of the same nature, and it may not perhaps be inappropriate to remark that a globe composed entirely of vitrified matter may thus have condensed and retained in solution within its own mass the gaseous elements which originally surrounded it, and which, but for this circumstance, would have constituted an atmosphere for it. And in applying this conception to our own globe, is it not conceivable that the primitive granitic crust, essentially rich in silica (a substance of which I have proved the extreme fusibility) had condensed before its solidification, a portion at least of the gases which form our atmosphere? On this hypothesis, watery vapor, hydrogen, carburetted and sulphuretted hydrogen (these last three bodies oxidising on coming to the surface) would be only the last remains of this atmosphere stored up by the rocks in fusion; just as the metallic fluorids, chlorids, and sulphurs, which still constitute our lavas, are only, according to the beautiful researches of M. Elie de Beaumont, the last representatives of the substances which have been successively disengaged from the eruptive rocks in forming the concreted veins.

J. B. C.

ENTOMOLOGICAL SOCIETY OF CANADA.

The second annual meeting of the society was held in the Council Room of the Canadian Institute, on Tuesday, May 14th, at 3 o'clock P.M., the President, Prof. Croft, in the chair.

The minutes of the previous meeting were read and confirmed.

Communications were read

From the Rev. Vincent Clementi of Peterborough, expressing regret at his inability to attend the meeting.

From Geo. Jno. Bowles, Esq., and others, on the establishment of a branch of the Society in Quebec.

W. E. Milward, Esq., M.D., of Grimsby, was proposed, and elected a member.

The committee on Lepidoptera reported the publication of a catalogue of all the known Canadian Butterflies and Sphinxes; copies of this catalogue will be forwarded to members immediately.

The committee on Coleoptera reported that considerable progress had been made in the determination of species, etc., though not sufficient to warrant the publication of a catalogue as yet.

The curator reported that the resolution passed at a previous meeting relative to the apparatus required in collecting and preserving insects, had been acted upon, and that sheet cork, entomological pins, etc., can now be had through the Society at cost prices.

Objections having been raised to the English pins, Dr. Morris and Mr. Hubbert were requested to secure 50,000 German pins as early as possible.

The following donations were announced, and the thanks of the Society cordially tendered to the donors:

From the Entomological Society of Philadelphia—

185 Specimens, including 135 species of Coleoptera.
25 " " 20 " Sot.

From Dr. Thomas Cowdry, and H. Cowdry, Esq., York Mills—

135 Specimens, including 65 species of Coleoptera.
3 " " 3 " Diptera.
4 " " 3 " Hemiptera.

From W. S[...]nders, Esq., collected by G. J. Bowles, Esq., Quebec—

54 Specimens, including	16 species of	Coleoptera.
8 "	"	6 "	Lepidoptera.

From W. Saunders, Esq., collected at London—

15 Specimens, including	11 species of	Coleoptera.
9 "	"	3 "	Lepidoptera.
1 "	"	1 "	Diptera.

From James Hubbert, Esq., M.A., Toronto—

240 Specimens, including	87 species of	Coleoptera.
39 "	"	26 "	Lepidoptera.
19 "	"	13 "	Diptera.
22 "	"	9 "	Hymenoptera.
14 "	"	5 "	Neuroptera.

From W. Turton, Esq., London—

18 Specimens, including 9 species of Lepidoptera.

From the Rev. W. F. Clarke. Toronto—

4 Specimens, including	4 species of	Canadian Lepidoptera.
7 "	"	6 "	Hymenoptera.
1 "	"	1 "	Neuroptera.
1 "	"	1 "	Hemiptera.

Also the following, many of which were insects of considerable interest.

8 Specimens, including	5 species of	Chinese Coleoptera.
1 "	"	1 "	Diptera.
3 "	"	2 "	Orthoptera.
1 "	"	1 "	Hemiptera.
1 "	"	1 "	Lepidoptera.

Mr. Sanderson moved, seconded by Mr. Reed, that a committee consisting of the following members be appointed to draft a constitution, and to report thereon at the next meeting—Prof. Croft, Prof. Hincks, Dr. Morris, and Mr. Hubbert.—Carried.

Moved by Dr. Morris, seconded by Prof. Hincks, that it is desirable to establish a class of corresponding members.—Carried.

Moved by Mr. Hubbert, seconded by Mr. Saunders, that the office of Vice-President be added to those already existing in the Society.—Carried.

Moved by Mr. Saunders, seconded by Prof. Hincks, that the action 'of Prof. Croft and Dr. Morris in reference to the Quebec branch be sustained.—

The following officers were then elected for the ensuing year:

President,	Wm. Saunders, Esq.
Vice-President,	Rev. Wm. Hincks, F.L.S.
Secretary-Treasurer,	Rev. Chas. J. S. Bethune, M.A.
Curator,	James Hubbert, Esq., M.A.

