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NOTES ON LATIN INSCRIPTIONS FOUND IN BRITAIN.

PART VIII.

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49. Restorations of imperfect inscriptions, although subjects of agreeable speculation, are generally very hazardous, excepting those cases in which the extant words or letters are parts of *formulæ*, and then a perfectly reliable reading may be supplied from known examples. It is very different, however, when the attempt is made to complete a fragment by supplying facts supposed to have been stated in the missing or mutilated portions. In such cases the restoration, although sometimes ingenious, is scarcely ever more than plausible. A remarkable example is presented by Governor Pownall's well known restoration of the imperfect inscription on stones found in Bath, and believed to have formed part of the frieze of the *temple of Minerva

* The only ancient authority for this temple is the following passage in Solinus :—"*fontes* calidi *opiparo exculti apparatu ad usus mortalium:* quibus fontibus *præsul est* Minervæ numen, in cujus æde *perpetui ignes nunquam canescunt in favillas, sed ubi iguis tabuit, vertit in globos saxeos.*" The identity of the second syllable of *præ*sul with the Celtic name of the goddess suggests that Solinus may have referred to it when he used the word, but the suspicion is groundless, as he says, in another place, of Angerona:—*diva* præsul *silentii.* Mr. Whitaker seems to have attached great importance to this passage in Solinus, and has built up some theories on it. In his estimate of its value I cannot concur: the facts and the Latinity of Solinus seem to be equally worthless. I am not disposed, however, to question the existence of a temple of Minerva in Bath, as it is otherwise probable.

in that city. The fragments are figured in Warner's *History of Bath*, *pl.* 1., *fig.* 7, and the words on them are thus read by the Rev. H. M. Scarth, *Journal of British Archæological Association*, 1857, p. 266:

(1.)	(2.)
LAVDIVS · LIGVR	OLEGIO · LONGA · SERIA
E · NIMIA · VETVST	VNIA · REFICI · ET · REPINGI · CVR

From these fragments Governor Pownall invented the following restoration:—

[AVLVS · C]LAVDIVS · LIGVR[IVS · SODALIS · ASCITVS
FABRORVM · C]OLEGIO · LONGA · SERIA · [DEFOSSA
HANC · AEDEM·]E · NIMIA · VETVST[ATE · LABENTEM
DE · INVENTA · ILLIC · PEC]VNIA · REFICI · ET · REPINGI ·
CVR[AVIT ·]

The supplied words and letters I have placed between brackets [ ].

The idea of *Claudius Ligurius* being a member of the College or company of smiths, was evidently suggested, as Mr. Scarth observes, by the inscription to *Julius Vitalis*, in which it is stated that he (*Vitalis*) was *ex *colegio fabrice elatus*. The objections to the use of the words—†*sodalis ascitus fabrorum colegio*—in the con-

* It has been inferred from these words that there was a *fabrica*, *i. e.* a public factory of arms, in or near Bath, although the *Notitia*, whilst noticing similar establishments in different parts of the empire, does not mention it. This, possibly, may have been the fact, but it must be borne in mind, that as *Vitalis* was one of the *fabri* or *fabricenses* attached to the 20th legion, the *collegium*, who manifested their regard for him by a funeral at their expense, may have been the association of smiths or armourers in that legion. Thus in Orelli, n. 4922 we find mention of the *collegia frumentariorum* in the 8th and 13th legions. *Elatus* (Orelli, nn. 4715, 4716) denotes that the corpse was borne to the place of interment on the shoulders—thus Horace, Sat. ii., 5:—

Ex testamento sic est elata: *cadaver*
Unctum oleo largo nudis humeris *tulit hæres.*

Tacitus, *Ann.* i., 8. *Conclamant patres corpus ad rogum* humeris *senatorum* ferendum.

We may also infer that this was a walking funeral, the procession being formed of the members of the guild, who followed the body on foot. FABRICE may stand either for FABRICE[NSIVM]; or for FABRIC[A]E. Orelli, n. 4079, adopts the latter, referring it, however, to the *fabrica* of the legion.

† Governor Pownall seems to have attached undue importance to membership in a *collegium fabrûm*. There were hundreds of such *collegia* or organizations of tradesmen, mechanics, and labourers of every class throughout the Roman Empire. The *collegia fabrum* alone may be counted by dozens; and we are not without examples of *collegia dendrophororum*, *mulionum et asinariorum*, *suariorum et confectuariorum*, whose members respectively occupied positions in society about the same as English porters, waggoners, and pork-butchers.

nection in which they appear, are, if the words be intended to mean on the occasion of his election or appointment, the money for the repairing and repainting, should, according to usage, have been provided from his own funds; and if the words be intended merely as an honorary designation, there is no authority, so far as I am aware, for their use in this sense under such circumstances. The words *seria* and *pecunia* suggested the invention of the story about the money having been found in a vessel. The objections to this application of *longa seria defossa* are—the word *longa* seems inappropriate when applied to *seria*, even though its shape is said to have been *oblonga;* and *defossa* does not signify *dug up*, which seems to have been the meaning intended, but *buried*, so that the translation of the words, as they stand, which would first present itself, would be, *a long earthen vessel having been buried*, not *having been dug up*. If *seria* be the correct reading the most probable *prima facie* reference would be to the *seria* which was kept in temples. Thus:

Lamprid. *Heliogab. c.* 6. "Penetrale sacrum [Vestæ] est auferre conatus: cumque *seriam*, quasi veram, rapuisset, atque in ea nihil reperisset, applosam fregit."

But it seems not unlikely that either the true reading of the word on the stone is *serie*, or that the final *a* is a mistake in orthography for *e*. We have thus *longa serie*, and if we supply *annorum*, this phrase and *nimia vetustate* will agree well with *refici et repingi*. Thus in Orelli, n. 3300, we have PERMVLTO TEMPORE VETVSTATE CONLAPSVS. As to the age of the inscription, a surmise may perhaps be formed with some reason from the use of the word *repingi*, a verb, which I do not recollect having seen in any Latin writer earlier than the 6th century, A. D. On the restoration, as a whole, it is unnecessary to say more than that I am persuaded that no one familiar with Latin Epigraphy would mistake it for a genuine inscription; indeed it is not as plausible as many of the Ligorian forgeries.

50. Another example, of the danger of attempting a restoration with insufficient data, is to be found in Mr. C. Roach Smith's remarks on an inscription on a stone found, I believe, at Netherhall, Cumberland.

It is figured in the *Collectanea Antiqua*, ii. pl. 48, fig. 7, and the following (p. 202) are Mr. Smith's observations on it:—

* * * * ILSER *
QVINANAT * * *
GALATIA · DEC
BVIT GALA****
XIT ANN * * * *
MORITV * * * * *
DESIDER *****
RIS·INT * * * * *

"This inscription is incorrectly given by Gordon, and Hodgson does not attempt to restore it. Two lines seem wanting at the beginning and one at the end. What is left may probably be read thus:—*f*ILius SERV*ii* QVI NAT*us* GALATIA DEC*u*BVIT GALATIA *vi*XIT ANNOS · · MORITV*rus* DESIDER*avit pat*RIS IN T*umulo sepeliri?*"

Mr. Wright (*Celt, Roman, and Saxon*, p. 320) gives the translation according to this reading:—

". . . . IL SER	. . . . son of Servius,
QVI NANAT	who born
GALATIA DEC	in Galatia
BVIT GALA. . .	died in Galatia;
XIT ANN	He lived . . . . years;
MORITV	On his death-bed
DESIDER	he desired
RIS INT	in his father's tomb to be buried."

To this is subjoined the following note:—

"The translation of this inscription is made after the ingenious restoration of Mr. Roach Smith, who (*Collectanea*, ii. p. 202) explains it, I believe correctly, as follows:—*f* IL*ius* SER*vii* QVI NAT*us* GALATIA DEC*u*BVIT GALATIA *vi*XIT ANNOS. . . MORITV*rus* DESIDER*avit pat*RIS IN T*umulo sepeliri*. In the second line, NANAT appears to be an error of the stone-cutter for NAT."

In p. 319, Mr. Wright refers to this inscription in the following terms:—

"A broken inscription in one of the stations along the wall of Hadrian commemorates a native of Galatia, whose father having, as it appears, died in in Britain, the son, who died in his native country, wished on his death-bed to be carried into Britain to be laid in his father's grave."

This simple statement of the story, as it is told in the restored inscription, manifests its improbability. It is not common, even now, with our increased facilities of transportation, for the bodies of the dead to be removed such a distance as Galatia was from Britain; and when these cases do occur, they are usually of members of families of distinction or in affluent circumstances, and with the object of having the remains deposited near those of relatives of the deceased in their native lands. Here the case seems to be of a son, whose remains, in accordance with his desire on his death-bed, were removed from his birth-place Galatia, being the place also of his death, to the grave of his father in Britain, whose presence there and whose death there are equally unexplained; and indeed inexplicable, unless on the supposition that he had gone there with the corps in which he was serving, probably as a private soldier. But besides this, at the time of the inscription (to whatever date during the Roman occupation of the island it should be referred) this power of removal seems not to have been at the pleasure of individuals. We know that the Romans did not allow a body, even temporarily interred, to be removed to any other place without the permission of the *pontifices* or other proper authorities. Of this we have an example in Gruter, p. DCVII. n. 1, where we find a copy of the memorial addressed by *Velius Fidius* for permission to remove the bodies of his wife and son from an *obruendarium*, or sarcophagus of clay, to a monument of marble, with the object—*ut quando ego esse desiero, pariter cum iis ponar.* (See p. 14 of *Roman Sepulchral Inscriptions*, a scholarly and very interesting little work, by the Rev. J. Kenrick, of York, England; and Orelli, nn. 794, 2439.) I do not mean to say that there is no authority for the removal of human remains, without a statement of permission, for there are examples, but I think that the absence of the notice in this case of both removal and permission, throws additional doubt on a reading previously highly improbable. It must also be admitted, that the improbability of the removal of the bones, which in those times would, perhaps, be the only remains, is less than that of the transportation of the body.