During the absence of Mr. Bethune in Britain, Mr. Hubbert was appointed Secretary-Treasurer *pro. tem.*

The following Members were appointed on the standing Committees for the Insect Classes, etc.:

On Coleoptera—Mr. Billings, Prof. Croft, and Mr. Saunders.

On Lepidoptera—Dr. Morris, Mr. Bethune, and Mr. Reed.

On Orthoptera and Neuroptera—Prof. Hincks, Mr. Billings, and Dr. Cowdry.

On Diptera—Mr. Hubbert, Mr. Rogers, Mr. Billings.

On Hymenoptera—Mr Saunders, Mr. Hubbert, Mr. Becket.

On Insect Architecture—Mr. Couper, Mr. Hubbert, Dr. Sangster.

These Committees to pay special attention to the insects injurious to vegetation, and to the works of man. Reports to be presented at the next annual meeting of the society.

A committee, on the silk-producing moths of Canada, was also appointed, with instructions to collect information, make observations, and, if possible, conduct experiments on the different species of Attacus, &c., and the possibility of utilizing their silk. The committee to consist of Prof. Croft, Mr. Hubbert, and Mr. Saunders. Reports to be given in at the next annual meeting, or earlier, if convenient. The attention of the members was called to the *Canada Farmer*, as a suitable medium for collecting and circulating information on the insect tribes, either injuriou or beneficial to man, their habits, and the best means of counteracting and preventing the ravages of destructive species.

Donations of insects were voted to the Quebec Branch, and to the museum of University College, Toronto.

Prof. Croft drew the attention of the members to some pecularities in the flight of Deiopéia bella, and to the ravages during the past summer of Clytus flexuosus, many of the acacia trees of Toronto, and the vicinity, having fallen victims to the boring of the larvae.

Dr. Morris exhibited and made some remarks on a rare Curculio (Hylobius) pinicola, from Quebec.

Mr. Saunders exhibited specimens of Cyanobius bella, and a rare Hesperia, presented by Dr. Scudder, of Cambridge, Mass.

The following Papers were laid before the Society.

On the structure and habits of Gastropacha velleda, by Prof. Croft.

On insect phenomena observed in Peterborough and the vicinity, by the Rev. V. Clementi, B.A.

Observations among the Lepidoptera, during the summer of 1863, by W. Saunders, Esq.

On the geographical distribution of the Dipterous faunas of Europe and North America, with the causes which influence it, by Jas. Hubbert, Esq., M.A.

The meeting then adjourned.

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST.—APRIL, 1864.