But if we examine the restoration in detail, we shall, I think, find the degree of improbability considerably increased.

Mr. Smith reads the fragment of the first line thus: [F]IL · SER-[VII]. Now the obvious objection to this reading is, that the order is contrary to usage: the name of the father should precede, and FIL · or F · follow. There can, I think, be but little doubt, that the name of the father was in the mutilated portion of the line before FIL · and that SER · stands for SER[GIA] *tribu*, which is thus in its proper place. In the second line—QVINANAT— NANA is treated as a blunder of the stone-cutter, who inadvertently doubled the NA, *i.e.* the reading QVI : NAT[VS] is given instead of QVINA-NAT[VS]. Sooner than resort to this uncritical expedient, I prefer regarding QVINA as the *cognomen,** even though I can produce no example of it. The letters are certainly in the position where the *cognomen* should be expected, scil. after the tribe. The translation of DECVBVIT—"died"—is liable to the objection, that this is not the ordinary meaning of the word. *Decumbere* commonly means "to fall sick," although there are examples of its gladiatorial application, "to fall in death." It is not impossible, however, that it may be used here in the sense—"he took to his bed and never left it alive." The last two lines of the inscription,† as given by Mr. Smith, scil. DESIDER**** RIS · INT**** are restored thus: DESIDER[AVIT · PAT]RIS · IN · T[VMVLO]; and to this is added, to complete the conjectural sense, but without a trace of authority on the stone, the word SEPELIRI.

The objection here is to the Latinity of the phrase *desideravit sepeliri.* So far as I am aware, there is no authority for its use; and the appearance of it in an inscription would, in my judgment, at once suggest doubts of the correctness of the reading or of the genuineness of the inscription.

It is not my intention to suggest any conjectural reading of the inscription which we have been examining; it seems to be too far gone to be within the reach of hopeful critical treatment. I may be permitted, however, to observe, that the reading GALA[VAE], probably the modern *Keswick,* or GALA[TI],‡ the Κάλατον of Ptolemy, is more probable than GALA[TIA]; and that the fragmentary words MORITV**** DESIDER**** may be more plausibly explained as intimating that the deceased pined and died from fretting for his distant or deceased father, mother, or brother, scil. *desiderio patris, matris,* or *fratris.* Thus we have in Henzen, n. 7378:—

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* It has occurred to me, that perhaps the true reading is OVINA, a name, of which the first four letters are found in Mommsen, *Inscript. Neapol.* n. 6811.

† In Gordon's *Itinerary, pl.* 45, we find NON VA in a line under RIS INT.

‡ The mention of the place of death is so uncommon, that there was probably some special reason for noticing it here. Perhaps the resemblance of *Galatum* to *Galatia* was the cause. It has been identified with *Galacum* of the Itinerary.

D · M · S
TELESINIAE · CRISPI
NILLAE · CONIVGI · SANCTIS
SIMAE · QVAE · OB · DESIDERIVM
P · LALI · GENTIANI · VICTORIS
FILI · SVI · PIISSIMI · VIVERE
ABOMINAVIT · ET · POST · DIES · XV
FATI · EIVS · ANIMO · DESPONDIT
&c. &c. &c.

And in Cicero, *Epist. ad. Attic.* i. 3. *Aviam tuam scito* desiderio tui mortuam esse.

51. That there was a goddess worshipped at Bath under the name *Sul,* there can be no doubt. She is named in inscriptions on four altars, and on a tombstone found in that city. Of the inscriptions on these altars, two of them prove that she was identified with Minerva. The similarity of the name suggests that she may have been the same as *Sulivia Idennica Minerva* in n. 2051, of Orelli's Inscriptions; and also leads to the belief, that there was some connection between her, and the *Sulevæ, Suleviæ, Silviæ,* or *Silvanæ,* mentioned in Orelli's, nn. 2099, 2101, 2103. The terms *Sulevis et Campestribus* in 2101, and *Silvanab. et Quadribis,* (i. e. *Silvanabus et Quadriviis*) favour the opinion, that the *Sulevæ* should be classed amongst the *Matres,* traces of whose worship have been commonly found, especially in Germany, Belgium, and Britain. Mr. Scarth, (Journal of the *Archæological Association,* 1861, p. 16,) regards them as "probably attendant nymphs" of *Sul*; and to Mr. Roach Smith, (*Roman London,* p. 38,) "they appear to have been Sylphs, the tutelary divinities of rivers, fountains, hills, roads, villages, and other localities, against whom were especially directed, in the fifth and subsequent centuries, the anathemas of Christian councils, missionaries, and princes."

Dr. Thurnam, in the very able dissertation on the "Historical Ethnology of Britain," in *Crania Britannica, Dec.* iv. *p.* 130, observes:—

"Under that of *Sul,* a Welsh name of the sun, he (Apollo) was worshipped in Brittany, where, under Christianity, he was represented by a pretended St. Sul. There are traces of this name in that of various hills—Solsbury, Salisbury, Silbury—at Bath, Ribchester, Edinburgh, and Abury, which are so many high places of the Sun-god, or Celtic Apollo." * * * * *

"The Celts had not only a great male divinity representing the Sun, but likewise a female one symbolising the passive powers of nature, and by whom the Moon (as by the Syrian Astarte or Venus-Urania), was originally intended."

* * * * * * * * *

"The goddess worshipped conjointly with Apollo at Aquæ Solis [or, as others prefer, Aquæ Sulis] was clearly the Celtic Minerva, as appears from the epithet SVL., by which she was there known, and which, like that of Baalsemen [Lord of Heaven,] had both a feminine and masculine application. The Solimara, [Orelli, n. 2050,] worshipped by the Bituriges may have been the same as the British Sul."

52. The following is a copy of the inscription on the Bath altar, in which the *Sulevæ* are named :

SVLEVIS
SVLINVS
SCVLTOR
BRV[C]ETI · F
SACRVM · F · L · M

Mr. Scarth remarks :—"In the name of the dedicator we have an instance of the name of an individual derived from the presiding deity of the waters [i. e. *Sul*] ; this is also to be remarked on another altar—*Sulinus Maturi fil.*" This account of the etymology of the name seems probable, especially when we call to mind the Greek and Roman usage of forming names of persons from the names of their deities, such as *Hermogenes, Jovinus, &c.*

The *prima facie* interpretation of the three middle lines, *scil.* "Sulinus Scultor, the son of Brucetus," is liable to the objections, that *Sulinus* of the other altar has but one name ; and that "the last three lines of this inscription are in letters much smaller, and not so deeply cut as the first two lines," whence "Mr. Hunter thinks that the first two lines are the original inscription and that the others were added afterwards." This peculiarity suggests the conjecture that the first inscription was left imperfect, and that a different person," 'Scultor, the son of Brucetus' took the vacant space for his inscription consisting of the last three lines. But the Greek and Roman stone cutters seem to have been so capricious as to the size of the letters and the depth of the cutting in the same inscription, that we are scarcely warranted in inferring in this case two inscriptions. I am inclined to think that *Scultor* is not a name of a person, but the designation of an occupation, scil. *sculptor*, the carver or stone cutter, *i. e.* "Sulinus the carver."

This conjecture is supported by the use of the rare formula F. L. M., which I read *fecit libens merito*. If the representation of the altar, as given by Mr Warner in pl. 2, fig. 6, be accurate, there is reason to suspect the reading BRV[C]ETI · F., as in that representation it seems to be more probably BRVCI · FIL ·, or rather BRVSCI · FIL., as in one of the Lincoln inscriptions, noticed in Art. 42 of these notes.

53. The opinion, which I have expressed in the last article, relative to *Sulinus* and *Scultor* is favoured by an examination of the inscription on another altar, scil.:

DEAE
SVLIMI
NERVAE
SVLINVS
MATV
RIFIL
VSLM.

i. e. Deæ Suli Minervæ, Sulinus, Maturi filius, votum solvit libens merito.

It may, I think, be reasonably inferred, from the apparent etymology of the name *Sulinus*, and from the circumstance, that the individual had but one name, that the dedicator was a barbarian, *i. e.* a native Briton, or Gaul. This inference derives support from the order of the words SVLI MINERVAE. If the dedicator had been a Roman, or a Romanized provincial, he would probably have conformed to the usage of placing the designation of the Roman deity first, and that of the identified barbarian deity second. There are many examples of this usage. Amongst the most obvious are *Marti Camulo, Apollini Toutiorigi, Dianæ Abnobæ*.

54. The tomb-stone, to which reference was made in art. 51, bears the following inscription:—

D. M.
C. CALPVRNVS
[R]ECEPTVS SACER
DOS DEAE SV
LIS VIX AN LXXV
CA[LP]VRNIA TRIFO
SA [THR]EPTE CONIVNX
F. C.

Mr. Scarth's remarks on it are :—

"This is expanded thus by Mr. Lysons :—"Diis Manibus Caius Calpurnius Receptus Sacerdos Deæ Sulis, vixit annos septuaginta quinque Calpurnia Trifosa Threpte conjunx faciendum curavit." Mr. Hunter, in the Bath Institution Catalogue, observes that *Receptus* may be an appellation of Calpurnius, or it may signify that he was an "admitted" priest of the goddess Sul."