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

Day.	Barom. at temp. of 32°.				Temp. of the Air.				Excess of mean above Normal.	Tens. of Vapour.				Humidity of Air.				Direction of Wind.			Resultant Direction.	Velocity of Wind.					Rain in Inches.	Snow in Inches.
	6 A.M.	2 P.M.	10 P.M.	MEAN.	6 A.M	2 P.M.	10 PM	ME'N		6 A.M	2 P.M.	10 P.M.	M'N	6 A.M	2 P.M.	10 P.M.	M'N	6 A.M.	2 P.M.	10 P.M.		6 A.M	2 P.M	10 PM	Re-sul't.	ME'N		
1	29.431	29.390	29.358	29.3873	32.7°	37.6°	36.0°	35.40°	− 0.83°	.180	.185	.196	.189	.97	.82	.93	.92	E N E	E b N	E N E	N 81° E	2.0	8.5	10.0	7.92	8.04	...	...
2	.320	.344	.456	.3812	35.4	41.7	39.6	39.00	+ 2.37	.205	.192	.219	.204	.99	.72	.90	.86	E b N	E N E	N E	N 65 E	8.5	11.8	3.6	6.92	7.57	0.045	...
3	.549	.619	—	—	37.4	43.9	—	—	—	.213	.209	—	—	.95	.72	—	—	N b W	S E b S	S E b S	N 86 E	5.4	5.5	4.0	2.96	4.71	Inp.	...
4	.609	.545	.492	.5435	36.7	43.5	39.6	40.42	+ 3.08	.197	.168	.176	.190	.90	.59	.72	.76	E b N	E b N	E b S	N 84 E	9.8	16.8	8.0	10.95	11.23	0.100	...
5	.526	.583	.656	.5952	36.0	37.8	37.8	37.35	− 0.37	.189	.165	.183	.178	.89	.72	.80	.80	E S E	E	E N E	N 81 E	9.0	12.2	5.8	7.35	7.63	0.015	...
6	.736	.810	.880	.8197	36.3	45.0	40.3	40.17	+ 2.13	.202	.239	.228	.220	.94	.80	.91	.88	N E b E	E S E	Calm.	N 87 E	4.8	3.8	0.0	1.10	1.22	0.005	...
7	.902	.858	.798	.8443	39.6	45.7	41.0	42.53	+ 4.12	.219	.221	.200	.214	.90	.72	.78	.79	Calm.	E b S	N E b E	N 89 E	0.0	9.0	1.5	3.32	3.50	...	...
8	.776	.686	.613	.6890	41.0	49.0	46.1	45.18	+ 6.47	.227	.256	.161	.220	.88	.74	.51	.73	N E b E	E	E N E	N 76 E	2.2	8.6	14.8	9.97	10.21	...	...
9	.512	.497	.423	.4658	39.2	41.0	39.9	39.83	+ 0.80	.180	.246	.233	.218	.75	.96	.95	.89	E b N	E	E	N 86 E	12.6	14.8	17.0	16.51	16.57	1.280	...
10	.338	.322	—	—	34.5	36.0	—	—	—	.192	.196	—	—	.96	.93	—	—	E b N	E b N	E b N	N 81 E	22.0	13.5	10.0	10.74	10.84	0.160	1.0
11	.488	.535	.606	.5487	36.3	44.6	39.9	41.07	+ 1.33	.202	.208	.233	.214	.94	.70	.95	.84	E b N	W N W	N b W	N 23 W	1.5	7.8	7.0	1.51	3.23	Inp.	...
12	.589	.541	.504	.5435	35.3	36.7	36.3	36.37	− 3.57	.181	.163	.185	.176	.88	.75	.86	.81	N E	E N E	E N E	N 72 E	6.0	12.0	18.5	11.25	11.37	Inp.	1.0
13	.414	.455	.503	.4622	33.4	39.2	35.3	36.45	− 3.98	.171	.199	.189	.187	.89	.83	.92	.87	N E	N W	W b S	N 48 W	7.0	11.8	3.4	5.85	6.89	Inp.	1.5
14	.526	.574	.592	.5670	35.6	43.5	39.6	39.38	− 1.35	.193	.194	.194	.196	.93	.68	.79	.81	N W	S	S W	N 62 W	6.8	3.8	1.5	2.62	4.77	0.033	...
15	.534	.440	.379	.4430	36.7	46.4	37.8	40.60	− 0.45	.179	.195	.157	.169	.82	.61	.69	.67	N W b N	S S W	S W b S	N 60 W	5.0	8.6	5.2	0.20	5.19	...	...
16	.350	.313	.363	.3447	32.0	44.6	37.4	39.32	− 2.17	.143	.191	.119	.161	.79	.65	.53	.66	E	S b W	N N W	N 21 W	0.5	6.2	10.2	3.37	8.42	...	...
17	.385	.409	—	—	31.6	47.2	—	—	—	.140	.175	—	—	.78	.52	—	—	N N W	W	W b N	N 59 W	6.5	19.2	7.0	12.98	13.12	...	...
18	.530	.569	.665	.5972	32.7	47.3	35.6	39.00	− 3.07	.185	.155	.142	.142	.73	.47	.68	.61	N W	S S W	N	N 18 W	9.2	3.0	9.2	5.79	8.06	...	...
19	.708	.734	.710	.7143	36.0	43.3	40.7	40.82	− 1.53	.172	.162	.161	.168	.81	.58	.62	.66	N	S S W	W N W	N 7 E	4.0	1.0	4.2	2.77	4.96	...	...
20	.666	.611	.615	.6277	36.7	44.3	38.9	41.52	− 1.27	.172	.140	.151	.166	.78	.47	.63	.62	N b W	S b E	N	N 49 W	7.0	3.8	0.5	1.31	4.01	...	...
21	.654	.677	.727	.6888	35.2	53.6	38.9	43.25	+ 0.15	.147	.155	.168	.150	.72	.36	.70	.56	Calm.	S S W	Calm.	S 17 W	0.0	10.0	0.0	2.22	3.83	...	...
22	.779	.667	.598	.6685	34.5	53.3	45.7	45.77	+ 2.40	.163	.178	.268	.207	.82	.43	.87	.69	Calm.	E	S b E	S 64 E	0.0	11.8	3.0	3.49	5.91	0.175	...
23	.577	.596	.607	.6295	40.3	48.6	41.4	46.18	+ 2.48	.332	.312	.250	.286	.94	.91	.96	.91	S W b S	N N W	N W b N	N 14 W	3.5	9.6	6.0	5.07	5.42	1.010	...
24	.785	.747	—	—	38.5	42.8	—	—	—	.208	.223	—	—	.89	.81	—	—	N W b N	E	E b N	N 75 E	5.0	12.5	17.5	14.73	14.95	...	...
25	.444	.447	.483	.4527	47.2	45.7	40.3	44.82	+ 0.42	.240	.288	.236	.260	.73	.94	.95	.89	N E b N	S W b S	Calm.	N 69 E	14.8	1.0	0.0	2.07	2.99	0.490	...
26	.467	.473	.521	.4053	41.0	54.4	49.3	49.25	+ 4.55	.246	.298	.293	.278	.95	.69	.83	.80	N W b N	S W b S	N W	N 67 W	2.5	3.2	13.5	7.89	9.34	...	...
27	.542	.575	.793	.6490	42.1	41.0	33.4	37.77	− 7.25	.232	.184	.112	.169	.86	.71	.58	.71	N b W	N W b N	N N W	N 28 W	9.0	30.5	18.0	18.46	18.52	0.215	...
28	.821	.834	.939	.8668	29.5	45.0	38.8	38.30	− 7.10	.121	.158	.160	.153	.74	.51	.68	.66	N N W	N	E N E	N 11 W	15.5	16.8	0.5	9.42	9.77	..	...
29	.968	.878	.851	.8835	35.6	47.2	40.3	41.43	− 4.30	.142	.128	.158	.135	.68	.38	.63	.52	N b W	S	W S W	S 1 W	6.0	8.5	3.5	1.22	5.15	...	...
30	.764	.609	.512	.6083	38.1	46.4	42.5	43.43	− 2.62	.187	.130	.244	.183	.81	.41	.89	.66	N b W	E N E	N N W	N 36 E	1.5	11.5	2.2	3.49	5.58	0.105	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
M	29.6008	29.5858	29.6052	29.5968	37.08	44.86	39.71	40.96	− 0.04	.191	.196	.193	.194	.85	.66	.78	.75	....	....	....	....	6.25	9.90	6.85	......	7.77	3.633	3.5