Of the two interpretations, mentioned by Mr. Hunter, I prefer the former, scil. *Receptus* as a *cognomen:* if the latter had been intended, the order would probably have been *Sacerdos receptus.*

The strangeness of the names of his wife might, perhaps, lead some to question the correctness of the reading, but on examination they will, I think, be found to be free from objection. According to my view of them, they afford evidence that the priest married a Greek slave, that was born and brought up in his house. TRIFOSA and THREPTE suggest that she was Greek, and CALPVRNIA and THREPTE that she had been his slave. TRIFOSA, TRYFOSA, TRIPHOSA and TRYPHOSA are all Latinized forms of a Greek female name, taken, as *Sympherusa, Prepusa, Terpusa* and many others, from the nominative singular feminine of the present participle active, *i.e.*—TRYΦΩΣΑ or τρυφῶσα, from the verb τρυφάω, the same name that is found in St. Paul's *Epist. ad Rom.* xvi. 12. THREPTE, or TREPTE as it is otherwise written, is used as a *cognomen,* but as the female mentioned here already has one, scil. *Tryphosa*—I regard the word as standing for θρεπτή, the Greek term corresponding to the Latin *verna.*

It is scarcely necessary to add, that, according to usage, she took her first name *Calpurnia* from the *nomen gentilitium* of her master.

It is worthy of observation, that two of the altars, dedicated *Deæ Suli,* were erected, probably, by Greek slaves who had been manumitted, viz: *Aufidius Lemnus**, (*Lemnius?*) and *Aufidius Eutuches* (*Eutyches?*). These *liberti* took their names *Aufidius* from their master, *Marcus Aufidius Maximus,* who is mentioned in each of the inscriptions, retaining, according to usage, as *cognomina,* their servile appellations—*Lemnus* (or *Lemnius?*), probably from his birth-place *Lemnos* in the Ægean, and *Eutyches,* from εὐτυχής, lucky. It is well known that some slaves were called after their birth-place *e. gr. Syrus, Geta, Cappadox, &c.*; and others, from reputed or real characteristics. Mr. Warner's supposition (as noticed by Mr. Scarth) that

* In Mommsen's *Inscript. Neapol.* n. 4333, we have LEMNIVS LIBERTVS.

"the name EVTVCHES is EIVS ADOPTATVS HERES" is unintelligible. If his meaning be that the name implies that he was "the adopted heir of his master," there is not the slightest foundation for the supposition, either in the name or in the inscription. Mr. Warner with equally little reason supposes the two altars to have been erected by the same freedman. Mr. Hunter and Mr. Scarth infer from the name CALPVRNIVS the rank of this priest as "a member of the noble Calpurnian family." To me there seems to be no ground for this inference; indeed, so far as we know, he may have derived this name, as a *libertus*, from the *nomen gentilitium* of his master. As to his connection with *Quintus Calpurnius Concessinius*, "legate in Britain under Caracalla," it is sufficient to observe, that there was no person of that name who is known to have held the office of legate. Mr. Wright, (*Celt, Roman, and Saxon*, p. 358), mentions an individual with the first two of these names as a governor of Britain, "believed to be of the age of Commodus," but this statement is erroneous. The only *Quintus Calpurnius Concessinius*, known in inscriptions found in Britain, was a *præfectus equitum*. *Vide* Horsley, *Brit. Rom.*, *Northumberland*, cviii, and art. 9 of my notes.

55. Since the publication of Part VI., I have had the opportunity of perusing extracts of letters from the late Sir S. Rush Meyrick to the late Samuel Lysons, Esq., and from the late Sir Wm. Drummond to the late Rev. Danl. Lysons, on the subject of the God *Nodons* or *Nodens*. Sir Samuel Meyrick was of opinion that "Deus Nodens "seems to be Romanised British, which correctly written in its original "language would be Deus Noddyns, *i.e.*, the god of the abyss, or it "may be 'God the preserver,' from the verb noddi, to preserve, both "words being derived from *Nawdd* which signifies 'protection.' I "think the latter translation best expresses the idea of Silvianus, and it "exactly answers to another epithet of the British deity, as mentioned "on an altar in Camden, found at Wigton, in Cumberland (Gough's "Edit. iii. p. 172)—DEO CEADIO, &c.

"Instead of Cea*d*io Camden writes Cea*i*co, but as in numerous in-"stances he puts *I*EO for DEO, and such like, I think he may be "presumed to have mistaken the *d* for an *i*. Duw Ceidiaw is 'God the "preserver.'" There are but few, I think, who will view this etymology with any favour. Sir Wm. Drummond in his first letter on this subject takes the same view as that which I expressed in article 34, and cites almost the same passages in illustration. Subsequently, however, whilst retaining the opinion that the *Nodinus* of Varro, otherwise the *Nodutus* of St. Augustine and Arnobius, was originally the same deity as the *Nodens* of the inscription, he identifies him with Æsculapius. "The emblems," "he remarks, "said to have been found "along with the inscription, serpents, cocks, and dogs, seem strongly to "confirm, nay, even to prove, the truth of this supposition" [originally advanced by Mr. Bathurst, that the deity in question could be no other than Æsculapius]. This leads him to search for another etymology for the name of the god as given in the inscriptions, and, with the help of certain peculiarities of the Etruscan language and letters, to which he believes the Latin "bore a considerable resemblance until about the 5th century after the foundation of Rome," and the further aid of the fact, that the worship of Æsculapius was introduced into Rome about that period, scil. 461, A. U. C.; he arrives at the conclusion that *Nodens* or *Nodons* is a corruption of *Nodunos, i.e.*, *νώδυνος, alleviator of pain,* than which "no name or epithet was more likely to be given by the Greeks to Æsculapius, who was supposed to be the inventor of medicine, and to whose salutary influence was ascribed the restoration of health." Of this theory it seems unnecessary to say more than that there is no authority for the application of the epithet νώδυνος to Æsculapius, and that there is no ground for questioning the received opinion, that the deity *Nodutus,* or *Nodinus,* derived his name from his office of presiding over the *nodi.* Any doubts, however, which I had as to the influence which *Nodons* was believed to possess over human health, have been removed by a notice of the site of the deity's temple in "*The Proceedings of the Archæological Institute, Bristol,* 1851." In a paper on "the British and Roman Roads communicating with Caerwent," Dr. Ormerod observes: "Between the Town of Lydney and Ailburton, it [the road] appears next as a hollow way between the present road and the hills on the right crowned with two Roman camps, of which one contains the remains of the once splendid temple dedicated to a deity of supposed sanitary powers, and is most rich in antiquities."

To this is subjoined the following note:—

"Within the greater camp, when excavated under directions of its owner, the late Rt. Hon. Chas. Bathurst, were discovered the foundation walls of an irregular quadrangle, the sides of which average severally about 200 feet, exclusive of a range of offices along the N. W. side, and of a Palatial fabric on its upper or N. E. side.

"This fabric, once, possibly, the residence of Flavius Senilis, hereafter mentioned, had a portico along its west front, and an open court in the centre, surrounded by corridors, in which, and in various other apartments, tesselated pavements occurred. This building measured about 150 by 135 feet.

"On the north side of this building, separated from it by an open space, were baths and Hypocausts, with a detached building measuring about 125 feet in length by 70 in greatest breadth.

"Near the centre of the principal quadrangle was (as is supposed) the temple of the tutelary deity, the "TEMPLUM NODENTIS," mentioned in the Inscription below. It was about 95 feet long by 75 broad, and in it were three tesselated pavements, the largest having the name of the erector (as in IV.) placed over a fanciful border representing the twisted bodies of salmons, the fish of the Severn.

"The whole was excavated under the direction of its late owner, the relics and coins carefully preserved, plans and drawings taken, and a series of engravings (of very limited number) executed, in which were eleven tesselated pavements. All was then covered again for preservation. Among the relics are coins to the time of Allectus inclusive, a statuette, votive offerings of limbs supposed to be acknowledgments of the sanitary powers of Nodens or Nodons, and three votive inscriptions given below, together with the inscription in the Temple. No. III. has been printed by Lysons, the others are not known to have been published, and are given with their errors of grammar and spelling:

I. D.M.NODONTI.
I.L.BLANDINVS.
ARMATVRA
V.SLM

II. PECTILLVS.
VOTUM. QVOD.
PROMISSIT.
DEO. NVDENTE.
M. DEDIT.

III. DIVO.
NODENTI. SILVIANVS.
ANILVM. PERDEDIT.
DEMEDIAM. PARTEM.
DONAVIT. NODENTI.
INTERQVIBVS. NOMEN.
SENICIANI. NOLLIS.
PERMITTAS. SANITA—
TEM. DONEC. PERFERAT.
VSQVE. TEMPLVM. NO—
DENTIS.

IV. Imperfect, but the seeming number of the deficient letters is shown by points, as follows:

D.A...FLAVIUS.SENILIS.PR.REL.EX.STEPIBVS.
POSSUIT O....ANTE.VICTORINO.INTER...ATE."

From these statements, it may, I think, be reasonably inferred, that this temple was the resort of persons seeking relief from sickness, and that the cocks, serpents, and dogs, as well as the limbs found there, were votive offerings of those who gratefully acknowledged the sanatory powers of the deity worshipped in the place.