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR APRIL, 1864.

NOTE.—The monthly means do not include Sunday observations. The daily means, excepting those that relate to the wind, are derived from six observations daily, namely at 6 A.M., 8 A.M., 2, 4 and 10 P.M., and midnight. The means and resultants for the wind are from hourly observations.

Highest Barometer........................29.964 at 8 a.m. on 29th } Monthly range =
Lowest Barometer ....29.301 at 4 p.m. on 16th } 0.663 inches.

Self-registering Thermom.:
Maximum Temperature ....59°4 on p.m. of 26th } Monthly range =
Minimum Temperature ....28°1 on a.m. of 28th } 31°3
Mean maximum Temperature .... 47°48 } Mean daily range =
Mean minimum Temperature .... 34°61 } 12°87
Greatest daily range ......24°4 from a.m. to p.m. of 21st.
Least daily range........... 5°2 from a.m. to p.m. of 10th.

Warmest day ....26th... Mean temperature........ 49°25 } Difference = 13°85.
Coldest day .... 1st... Mean temperature .... 35°40 }
Maximum Radiation. { Solar.............................. 101°5 on p.m. of 26th } Monthly range =
{ Terrestrial....................... 20°0 on a.m. of 17th } 81°5
Aurora observed on 4 night, viz.,—on 7th, 24th, 27th and 29th.
Possible to see Aurora on 10 nights; impossible on 20 nights.
Snowing on 3 days, depth 3.5 inches; duration of fall, 10.0 hours.
Raining on 16 days, depth 3.633 inches; duration of fall 78.6 hours.
Mean of cloudiness = 0.74; above average 0.15.
Most cloudy hour observed, 4 p.m; mean = 0.79; least cloudy hour observed, 8 a.m.; mean, = 0.68.

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

North.	South.	East.	West.
2354.18	503.01	2812.96	1217.19

Resultant direction N. 41° E.; Resultant velocity 3.39 miles per hour.
Mean velocity ....7.77 miles per hour.
Maximum velocity .... 33.0 miles, from 3 to 4 p.m. on 27th.
Most windy day ......27th............Mean velocity, 18.52 miles per hour. } Difference =
Least windy day ... 6th............Mean velocity, 1.22 ditto } 17.30 miles.
Most windy hour ... 11 a.m to noon.........Mean velocity, 10.55 ditto. } Difference =
Least windy hour ...2 a.m. to 3 a.m..........Mean velocity, 5.74 ditto. } 4.81 miles.

1st. Dense fog 6 and 8 a.m., gloomy and mild.—2nd. Dense fog 6 and 8 a.m., dark and mild.—4th.—Solar halo from noon to 2 p.m., dark and mild.—7th. Fog 6 and 8 a.m.; faint auroral light at 10 p.m.—8th. Solar halo at 1 p.m.; sheet lightning in S.W. at 9 and 10 p.m.—10th. Rain and snow intermixed 6 to 11 a.m.—11th. Fog 6 and 8 a.m.—12th. Fog at 6 a.m.—14th. Well defined rainbow 6 p.m.—17th. Solar halo at 6 a.m.—20th. Lunar halo at midnight.—21st. Lunar corona at midnight.—22nd. Solar halo 1 p.m.—23rd. Fog 6 and 8 a.m.—24th. Solar halo 4 p.m., and auroral light at 9 p.m.—25th. Dense fog 10 p.m. and midnight.—28th. Fog 6 a.m.

April, 1864, was very rainy, and the snow being also above the mean, the precipitation was greater than the average; mean temperature just equalled the average of 25 years.

COMPARATIVE TABLE FOR APRIL.