The circumstance that limbs were offered, leads to the conjecture that the diseases cured here were such as affect these portions of the body, perhaps rheumatism and gout, the influence of which is felt in the joints, the *nodi*, whence we find *nodosa cheragra*, or *podagra*. And this further suggests the query,—whether the same deity presided over vegetable and animal *nodi?* But—to turn from mere conjecture to something more certain—the inscriptions, marked I. II. and III. are the same as those which formed the subjects of my articles 35, 36, and 37.

The only thing worth noticing regarding them is, that, as given by Dr. Ormerod, they present one or two different readings. They are, however, of no importance; but n. IV. is particularly deserving of attention. The beginning is unfortunately so imperfect, that I can offer no explanation which satisfies me. If the D be regarded as standing for *Deo* or *Dei*, it is not easy to find a suitable word or abbreviation of four* letters, commencing with A. *Aram* (or *Adem?*) seems the most plausible. It is possible that D. A... may be *prænomina* of *Flavius Senilis*, scil. Decimus Aulus, the A and V being ligulate. The abbreviations PR · REL · are also doubtful, from the want of authority. It seems probable to me, however, that they stand for PR[ETIO]† REL[ATO], the cost [of the structure or altar] having been obtained *ex stipibus*, *i.e.* the small pieces of money offered by the votaries of the god, either voluntarily or at the solicitation of the priests, who, like others of their order, during a portion of the day,—"*post templi apertionem* stipes *emendicabant.*" The portion of the inscription—*ex stepibus* [stipibus] *possuit* [posuit]—may be well illustrated by an inscription to *Mercurius Augustus*, found at Yverdun, in Switzerland, *Orelli*, n. 348.

DONA VENIBVNT
AD ORNAMENTA EIVS
ET EX STIPIBVS
PONENTVR·

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* This limitation excludes the conjectures, otherwise plausible, AGREST· or AGRIC·

† The following may also be suggested: pr[æses], pr[æsul], or pr[æfectus] rel[igionis].

This I interpret as meaning that the gifts offered to Mercury, whose statue is referred to in the preceding portion of the inscription, shall be sold to purchase decorations, and the cost of putting them up shall be defrayed from the money-offerings, or what we may call penny contributions.

O .... ANTE · VICTORINO · INTER ... ATE · I regard as standing for OP · CVRANTE · VICTORINO · INTERAMNATE, *i.e. Opus curante Victorino Interamnate,* Victorinus, an Interamnian, (*i.e.* as I understand it, a native of the country between the rivers Wye and Severn), directing the work.

The word INTER .... ATE seems to me to explain INTER, in line six of the third inscription, about the meaning of which I expressed doubts in my former article on the subject. I now regard it as an abbreviation of INTERAMNATI, an epithet given to Nodon, from the situation of his temple and the position of the district in which he was specially worshipped, *i.e.* NODENTI · INTERAMNATI ; as we find *Hercules Tiburtinus, Juno Albana. Jupiter Poeninus, Apollo Actiacus,* &c.

I avail myself of this opportunity to add what I inadvertently omitted mentioning in my former article, that I trace the use of a tablet of lead for this inscription to the fact, that this material was used in recording execrations and for magical *defixiones.* Thus in Tacitus, *Ann.* ii. 69,—*nomen Germanici* plumbeis tabulis *insculptum,* is noticed amongst the *maleficia quîs creditur animas numinibus infernis sacrari;* and Dio Cassius (lvii. 18), whilst telling the same story of Piso's machinations against the life of Germanicus, says: ἐλασμοὶ μολίβδινοι ἀράς τινας μετὰ τοῦ ὀνόματος αὐτοῦ ἔχοντες.

56. The principal remains of Roman metallurgy in Britain are blocks of lead, presenting an appearance of which a good idea may be formed from the subjoined wood-cut.*

(Weight, nearly 156 lbs.; upper, or larger, surface, 24 in. by 5 in.; inscribed surface, 21 in. by 3½ in.; thickness, 5 in.)

* Copied from a wood-cut, in *Journal Arch. Assoc.,* vol. v., illustrating an article, by Mr. C. Roach Smith, which contains much valuable information relative to these blocks.

Mr. Albert Way, in an excellent article (*Journal of Archæological Institute*, 1859, n. 61), has carefully collected the scattered notices of all the relics of this class, which have at various times been found in Britain, and has thus produced a valuable *précis* of almost all that is known on the subject.

The blocks, or "pigs," according to the information given in that article, present the following varieties of inscription:

(1) BRITANNIC**AVG II. (*a*)
(2) TI·CLAVDIUS·CAESAR·AVG·P·M·TRIB·P·VIII·IMP·
XVI·DE·BRITAN. (*b*)
(3) TI·CL·TR·LVT·BR·EX·ARG. (*c*)
(4) NERONIS AVG·EX KIAN $\overline{\mathrm{IIII}}$ COS BRIT. (*d*)
(5) IMP·VESP·$\overline{\mathrm{V}}$::T·IMP·$\overline{\mathrm{III}}$·COS. (*e*)
(6) IMP·VESP·$\overline{\mathrm{VII}}$·T·IMP·$\overline{\mathrm{V}}$·COS. (*f*)
(7) IMP·DOMIT·AVG·GER·DE
CEANG. (*g*)
(8) IMP·CAES·DOMITIANO·AVG·COS·VII. (*h*)
(9) CAESAR ***** VADON. (*i*)
(10) IMP·CAES·HADRIANI·AVG·MET·LVT. (*k*)
(11) IMP·HADRIANI·AVG. (*l*)
(12) IMP·DVOR AVG ANTONINI
ET VERI ARMENIACORVM. (*m*)
(13) L·ARVCONI·VERECVNDI·METAL·LVTVD. (*n*)
(14) C·IVL·PROTI·BRIT·LVT·EX·ARG. (*o*)

It is plain, on inspection, that the simplest of these are nn. (2), (5), (6), (8), (11), and (12). We shall therefore take these up first, and then proceed to the more obscure.

(*a*) Found on Blackdown Range, Mendip Hills, Somerset.
(*b*) Found near Wokeyhole, Somerset.
(*c*) Found at Matlock, Derbyshire; also in Pulborough, Sussex.
(*d*) Found near Stockbridge, Hants.
(*e*) Found about a mile from Chester, on the road to London.
(*f*) Found at Hints, Staffordshire; also on the coast of Cheshire.
(*g*) Found on the coast of Cheshire.
(*h*) Found about eight miles from Ripley, in Yorkshire.
(*i*) Found near Common Hall Street, Chester.
(*k*) Found near Matlock, Derbyshire.
(*l*) Found about ten miles from Shrewsbury, Shropshire; also about seven miles north of Bishop's Castle, Salop; also about four and a half miles from Montgomery, Shropshire; also near Sydney Buildings, Bath.
(*m*) Found at Bruton, Somerset.
(*n*) Found upon Matlock Moor, Derbyshire.
(*o*) Found about six miles from Mansfield, Nottinghamshire.

(2) Ti[berius] Claudius Cæsar Aug[ustus] P[ontifex] M[aximus] Trib[unitia] Pot[estate] viii. Imp[erator] xvi. de Britan[nis].

The date is A.D.49.

Following Mr. Way, I have regarded the object of lead, bearing this inscription, as a pig. Leland, *Collect. Assert. Artur.* v., p. 45, describes it as *trophæum ex oblonga plumbi tabula.* Similarly Camden, i., p. 82, (*Gough's edit.*) but Gough, p. 104, applies the term "pig" to it. In the *Monum. Hist. Brit.* it is called *lamina.* The learned author of the *Historical Ethnology of Britain, Cran. Brit., Dec.* iii., *chap. V., p.* 101, speaks of it as "often described as a pig, but really an oblong plate, 'oblonga plumbi tabula,' and part, probably, of a trophy.' It is plain from the context of the passage in which Leland mentions it that it was not a *lamina* or sheet, for just before noticing it he more than once mentions *laminæ plumbeæ,* but in describing it substitutes, for *lamina, tabula,* the difference being, as I understand, that the latter was thicker.

Mr. Way (p. 22) speaks of these objects generally as "the *massæ plumbi,* 'Ελασμοὶ μολίβδινοι of Dion, in the mediæval times termed *tabulæ.*" The passage in Dion, referred to by Mr. W., is the same that I have cited on page 15, and there can, I think, be but little doubt that the ἐλασμοὶ mentioned there, were what the ancient Romans called *tabulæ.*

The idea of its being a trophy was, I conceive, suggested by the name being in the nominative, and by the use of the preposition *de* which seems to denote that the object was not an article of commerce or of tribute, but of spoil; thus Virgil, *Æn.* iii., 288, *Æneas hæc* de *Danais victoribus arma.* This supposition derives support from the use of the same formula—*de Britannis*—on the coins of Claudius of the years 46 and 49, A. D., which also bear on the reverse a triumphal arch surmounted by an equestrian statue between two trophies. The first issue of these coins was most probably to commemorate the completion of the triumphal arch decreed for his triumph over the Britons in A. D. 44, and the second, which bears the same legend as this object of lead, was in honor of his enlargement of the pomœrium in A. D. 49. It seems no improbable supposition, that objects of lead were prepared in Britain to grace the triumphal procession on the first occasion and some pageant on the second. It is possible, too, that the word *tropæum* may correctly designate one of these objects, as a trophy won from conquered enemies, or as intended to form* part of a trophy. Even with these admissions, however, it may have been "a pig," for the block, as well as the plate, seems appropriate for the purpose. On the whole, I am inclined to think that it was of the same class of leaden objects as that bearing the inscription IMP·DOMIT·AVG·GER·DE CEANG. If this be, as seems to be universally admitted, "a pig," then it is probable that the other of Claudius DE BRITAN· was the same. Leland seems to have applied the term *tabula* to one of those objects which others after his time called *massæ*.

(5) Imp[eratore] Vesp[asiano] v. T[ito] Imp[eratore] iii. Co[n] s[ulibus].

The date is A.D. 74.†

(6) Imp[eratore] Vesp[asiano] vii. T[ito] Imp[eratore] v. Co[n] s[ulibus].

The date is A.D. 76.‡

(8) Imp[eratore] Cæs[are] Domitiano Aug[usto] Co[n] s[ule] vii.

The date is A.D. 81, and refers to the last three months and a half of the year, for Titus died on the 13th of September.

On the side of one of the blocks, bearing this inscription, the letters BRIG· are found, which have been interpreted very probably as referring to the *Brigantes*, in whose territories the lead was produced.

(11) Imp[eratoris] Hadriani Aug[usti].

The date is A.D. 117—138.

(12) Imp[eratorum] duor[um] Aug[ustorum] Antonini et Veri Armeniacorum

The date is A.D. 164—169.§

We shall now take up n. (7), as there is but one word in it the interpretation of which is obscure. It may be read thus: Imp[erator] Domit[ianus] Aug[ustus] Ger[manicus] de Ceang[is].

* There is a passage in Statius, *Silv.* iv. 3, which at first sight seems to support this supposition, scil.:

"*Hujus janua, prosperumque limen*
Arcus, *belligeri Ducis* trophæis
Et totis Ligurum nitens metallis."

Statius, however, both here and elsewhere, uses *metalla* in the sense of "slabs of marble."

† Mr. Way, in the heading of his notice of this pig, assigns it to the right date, but inadvertently gives "VESPASIAN, third Consulate;" instead of "VESPASIAN, fifth Consulate, and TITUS, third Consulate."

‡ In the heading of Mr. Way's notice of this pig also, there is a similar slip. Instead of "VESPASIAN, fifth Consulate," as given, he intended "VESPASIAN, seventh Consulate, and TITUS, fifth Consulate."

§ Mr. Way gives as the date 163—169. This is correct, so far as it relates to Verus; but Antoninus did not take the title *Armeniacus* until 164, and here the epithet is applied to both.

The date is A.D. 84—96.*

The *Ceangi* mentioned here, and also in the inscriptions on the sides of the blocks bearing nn. (5) and (6), seem to be the same as the *Cangi* of Tacitus, *Ann.* xii. 32: *ductus in* Cangos *exercitus*. Different opinions have been formed relative to their position. Camden (Gough's Edition, i. 82), Gibson, Gough, and the author of the Index of the *Monum. Hist. Brit.* place them in Somersetshire. Camden subsequently (iii. 45) altered his opinion, and was inclined to place them in Cheshire. Thus also Latham (Smith's *Dic. Gr. and Rom. Geogr.*) regards "North Wales as a likelier locality" than Somerset. In this opinion I concur. The position suits better the description of Tacitus—*jam ventum* haud procul mari quod Hiberniam insulam aspectat. It accords also with the situation of *Cancanorum* (or *Ganganorum*) *Promontorium* of Ptolemy, and Flintshire, in which and the adjoining counties of Cheshire and Denbighshire, I would place them, was probably even then noted for its lead-mines, at present the most productive in the island.

Horsley and the author of the *Index Monum. Hist. Brit.*, identify the *Cancanorum promontorium* as *Brachypult point*, in Carnarvonshire, which suggests that the *Cangi* may have occupied that county also. I am inclined to suggest *Great Orme's Head.*

As it is most probable that Domitian did not receive the title *Germanicus* until 84 A.D., we may take this date for this inscription: and it seems no improbable supposition that this was one of a set of blocks prepared for transmission to Rome, with a view to being exhibited at his triumph, which took place in that year. It will be remembered that, on Domitian's accession, Agricola was pursuing his successful career in Britain, and that 84 A.D. was the year of his seventh campaign.

We shall now take up the remaining inscriptions. Of these, nn. (1) and (9) are imperfect; and the difficulties in interpreting the others arise from LVT · in nn. (3), (10), and (14); MET · LVT · in n. (10), and METAL · LVTVD · in n. (13); EX · ARG · in nn. (3) and (14); and TR · and BR · in n. (31). As various explanations have been given of these abbreviations, we shall first investigate their meaning, and then proceed to the inscriptions themselves.

* Mr. Way gives as the date 81—96; but Domitian did not obtain the title *Germanicus* until after his reputed victory over the *Catti*, in the close of 83 or the beginning of 84. Eckhel, *Doct. num. vet.* vi. p. 396, has sufficiently refuted the notion that Domitian assumed this title on his accession.

ILLUSTRATIVE EXAMPLES OF SOME MODIFYING ELEMENTS AFFECTING THE ETHNIC SIGNIFICANCE OF PECULIAR FORMS OF THE HUMAN SKULL.

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The antiquity and wide geographical diffusion of the practice of cranial deformation on the American continent, have tended in some degree to divert the attention of craniologists from causes, some, at least, of the operations of which have been long recognised in other departments of natural history. The palæontologist is familiar with the occurrence of skulls distorted or completely flattened, and even with solid bones and shells greatly changed in form by compression. It was due to such compression transforming the skull of a fossil batrachian into some rude resemblance of the human cranium, that the famous *Cryptòbranchus Scheuchzeri*, found in a quarry at Œningen in 1725, was announced to the world in M. Scheuchzer's "*Homo diluvii testis et theoscopos,*" as the remains of one of the sinful antediluvians who perished in the Noahic deluge! In some of such examples, the palæontologist looks in reality only on the cast of the ancient bone or shell, compressed along with its matrix, probably at a date long subsequent to its original deposition. But in the following examples of similar changes affecting the human skull it will be seen that the distortion by which the crania now referred to have acquired their abnormal shapes, must have taken place at no long period subsequent to inhumation, while the animal matter still remained in such abundance as to preserve the flexibility of the bones; and even in some cases when the soft tissues still existed to resist the fracture consequent on the pressure of the superimposed weight of earth or stone.

In the Museum of the University of Toronto a female skull is now preserved, recovered in 1859 from an ancient Indian cemetery on the Georgian Bay. It is marked by considerable prolongation of the occiput, and is essentially a dolichocephalic cranium; but the natural excess in the longitudinal diameter has been exaggerated by great lateral compression, under which the left parietal and temporal bones, after being depressed and flattened, have at length partially yielded at the squamous suture. The head appears to have lain on the left side, and to have been subjected to slow continuous pressure which modified the contour of the lower side before the bones gave way at the suture. The measurements of this skull are:

Longitudinal diameter	7. 40
Parietal diameter	4. 95
Frontal diameter	4. 10
Vertical diameter	5. 35
Intermastoid arch	13. 30
Occipito-frontal arch	14. 00
Horizontal circumference	20. 00

In an interesting paper on "Aboriginal Antiquities recently discovered in the Island of Montreal," published by Dr. Dawson in the "*Canadian Naturalist*," he has given a description of one female and two male skulls, found along with many human bones, at the base of the Montreal Mountain, on a site which he identifies with much probability, as that of the ancient Hochelaga, an Indian Village visited by Cartier in 1535; and which he assigns on less satisfactory evidence to an Algonquin tribe. Since the publication of that paper, my attention has been directed by Dr. Dawson to two other skulls, a male and female, discovered on the same spot, both of which are now in the Museum of McGill College, Montreal. One of these furnishes a still more striking example of a cranium greatly altered from its original shape subsequent to interment. It is the skull of a man about forty years of age, approximating to the common proportions of the Iroquois and Algonquin cranium, but with very marked lateral distortion, accompanied with flattening on the left, and bulging out on the right side. There is also an abnormal configuration of the occiput, suggestive at first sight, of the effects produced by the familiar native process of artificial malformation. This tends to add, in no slight degree, to the interest which attaches to the investigation of such illustrations of abnormal craniology; as the occurrence of well established examples of posthumous deformation among crania purposely modified by artificial means exhibits in a striking manner the peculiar difficulties which complicate the investigations of the naturalist when dealing with man. The evidence which places beyond doubt the posthumous origin of the distortion in this Hochelaga skull is of the same nature as that which has already been accepted in relation to an example recovered from an Anglo-Saxon cemetery at Stone, in Buckinghamshire. The forehead is flattened and greatly depressed on the right side, and this recedes so far, owing to the distortion of the whole cranium, that the right external angular process of the frontal bone is nearly an inch behind that of the left side. The skull recedes proportionally on the same side throughout, with considerable lateral development at the parietal protuberance, and irregular posterior projection on the right side of the occiput. The right superior maxillary and malar bones are detached from the calvarium, but the nasal bones and the left maxillary remain in situ, exhibiting, in the former, evidence of the well developed and prominent nose characteristic of Indian physiognomy. The bones of the calvarium, with one slight exception, have retained their coherence, notwithstanding the great distortion to which it has been subjected, though in this example ossification has not begun at any of the sutures. The exception referred to is in the left temporal bone, which is so far partially displaced as to have detached the upper edge of the squamous suture. Part also of the base of the skull is wanting.

The posthumous origin of the distortion of this skull is proved beyond dispute on replacing the condiles of the lower jaw in apposition with the glenoid cavities, when it is found that, instead of the front teeth meeting the corresponding ones of the upper maxillary, the lower right and left incisors both impinge on the first right canine tooth, and the remaining teeth are thereby so displaced from their normal relation to those of the upper jaw, as to preclude the possibility of their answering the purpose of mastication—which their worn condition proves them to have done,—had they occupied the same relative position during life.