YEAR.	TEMPERATURE.					RAIN.		SNOW.		WIND.		
	Mean.	Excess above aver'ge (26.1)	Max. ob-served.	Min. ob-served.	Range.	No. of days.	Inches	No. of days.	Inches	Resultant. Direction.	Resultant. V'y.	Mean Force or Velocity.
1840	42.4°	+ 1.4°	65.9°	25.3°	40.6°	14	3.420	2	...	...	...	....
1841	39.2	— 1.8	62.9	22.1	40.8	3	1.370	3	...	...	...	0 51lbs.
1842	43.1	+ 2.1	89.5	21.6	67.9	8	3.740	2	...	...	...	0.57
1843	40.9	— 0.1	70.0	15.1	54.9	7	3.185	3	...	...	...	0.46
1844	47.5	+ 6.5	74.5	17.2	57.3	10	1.515	1	Inap	...	...	0.24
1845	42.1	+ 1.1	66.0	14.8	51.2	11	3.290	4	1.5	...	...	1.00
1846	44.0	+ 3.0	79.4	24.4	55.0	10	1.300	2	1 5	...	...	0.55
1847	39.2	— 1.8	65.6	8.4	57.2	8	2.870	2	4.0	...	...	0.59
1848	41.3	+ 0.3	65.4	26 5	38.9	5	1.455	1	0.5	N 77° W	1.46	4.89mls.
1849	39.0	— 2.0	70.9	23.2	47.7	10	2.655	2	1.7	N 43° W	3.14	7.50
1850	37.9	— 3.1	63.2	18.2	45.0	7	4.720	2	1.1	N 39° W	1.12	7.64
1851	41.3	+ 0.3	59.2	25.8	33.4	11	2.295	5	1.2	N 14° E	2.52	8.07
1852	38.2	— 2.8	53 8	19.8	34.0	6	1.990	4	9.4	N 23° E	2.44	6.68
1853	41.9	+ 0.9	65.7	27.0	38.7	10	2.625	1	1 0	N 12° W	1.95	5.20
1854	41.0	0.0	65.1	22.3	42.8	12	2.685	4	2.7	N 50 E	2.57	6.81
1855	42.4	+ 1.4	63.8	12.2	51.6	8	2.030	3	1.6	N 36° W	3.99	7.57
1856	42.3	+ 1.3	69.8	15.1	54.7	13	2.780	3	0.1	N 29° E	1.64	6.05
1857	35.4	— 5.6	51.9	10.0	41.9	10	1.755	11	12.9	N 60° W	4.15	10.24
1858	41.5	+ 0.5	61.5	23.8	37.7	13	1.642	2	0.1	N 14° W	1.64	9.57
1859	39.5	— 1.5	62.1	23.9	38.2	9	2.527	8	1.2	N 36° W	2.33	10.79
1860	39.5	— 1.5	60.7	19.7	41.0	11	1.282	5	0.3	N 37° W	4.10	10.80
1861	42.0	+ 1.0	62.3	26.2	36.1	12	1.619	4	6.9	N 37° E	2.31	8.90
1862	39.6	— 1.4	64.1	20.1	44.0	10	2.235	4	0.2	N 50° E	2.48	9.77
1863	42.0	+ 1.0	67.7	8.9	58.8	8	2.210	4	1.6	N 14° E	3.75	9.20
1864	40.9	— 0.1	58.3	29.5	28.8	16	3.633	3	3.5	N 41° E	3.39	7.77
Results to 1864.	40.96	...	55.57	20.04	45.53	9.7	2 433	3.3	2.40	N 7° W	2.07	8.06
Exc. for 1864.	— 0.01	...	— 7.27	+ 9.46	— 16.73	+ 6.3	+ 1.200	— 0.3	+ 1.10	....	... ..	— 0.29

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST,—MAY, 1864.