The extreme distortion which this skull has undergone is still more apparent when looking on it at its base. The bone has been fractured, and portions of it have become detached under the pressure, while the mastoid processes are twisted obliquely, so that the left one is upward of an inch in advance of the right.

The circumstances under which this Indian skull was found tend to throw some light on the probable process by which its posthumous malformation was effected. It was covered by little more than two feet of soil, the pressure of which was in itself insufficient to have occasioned the change of form. The skull, moreover, was entirely filled with the fine sand in which it was embedded. If, therefore, we conceive of the body lying interred under this slight covering of soil until all the tissues and brain had disappeared, and the infiltration of fine sand had filled up the hollow brain-case; and then, while the bones were still replete with animal matter, and softened by being filled with moist sand and embedded in the same, if some considerable additional pressure, such as the erection of a heavy structure, or the sudden accumulation of any weighty mass, took place over the grave, the internal sand would present sufficient resistance to the superincumbent weight, applied by nearly equal pressure on all sides, to prevent the crushing of the skull or the disruption of the bones, while these would readily yield to compression of the mass as a whole. The skull would thereby be subjected to a process in some degree analogous to that by which the abnormal developments of the Flathead crania are effected during infancy, involving as it does, great relative displacement of the cerebral mass, but little or no diminution of the internal capacity. The discovery of numerous traces of domestic pottery, pipes, stone implements and weapons in the same locality, furnishes abundant proof that it was the site of the Indian village as well as the cemetery, and thereby demonstrates the probability of the erection of such a structure, or the accumulation of some ponderous mass over the grave, at a period so near to that of the original interment, as would abundantly suffice to produce the change of form described. To some such causes similar examples of posthumous cranial malformation must be ascribed; as they are so entirely exceptional as to preclude the idea of their resulting from the mere pressure of the ordinary superincumbent mass of earth.

Another skull found in the same ancient Indian cemetery, apparently that of a female, and now in the collection of M. Guilbault, of Montreal, has also the appearance of having been modified in form by artificial means, whether posthumous or otherwise. The supercilliary ridges are prominent, the frontal bone is receding, but convex, and the occipital bone has considerable posterior projection, which is rendered the more prominent by a general flattening of the coronal region, and a very marked depression immediately over the lambdoidal suture, probably the result of unequal posthumous compression. The abnormal conformation of this skull is shown in the proportions of the intermastoid arch, which measures only 11.75, while the normal mean, so far as ascertained by me from measurements of thirty-three examples of Algonquin crania is 14.34, and of thirty-six examples of Huron crania is 14.70.

The great importance now justly attached to the form and relative proportions of the human skull, as elements of classification in physical ethnology, confers a new significance on all external forces affecting its normal ethnic condition. Influences artificially superinduced upon those conditions which, in relation to all other animals, would be regarded as their natural state, tend greatly to complicate that novel department of Natural History which deals with man as its peculiar subject; and in no respect is this more apparent than in the form of the human head. It is man's normal condition to be subjected to many artificial influences; and this fact must never be lost sight of by the ethnologist. In the rudest stage of savage life, which is sometimes, on very questionable grounds, characterised as a state of nature, man clothes and houses himself, makes and uses weapons and tools, and subjects his infant offspring to many influences dependent upon hereditary custom, taste, or superstitious obligations. All those tend to leave permanent results stamped on the individual, and when universally practised, confer on the tribe or nation some artificial ethnological characteristics which are nevertheless as essentially foreign to any distinctive innate peculiarity, as tatooing, circumcision, or other similar operation admitting of universal application. The naturalist has to deal with nothing analogous to this among the most ingenious and constructive of the lower animals.

Diverse physical characteristics have been noted among the various tribes of mankind, but concurrent opinion points to the head and face as embodying the most discriminating tests of ethnic variety. Yet these are the very features most affected by artificial appliances. Tatooing, nose, lip, and ear piercing; filing, staining, and extracting the teeth; staining the eyelids, shaving and plucking the head and beard, all effect important changes on the physiognomy. Nor is the head more constant in its proportions. Undesignedly and with deliberate purpose alike, artificial means tend to modify the shape of the human skull, and so to introduce elements of confusion and error into any system of classification based on cranial conformation, in which such sources of change are overlooked. In one respect, however the American ethnologist might seem to incur little risk of such oversight. The barbarous custom of giving artificial forms to the skull is practised as sedulously at the present day among the Flathead tribes of the Pacific, as by the Peruvians before the conquest of Pizarro, or on the shores of the Euxine among the Scythian Macrocephali in the days of Hippocrates. The effects resulting from this practice have accordingly assumed a prominent place among the phenomena specially distinctive of American ethnology. But, on this very account, such artificial cranial distortion, especially among ancient and modern American tribes, now receives so much attention from the craniologist, that we are apt not only to forget how entirely this barbarous practice had been lost sight of until the recent revival of the subject, as one necessarily involved in determining the true significance of generic forms of the human head in the deductions of physical ethnology; but also to ignore all other causes tending to produce corresponding results.

The possibility of artificial modifications of the form of the human skull, after having been denied by Sabatier, Camper, and Artaud, was reasserted in strong terms by Blumenbach, when describing a flattened Charib skull brought from the island of St. Vincents. Nevertheless opinions oscillated with varying uncertainty on this disputed question; and even after the publication of Dr. Morton's *Crania Americana* had furnished a complete history of the practice, and abundant illustrations of its results, the artificial origin of such cranial malformation was still denied by eminent anatomists and physiologists. The celebrated anatomist, Tiedmann, after careful inspection of the distorted skulls brought by Mr. Pentland from the ancient sepulchres of Titicaca in Peru, still maintained that their singular forms were entirely due to natural causes; and this idea appeared to receive remarkable confirmation from opinions published by Dr. Tschudi, after personal examination of numerous skulls and mummies exhumed during his travels in Peru. Without denying that some of the peculiarities of cranial conformation frequently observed in skulls found in ancient Peruvian graves are the result of artificial deformation, purposely superinduced by bandaging and mechanical pressure during infancy: Dr. Tschudi maintains that diverse natural forms of skull pertain to different ancient races of Peru, and especially that one peculiar and extremely elongated form of head is a natural Peruvian characteristic. In confirmation of this he not only refers to mummies of children of less than a year old, belonging to the tribe of Aymaraes, exhibiting the dolichocephalic proportions observed in adult skulls: but the very same specialities which he had noted in adult crania of the Huancas came under his observation in more than one mummied fœtus, which could not have been subjected to any artificial apparatus for the purpose of modifying the cranial configuration. In proof of this, he makes special reference to a fœtus in his possession found enclosed in the womb of a mummy discovered, in 1841, in a cave at Huichay, two leagues from Tarma, in Peru. Professor D'Outrepont, an experienced obstetrician, determined the age of the fœtus at about seven months; and Dr. Tschudi refers to his illustrative drawing of it as affording interesting and conclusive proof, in opposition to opinions advanced by the advocates of mechanical pressure as the sole cause of the remarkable cranial forms recovered from Peruvian sepulchres. Similar proofs are also stated by him to be furnished by another mummy, preserved under the direction of Don Mariano Edward de Rivero, in the National Museum at Lima. The heads exhibit a flattened, receding forehead, and a remarkable posterior elongation; and these characteristics are no less markedly noticeable in another example, from the same Lima collection, figured by Dr. Tschudi in his "*Antiqüedades Peruanas*," of a mummied child of the Opas Indians. Its form, as shewn both in profile and vertical view, is only comparable to the most depressed skulls of the Chinouk Indians; while in the vertical or front view, it is seen to be exceedingly unsymmetrical. The right side is considerably in excess of the left, as is frequently the case in the elongated skulls of the Flatheads of Oregon and British Columbia; and to those familiar with the irregular development of artificially compressed heads, the idea of mechanical pressure is at once suggested as the cause of some of the peculiar cranial characteristics of this Lima mummy.

There is conclusive evidence, I conceive, to prove that there were essentially distinct dolichocephalic and brachycephalic tribes among the ancient Peruvians; and that a markedly elongated head was common, apart from any artificial anterior depression and abnormal elongation to which it was frequently subjected. This question has been discussed, with varying results, in more than one of Dr. Morton's papers, though latterly he appears to have rejected the idea of two or more distinct cranial types, in favour of his theoretical unity of the American race. I have been confirmed in the belief in the existence of such essentially diverse South American cranial types after examining numerous Peruvian crania, including those of the Morton Collection, along with later additions, in the cabinet of the Academy of Natural Sciences at Philadelphia; and especially from recent careful study of a collection of Peruvian mumm ies and skulls, including both normal and compressed dolichocephalic crania, brought from ancient cemeteries of South America, by Mr. John H. Blake, and now preserved in his collection at Boston, along with other interesting illustrations of the ancient arts and customs of the Peruvians. This primary distinction in the forms of Peruvian crania, apart from the changes wrought on them by artificial means, must be borne in remembrance while estimating the bearings of such evidence as that adduced by Dr. Tschudi from the Opas Indian mummy; for assuredly no conceivable amount of change in the progress from infancy to maturity, could convert the elongated head figured in Rivero and Tschudi's Atlas, into the brachycephalic cranium frequently pertaining to the ancient Peruvian adult. But while evidence derived from various sources tends to confirm the opinion that at least two, if not three essentially distinct forms of head, prevailed among the ancient Peruvians, the evidence produced by Dr. Tschudi fails to prove that the examples referred to by him ought to be accepted as illustrations of a normal cranial type.