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.	ME'N	Excess of mean above Normal.	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.	Result't. Direction.	Velocity of Wind. 6 A.M.	2 P.M.	10 P.M.	Re-sult't.	ME'N	Rain in inches.	Snow in inches.
					°	°	°	°	°												°							
1	29.450	29.289	—	—	40.3	53.6	—	—	—	.236	.227	—	—	.95	.54	—	—	w b N	sw b w	N w b w	s 78 w	3.0	7.0	0.2	3.84	4.93	Inp.	...
2	.332	.166	29.197	29.2325	41.7	51.1	38.1	42.75	— 3.97	.218	.247	.213	.222	.82	.65	.93	.81	s w b w	E N E	w b s	N 11 w	1.0	17.0	8.2	3.34	7.65	0 310	...
3	.192	.280	.463	.3262	35.3	41.0	44.6	40.85	— 6.20	.189	.237	.245	.230	.92	.92	.83	.89	E b N	s w b s	N W	N 43 W	5.5	6.5	16.0	4.92	6.93	.300	...
4	.609	.647	.708	.6628	41.0	61.6	45.0	49.68	+ 2.27	.218	.256	.221	.246	.85	46	.74	.71	w b N	w b N	w s w	N 75 W	3.5	11.8	2.5	6.29	7.25	..	...
5	.771	.686	.611	.6862	44.3	62.3	55.8	54.43	+ 6.70	.230	.324	.280	.285	.79	.58	.62	.67	Calm.	s s w	s W	s 30 W	0.0	14.5	8.5	6.39	6.50	...	...
6	.554	.489	.658	.5707	51.8	66.3	48.6	55.93	+ 7.90	.310	.419	.292	.344	.80	.64	.85	.77	Calm.	s w b s	N b W	N 48 W	0.0	8.2	4.0	2.94	6.81	.090	...
7	.633	.541	.500	.5532	43.5	43.5	44.3	43.88	— 4.53	.259	259	.278	.265	.92	.92	.95	.93	E b S	E N E	E	N 83 E	5.0	7.0	0.5	3 04	3.08	.200	...
8	.469	.401	—	—	43.5	56.2	—	—	—	.268	.406	—	—	.95	.90	—	—	E	E b s	Calm.	s 48 E	0.8	1.5	0.0	0.75	0.82	.258	...
9	.383	.296	.236	.2903	50.4	66.3	53.3	57.55	+ 8.38	.351	.407	.355	.383	.96	.62	.87	.81	Calm.	s w b s	Calm.	s 26 w	0.0	10.0	0.0	3.35	3.47	.225	...
10	.225	.315	.567	.3823	52.2	42.5	36.7	42.55	— 6.95	.381	.263	.155	.251	.97	.67	.71	.88	N E	N N W	N b W	N 18 W	6.5	22.0	6.0	11.94	12.20	.620	...
11	.616	.570	.555	.5747	36.3	39.2	40.7	39.58	—10.32	.157	.138	.204	.169	.74	.57	.80	.69	E N E	Calm.	E S E	N 75 E	6.5	0.0	1.2	1.80	1.93	...	...
12	.535	.523	.531	.5280	38 8	51.5	42.1	45.22	— 4.95	.195	.174	.223	.203	.82	.45	.83	.69	Calm.	s s E	E N E	s 40 E	0.0	2.5	3.5	1.79	2.85	.095	...
13	.528	.469	.457	.4833	44.3	51.0	52.6	50.47	— 0.10	.178	.379	.321	.328	.95	.91	.80	.89	N E b N	N b E	N	N 8 E	2.8	13.8	14.0	9.37	9.53	.445	...
14	.485	.499	.545	.5108	51.1	57.6	54.7	54.78	+ 3.90	.362	.446	.392	.396	.96	.94	91	.92	N	E N E	E b N	N 69 E	9.0	16.5	12.2	10.13	10.57	.027	...
15	.591	.624	—	—	53.6	64.1	—	—	—	.373	.398	—	—	.91	.66	—	—	E b N	E N E	N E b N	N 66 E	12.4	12.5	7.0	9.14	9.31	.515	...
16	.627	.602	.486	.6055	56.9	66.6	60.9	61.10	+ 9.52	.431	.479	.441	.454	.93	.73	.82	.84	E	E b s	Calm.	N 80 E	9.5	6.8	0.0	3.43	3.64	Inp.	..
17	.556	.514	.507	.5252	61.2	69.5	65.6	66.03	+14.05	.446	.533	.453	.473	.83	.74	.71	.74	N N W	Calm.	E	N 17 E	1.8	0.0	0.8	2.30	3.75	...	...
18	.547	.536	.520	.5353	57.6	64.1	59.0	61.50	+ 9.22	.399	.291	.292	.333	.84	.48	.57	.61	N	s	N W b N	N 77 E	8.0	3.2	2.8	1.56	3.28	...	...
19	.568	.584	.556	.5700	54.7	65.2	55.4	59.05	+ 6.43	.263	.334	.295	.287	.60	.53	.67	.57	E E b E	s b w	Calm.	s 80 E	2.4	2.8	0.0	1.07	2.03	...	...
20	.562	.438	.352	.4432	52.2	67.0	60.9	60.82	+ 7.80	[illegible]	[illegible]	438	384	.78	.58	.81	.72	N b E	s b w	w s w	s 89 w	1.0	8.4	3.2	4.21	5.81	...	...
21	.334	.275	.308	.3057	63.4	72.0	64.8	67.23	+13.92	.445	.500	.445	.468	.76	.63	.72	.70	N w b w	N W b N	N W	N 52 W	1.0	12.5	12.0	7.85	9.27	Inp.	...
22	.446	.534	—	—	56.2	65.9	—	—	—	.360	.290	—	—	.80	.45	—	—	N N W	N N W	s E b s	N 4 W	5 0	7.5	1 0	2.52	4.06	...	...
23	.536	.377	.322	.4017	49.0	59 4	54.0	55.00	+ 1.03	.297	.297	.325	.312	.85	.58	.78	.72	Calm.	E	E N E	N 84 E	0.0	9.8	1.2	3.67	4.11	...	...
24	.356	.346	.376	.3593	54.0	69.5	63.0	63.02	+ 8.73	.367	.532	.487	.470	.88	.74	.85	.81	s E b s	s b w	N E b N	s 39 w	1.5	8 0	4.2	1.55	5.48	.335	...
25	.372	.406	.430	.3987	59.8	65.5	56.2	60.80	+ 6.12	.492	.506	.417	.467	.96	.80	.93	.88	N N E	s E b s	Calm.	s 76 E	2.8	1.4	0 0	1.02	1.22	...	...
26	.406	.312	.274	.3225	58.7	64.1	63.4	61.70	+ 6.72	.467	.512	.444	.464	.95	.85	.76	.84	E N E	s E b s	N w b N	N 24 W	1.5	1.8	5.5	3.04	4.41	.010	...
27	.279	.346	.488	.3828	60.1	73.3	55.4	62.78	+ 7.50	.414	.252	.285	.300	.79	.30	.64	.54	N E b N	N W	N W b W	N 24 W	12.8	19.5	9.2	12.19	12.64	...	..
28	.630	.689	.718	.6848	48.6	56.5	45.7	50.57	— 5 08	.201	.175	.211	.193	.58	.38	.68	.53	N N W	N W b N	Calm.	N 22 W	14.8	15.5	0.0	8.91	9.36	...	...
29	.667	.495	—	—	46.8	49.7	—	—	—	.206	328	—	—	.64	.91	—	—	Calm.	s b w	Calm.	s 32 w	0.0	9.5	0.0	3 82	4.18	.010	...
30	.495	.460	.334	.4335	51.5	60.1	54.4	54.97	— 1.28	.294	.366	.341	.327	.77	.70	80	.75	N W b W	E b s	s w	s 80 E	2 5	7.0	1.3	3.20	3.96	..	...
31	.434	.486	597	.5053	60.5	73.8	55.5	62.90	+ 6.35	.408	.409	.404	.402	.77	.49	.92	.72	Calm.	s E	N	N 11 W	0.0	2.2	2.5	1.43	3.72	.580	...
M	29.4833	29.4558	29 4761	29.4721	50.73	60.13	52.72	54.81	+ 3.33	.322	.351	.325	.333	.81	.66	.79	.75	....	....	....	....	3.89	8.60	4.11	......	5.64	4.070	0.0