In this as in so many other departments of Ethnology, the naturalist cannot be too frequently reminded that the most primitive condition of man's savage life is an artificial one when compared with that of any of the lower animals. With man alone the osteologist finds his investigations complicated by altered forms produced by artificial means; and under this head must be included the accidental and undesigned, as well as the purposely superinduced changes effected on the human frame, and especially on the skull; while to causes thus operating to modify or counteract the normal vital functions, have to be added others, illustrated by the examples produced above, and clearly traceable to a posthumous origin.

The intra-uterine position of the Huichay cave fœtus furnishes indisputable proof that its peculiar cranial development is not due to art: if by this is understood the application of mechanical pressure with an express view to the production of such configuration; but this by no means exhausts the possible sources of abnormal modification. It may be the undesigned result of mechanical pressure inevitable in the process of dessication, accompanied as it invariably was, in the case of Peruvian mummies, with the forcing of the body into a crouching position, in which the legs were compressed upon the abdomen, and the arms folded across the chest. The naturalist who aims at applying the deductions of physical ethnology to the determination of ethnic classification, cannot content himself with accepting such osteological evidence as presents itself to him, in the unquestioning spirit which may be permissible in other branches of natural history. The most anthropoid of the inferior animals has not as yet been affirmed to cradle, bandage, or clothe its young; or to mummify or inter its dead. With rare exceptions, therefore, the comparative anatomist finds their skeletons in a uniform normal condition, and is justified in assigning a specific classification to distinctive cranial forms. But it is otherwise with the naturalist when he has man as the object of his study. Every scheme by which the ethnologist aims at systematising ethnic variations of cranial configuration, implies the recognition of national diversities in the form and proportions of the human head; but before attempting to determine their classification and significance, it is important to eliminate the various elements of extrinsic change. These then may be stated as follows:—

I. Undesigned changes of form superinduced in infancy by bandaging or other custom of head-dress; by the form of pillow or cradle-board; and by persistent adherence to any unvarying position in suckling and nursing.

II. Artificial deformation undesignedly resulting from the habitual carrying of burdens on the head, or by means of straps or bandages pressing on any part of the skull, when such is continued from early youth.

III. Artificial configuration designedly resulting from the application of mechanical pressure in infancy.

IV. Deformation resulting from posthumous compression, or any mechanical force brought into operation after death.

The first of those four classes has hitherto been overlooked, I believe; yet several remarkable instances have come under my own observation; and especially two examples of strikingly unsymmetrical heads, which appear to be clearly traceable to the fact that in both cases the mother was only able to suckle at one breast, and hence the infant skull while still in a soft and pliant condition, was constantly subjected to lateral compression only on one side. Even the persistent habit of carrying and laying to sleep on the same side, may permanently affect the form of the infant head.

In relation to the second class, my observations have been directed to the heads of Scottish fishwives and porters, and to Indian squaws, all of whom carry heavy burdens by means of a strap over the head or across the forehead, and to Edinburgh bakers, who carry their bread-boards on the crown of the head. But it seems doubtful if the form of the skull is ever in any material degree affected, unless pressure is applied in very early life.

The third cause of artificial configuration is now universally recognised, though it is possible that in referring to the mummy of the Opas child preserved in the national collection at Lima, Dr. Tschudi ignores results produced even by this familiar source of cranial deformation; for the unsymmetrical form of the head figured by him is strongly suggestive of mechanical pressure, whether designedly or undesignedly applied during life, or arising solely from the rude processes of mummification. But where the more general custom of inhumation prevails another source of undesigned and posthumous compression comes into play, some results of which find striking illustration in the Indian skulls described above. To this neglected element of error in the ethnic value of cranial forms, attention was first directed by Dr. Thurnham, in describing the skull of a man about sixty years of age, found, in 1850, at the Village of Stone, near Aylesbury, Buckinghamshire, along with an iron spear-head and knife, the umbo of a shield, and other relics clearly recognisable as of the common forms and characters pertaining to Anglo-Saxon pagan sepulture. This skull attracted attention from features of an unusual and striking character. It is marked by distortion not only involving the most unsymmetrical deformity,—the whole right side of the skull having been thrust forward, and the left side proportionally thrown back, with great lateral protrusion of the right temporal and parietal bones,—but the articulating surface of the right temporal bone has been forced so much in advance of the left side as to render it no longer possible to replace the lower jaw, which retains its normal form. The remarkable distortion which this skull has undergone without the displacement or fracture of the bones of the calvarium, led at first to considerable difference of opinion as to the causes to which such singular malformation ought to be ascribed. But the impossibility of the essential vital functions of the jaws having been performed if the temporal bones had existed during life in the same unconformable relation to the lower jaw, left no room to doubt that the distortion had been produced subsequent to inhumation. Mr. J. B. Davis has accordingly devoted special consideration to the general subject of "posthumous distortion," when treating, in the "*Crania Britannica*" of various sources of abnormal cranial conformation; and refers to it as "another and distinct mode which will in future be required to be taken into consideration in all investigations having reference to deformed crania." At the same time Mr. Davis accumulates additional evidence in confirmation of the opinions that the artificial distortion of the human head is by no means limited to the savage tribes of the New World; and discusses not only its practice among the ancient Macrocephali, including the received theory of Hippocrates that such artificial forms may be at length perpetuated by natural generation; but also "the extraordinary fact that the practice of distorting the skull in infancy is not yet extinct even in Europe." To this curious inquiry the attention of some of the distinguished Physiologists and Anatomists of France has been directed, and the result of the combined observations of MM. Foville and Gosse, along with those of M. Lunier, is to satisfy them that in different Departments of France, the practice of applying constricting coverings and bandages to the heads of infants still prevails; and that certain diversities of cranial configuration in some of the Provinces, and especially in Normandy, Gascony, Limousin and Brittany, are traceable to prevalent modes of infantile head-dress. It detracts considerably from the force of such conclusions, that the most remarkable examples produced by Dr. Foville, are derived from inmates of lunatic asylums; whereas the result of numerous independent observations on the Flathead tribes of the Pacific tends to prove that whatever may be the increase of mortality in infancy, produced by the barbarous practice of cranial deformation, the adults exhibit no mental inferiority to other Indians. On the contrary they are objects of dread to the neighbouring tribes among whom no such practice prevails, enslaving them, and retaining them in degrading servitude, while they rigorously exclude their slaves from the privilege of distorting the heads of their offspring; so that the normal head is with them the badge of servile inferiority. Mr. Davis has figured a distorted skull of an aged French woman in his collection, believed to have been the inmate of a lunatic asylum in one of the Southern Departments of France. It is produced in illustration of the most usual variety of deformation, denominated by MM. Foville and Gosse the *tête annulaire*: but though of somewhat brachycephalic proportions, there is nothing in the profile view, which is the only one given, calculated to suggest the idea of abnormal configuration.

From the various aspects which this craniological department of physical ethnology thus discloses to the inquirer, it becomes obvious that it is a greatly less simple element of classification than was assumed to be the case by Retzius, Morton, or any of the earlier investigators of national forms of the human skull. To the *brachycephalic* and *dolichocephalic* types of Retzius, have now been added the *kumbecephalic*, the *platycephalic*, and the *acrocephalic*; and to the disturbing element of designed artificial compression, it is apparent we have also to add that of posthumous distortion, as another source of change, affecting alike the mature adult, even when old age has solidified the calvarium into an osseous chamber from which nearly every suture has disappeared, and the immature fœtus in which adhesion of the plates of the skull has scarcely begun. When more general attention has been directed to this element of abnormal cranial development, additional illustrative examples will no doubt be observed by craniologists; and the circumstances under which they are found will help to throw further light on the peculiar combination of causes tending to produce such results.

A POPULAR EXPOSITION OF THE MINERALS AND GEOLOGY OF CANADA.

(Continued from page 166.)

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PART III.

HOW ROCKS ARE CLASSIFIED AND DISTINGUISHED: WITH SPECIAL REFERENCE TO THE ROCKS OF CANADA.

In different localities, as a general rule, different kinds of rock occur. This must be familiar to the most casual observer. Thus, around the Falls of Niagara, and extending for miles across that section of the country, we find vast beds of limestone. About Hamilton, with other rocks, we have sandstone or freestone. At Toronto, our rock-masses consist of beds of clay and gravel, overlying grey and greenish shales. Near Collingwood, and again at Whitby, we observe dark-brown and highly bituminous shales, containing the impressions of trilobites in great numbers. At Kingston, we meet with limestone rocks differing from those at Niagara, and giving place, as we proceed north and east of the city, to beds of crystalline rock of granitic aspect, geologically known as Gneiss. Some of the "Thousand Islands" consist of a very ancient sandstone. At Montreal, again, together with limestone, &c., we find in the picturesque Mountain, a dark and massive (or unstratified) rock, termed Trap, and more or less closely allied to the lavas of volcanic districts. These examples, without proceeding further, are sufficient to shew the diversity which prevails with regard to the rock-matters of comparatively neighbouring localities. But if we look, not to the mineral characters of these and other rocks, but to their respective origins or modes of formation—as evidenced by what is now going on in Nature in different parts of the world—it will be found that they fall naturally into three groups, as follows:

Eruptive Rocks.
Metamorphic Rocks.
Sedimentary Rocks.

In each of the above groups, the included rocks are of various periods of formation, as explained in the Chronological Classification at the close of the present Part of our Essay. Before proceeding, however, to a discussion of this question, and in order more especially to prepare the general reader for a proper understanding of Part V, in which the geology of Canada first comes properly under review, it is necessary to consider these groups separately, and to enter into a few of their more practical details.