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR MAY, 1864.

NOTE.—The monthly means do not include Sunday observations. The daily means, excepting those that relate to the wind, are derived from six observations daily, namely, at 6 A.M., 8 A.M., 2 P.M., 4 P.M., 10 P.M., and midnight. The means and resultants for the wind are from hourly observations.

Highest Barometer . . . . . . 29.788 at 8 a.m. on 5th. } Monthly range=
Lowest Barometer . . . . . . 29.166 at 2 p.m. on 2nd. } 0.622 inches.

Self-registering Ther.:
- Maximum temperature . . . . 79°0 on p.m. of 21st } Monthly range=
- Minimum temperature . . . . 32°2 on a.m. of 11th } 46°8
- Mean maximum temperature . . 62°86 } Mean daily range=16°67
- Mean minimum temperature . . 46°20 }
- Greatest daily range . . . . . . 26°2 from a. m. to p. m. of 4th.
- Least daily range . . . . 6°2 from a. m. to p. m. of 7th.

Warmest day . . . 21st...Mean Temperature . . . 67°23 } Difference=27°65.
Coldest day . . . 11th...Mean Temperature . . . 39°58 }
Maximum { Solar (Vacuum) . . . . 121°0 on p. m of 31st } Monthly range=
Radiation { Terrestrial . . . . 24°6 on a. m. of 12th } 96°.4
Aurora observed on 3 nights, viz.:—on 3rd, 5th, and 28th.
Possible to see Aurora on nights 12; impossible on 19 nights.
Snowing on ... days; depth ... inches; duration of fall, ... hours.
Raining on 18 days; depth, 4 070 inches; duration of fall, 87.6 hours.
Mean of cloudiness=0.68; above average, 0.15. Most cloudy hour observed, 4 p.m; mean=0.73; least cloudy hour observed, mid't.; mean=0.62.

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

North.	South.	East.	West.
2103.84	734.06	1133.15	1312.51

Resultant direction, N. 7° W.; Resultant Velocity, 1.86 miles per hour.
Mean velocity 5.64 miles per hour.
Maximum velocity 24.5 miles, from 2 to 3 p.m. on 10th.
Most windy day 27th—Mean velocity 12.64 miles per hour. } Difference 11.82.
Least windy day 8th—Mean velocity 0.82 miles per hour. }
Most windy hour, 1 to 2 p. m.—Mean velocity, 8.92 miles per hour. } Difference
Least windy hour, 4 to 5 a.m.—Mean velocity, 3.45 miles per hour. } 5.47 miles.

3rd, Faint Auroral light in N. and N.E at midnight.—5th, Solar Halo from 11.30 a.m. to 2 p.m., Auroral light and faint Streamers at 10 p.m. and midnight.—6th, Rainbow at 6.40 p.m, Lightning and distant Thunder at 10 p.m.—7th, Foggy and damp day.—8th, Foggy; Thunder in S.W. at 10 a.m.—9th, Lightning and distant Thunder at midnight; Foggy at 6 a.m.—11th, Hoar Frost and thin Ice at 6 a.m., Solar Halo and Parhalia at 6.20 a.m.—12th, Hoar Frost at 6 a.m.; pleasant day. 15th, Severe Thunderstorm, vivid Lightning and heavy Rain from 8.10 to 9 p.m.—17th, Distant Thunder 10 30 a.m. to 4 p.m.—20th, Solar Halo at 3 p.m.—23rd, Thunderstorm and incessant Sheet Lightning 10 p.m., and midnight.—24th, Solar Halo, 11.30 a.m. to 0.30 p.m.—25th, Ground Fog at midnight.—26th, Dense Fog.

May 1864 was comparatively mild, wet, cloudy, and calm.

COMPARATIVE TABLE FOR MAY.

YEAR.	TEMPERATURE.					RAIN.		SNOW.		WIND.		
	Mean.	Excess above Average (45°5).	Maximum observed.	Minimum observed.	Range.	No. of days.	Inches.	No. of days.	Inches.	Resultant. Direction.	Resultant. Velocity.	Mean Force or Velocity
	°		°	°	°							
1840	53.8	+ 2.1	74.5	30.8	43.7	9	4.150	0	...	...	...	...
1841	50.5	— 1.2	76.2	26.6	49 6	11	2.350	1	...	...	...	0.35 lbs
1842	49.1	— 2.6	74.3	30.0	44.3	7	1.275	0	...	...	...	0.53 "
1843	49.1	— 2.6	79.6	28.9	50.7	5	1·570	0	0.0	...	...	0.52 "
1844	53.6	+ 1.9	77.7	29.0	48.7	14	5.670	0	0.0	...	...	0.30 "
1845	49.6	— 2.1	76.6	29.4	47.2	8	2.300	0	0.0	...	...	0.55 "
1846	55.5	+ 3.8	78.1	34.3	43.8	9	4.375	0	0.0	...	...	0.46 "
1847	54.4	+ 2.7	72.5	27.8	44.7	12	2.040	0	0.0	...	...	0.29 "
1848	54.1	+ 2.4	78.5	31.9	46.6	13	2.527	0	0.0	N 40 W	1.31	4.93 ms
1849	48.0	— 3.7	72.5	32.7	39.8	16	5.115	0	0.0	N 51 E	1.97	5.33 "
1850	47.6	— 4.1	76.3	31.1	45.2	7	0.545	1	Inp.	N 64 W	2.05	6.32 "
1851	51.3	— 0.4	73.2	28.7	44.5	12	2.950	1	0.5	N 32 W	1.59	6.34 "
1852	51.4	— 0.3	73.3	34.5	38.8	7	1.125	1	Inp.	S 82 W	0.99	4.00 "
1853	50.9	— 0.8	78.4	38.4	40.0	17	4.420	1	Inp.	N 2 W	0.83	5.16 "
1854	52.2	+ 0.5	69.0	27.6	41.4	11	4.630	0	0.0	E	0.40	5.38 "
1855	53.1	+ 1.4	74.8	33.9	40.9	6	2.565	2	0.9	N 1 W	2.76	5.93 "
1856	50.5	— 1.2	80.1	35.5	44.6	14	4.580	1	Inp.	N 4 E	3.99	9.81 "
1857	48.9	— 2.8	72.5	27.9	44.6	15	4.145	1	Inp.	N 23 W	1.14	8.13 "
1858	48.9	— 2.8	66.0	35.0	31.0	17	6.367	0	0.0	N 42 E	3.33	9.30 "
1859	55.2	+ 3.5	76.2	41.5	34.7	11	3.410	0	0.0	N 72 E	1.59	5.70 "
1860	55.5	+ 3.8	73.2	35.6	37.6	16	1.815	0	0.0	N 26 E	2.66	7.17 "
1861	47.5	— 4.2	72.0	29.1	42.9	12	3.380	1	0.5	N 47 W	3.60	9.17 "
1862	52.2	+ 0.5	77.8	38.1	39.7	8	1.427	0	0.0	N 52 W	2.80	7.87 "
1863	54.3	+ 2.6	77.1	38.1	39.0	14	3.363	1	0.1	N 56 E	0.41	5.89 "
1864	54.8	+ 3.1	74.2	35.3	38.9	18	4.070	0	0.0	N 7 W	1.86	5.64 "
Results to 1864.	51.68	...	74.98	32.47	42.52	11.6	3.206	0.4	0.09	N 6 W	1.46	6.59
Exc. for 1864.	+3.13	...	—0.78	+2.83	—3.62	+ 6.4	+ 0.864	— 0.4	— 0 09	...	...	—0 95