ERUPTIVE ROCKS.

The rocks of this division are of Igneous or of Aqueo-Igneous origin. That is to say, their present form is due to solidification from a fluid or plastic condition brought about by the agency of heat, assisted, in most (if not in all) cases, by that of steam or heated water. They have been formed beneath the earth's surface (whence the term "Endogenous" applied to them by Humboldt), and they have been driven up or erupted, at various geological epochs, through cracks and fissures in the overlying rocks. They are distinguished by never occurring in true strata, but always in the form of irregular, protruded masses, which sometimes present a columnar structure, or in that of broad overlying or intercalated sheets, or in straight veins called "dykes" (see further on), or in ordinary tortuous veins. Secondly, by never exhibiting in their structure the marks of a sedimentary origin, such as rolled stones, grains of sand, &c. And, thirdly, by never containing organic remains.

Where eruptive rocks traverse or lie in contact with other formations, these latter are usually found to be more or less altered, as though by the agency of heat, near the points of contact. Coal-beds are thus for some distance often burnt into cinder or converted into coke; soft limestones changed into crystalline marbles; sandstones altered in colour, hardened, and changed into quartz-rock, and so forth.

These rocks are arranged by Sir Charles Lyell in two broad divisions: Volcanic and Plutonic rocks; but it is impossible to draw a distinct line of demarcation between the two. Granite and syenite, for example, belong to the Plutonic series; but certain granitic trachytes connect the granites with the volcanic rocks; and in like manner, certain greenstones merge on the one hand into syenite, and on the other (the distinction between augite and hornblende being now essentially broken down) into augitic lavas. This equally affects the sub-division into Volcanic, Trappean, and Granitic rocks, adopted by other observers. I would therefore propose, as an arrangement of convenience, the distribution of the Eruptive rocks into the six following groups:—1. Lavas; 2. Obsidians; 3. Trachytes; 4. Traps and Greenstones; 5. Serpentines; 6. Granites. On each of these it is necessary to make a few observations.

1. *Lavas.*—These comprise the actual rock-matters which issue in a molten condition from volcanic vents. During the solidification of lava currents, dense volumes of steam are emitted from the cooling mass. Lavas are of two general kinds: feldspathic, and feldspatho-augitic. The first, and by far the most common of the two, are composed essentially of feldspar, and are mostly of a dark or light grey colour. They pass into trachytes. The second are composed essentially of feldspar and augite,* are dark green or almost black in colour, and undistinguishable, except by their actual conditions of occurrence, from many traps or basalts. As examples of these rocks are not found in Canada, we need not describe their varieties, or enter into further particulars respecting their conditions of occurrence.

2. *Obsidians.*—The rocks grouped under this division, are lavas, or other igneous products, in a vitreous or glassy state. They are entirely feldspathic in composition. When in connexion with volcanic

* See descriptions of these minerals in Part II. of this Essay.

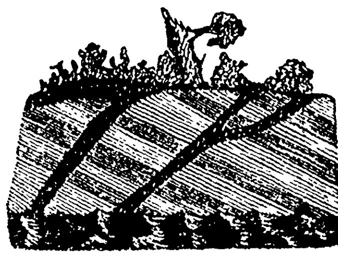
cones, and of a grey, black, green, brown, or varied colour, and breaking into sharp-edged fragments, they constitute the variety properly called Obsidian. Pearlstone is a closely-related variety, containing small spherical concretions of a more or less pearly aspect. Another form, of a black, dull-red, green, or dark colour, and of a somewhat pitch-like aspect, is called Pitchstone or Retinite. This latter is stated by Sir. W. E. Logan to occur on the north shores of Lakes Huron and Superior. It should be observed, however, that the term Retinite is applied by some authors to a bituminous substance of a very different character.

3. *Trachytes.*—These rocks have normally a harsh, rough texture (whence their name from τραχυς), and a white or light colour; and they are either entirely or essentially feldspathic in composition. They offer three principal varieties, exclusive of Pumice, which may be placed either here or amongst the lavas. These varieties merge, however, into one another. They comprise: common Trachyte and compact Trachyte, composed normally of Orthoclase or potash feldspar, and Granitic Trachyte, a rock of a granitic structure, made up of orthoclase feldspar, with small crystals or grains of hornblende, augite, or mica. Common Trachyte occurs chiefly in active or extinct volcanic districts. It often contains crystals of glassy feldspar, and sometimes scales and crystals of mica, &c. Occasionally, also, free silica or quartz is found in it, although accidentally, as it were, and only in small quantity. Compact Trachyte, or feldspar trap, as this variety has been termed, is found in broad straight veins or "dykes," of a white colour, traversing the Montreal mountain, and occurring also (of a pale-reddish colour) at Chambly, &c. Granitic Trachyte (in some instances closely resembling granite, but differing from that rock by the absence of quartz) forms the eruptive mountains of Brome, Shefford, Yamaska, Rougemont, Belœil, Mount Johnson, &c., of the Eastern Townships. These granitic trachytes (or granitic diorites, as they might be termed with equal justice, see below) differ a good deal in colour and appearance, according to the amount of hornblende, mica, &c., which they contain. Like the compact trachyte of Lachine and Chambly, they are sometimes "porphyritic" —containing more or less distinct and large crystals of feldspar. (See Mr. Hunt's Report for 1856, and that for 1858; also this Journal, Vol. V. page 426.) Many of the trachytes of these localities are in a partially altered state, effervescing in acids from the presence of

carbonates. By weathering, also, they become reddish-brown, dull-white, &c., and tend to decompose into clay-stone or "Domite." This latter term is derived from the partially-decomposed trachytes of the Puy-de-Dôme, in central France.

4. *Traps and Greenstones.*—The rocks of this group chiefly affect the form of intrusive dykes (*i.e.* broad and more or less straight or simply-forking veins (as in fig. 52), or otherwise occur in overlying, intercalated, and irregular masses, which frequently present a columnar structure. The traps proper, or dolerites, are always of a black or dark colour, and consist essentially of a more or less uniform mixture of lime feldspar (or soda feldspar) and augite, with in general a mixture of zeolitic minerals and magnetic iron-ore. The green-stones or diorites, consist normally of soda feldspar (or of a feldspathic mixture) and hornblende, and have usually a more or less decided green colour. It is sometimes impossible, however, to distinguish greenstone from trap, more especially as late researches have shewn that augite and hornblende possess the same atomic composition. Hence the two rocks should properly be classed together.

52.



When the rock is of a black or dark colour, more or less compact, and amorphous in form, it is termed *Trap*. This variety occurs in numerous dykes on the north shore of Lake Huron and on the shores of Lake Superior. When a trap rock contains distinctly imbedded crystals of any mineral distributed through its mass, the name of this mineral may be conveniently attached to it. Thus, the Montreal mountain consists principally of *Augitic Trap*. The same variety, containing olivine* in addition, forms the mountains of Montarville and Rougemont. When the rock assumes a columnar or basaltiform structure, it becomes *Basalt*. This variety does not appear to be common in Canada, but it occurs, here and there, on the north shore of Lake Superior, and probably in other parts of the Province. When, again, as frequently happens, a trap or basalt is of a more or

* The student should refer to the descriptions of these minerals in the preceding Part of this Essay. See the Index, pages 162-4, of this volume.

less coarsely-vesicular structure, or contains oval or other shaped cavities usually filled with calc-spar, amethyst-quartz, agates, various zeolites, &c., the rock is called an *Amygdaloid*, or *Amygdaloidal Trap*. Numerous examples occur in the northern district of Lakes Huron and Superior; and the agates of Michipicoten Island and other localities of this region, are derived from the disintegration and washing away of the amygdaloidal traps in which they were originally enclosed.

The greenstones, or diorites, occur under the same conditions as the traps. Compact and amygdaloidal varieties are common about Lake Huron, &c.; and Sir William Logan, in his Report for 1853, has described the occurrence of a columnar greenstone in the Township of Grenville, Argenteuil Co., C. E. In some greenstones, the component minerals, feldspar and hornblende, become individually perceptible. This variety might be called, indifferently, a granitic trachyte, or a granitic diorite, and placed in either of these groups.* A latitude of this kind, in the classification of these eruptive rocks, is unavoidable. Their frequent transitions and irregularities of composition, render the drawing of very definite lines a complete impossibility. For this reason, the attempt to frame a number of so-called species out of the trappean and other eruptive rocks, and to bestow upon these distinct names, becomes both useless and unphilosophical.

Finally, it may be observed, that many varieties of trap and greenstone are very subject to decomposition, yielding soils of much fertility. By weathering, they become mostly dull-grey, brown, or red.

5. *Serpentines*.—The rocks of this series are essentially hydrated silicates of magnesia. They consist, strictly, of varieties of one mineral substance, *serpentine*. (See above, p. 159.) Their colour is somewhat variable, but chiefly green, brown, reddish, or greenish-grey—these tints frequently occurring together in veins and patches. They are more or less soft and sectile, and somewhat granular or compact in structure; forming dykes and irregular masses, although comparatively of rare occurrence as eruptive rocks. Most serpentines are found in large beds, and are evidently altered sedimentary deposits or metamorphic rocks, but undoubted instances of eruptive serpen-

* If minute distinctions be advisable, the term *granitic trachyte* might be restricted to such of these rocks as contain orthoclase or potash feldspar, whilst those in which triclinic feldspars are present might be called granitic diorites; but it is not always possible to carry out these distinctions.

tines occur in Tuscany and elsewhere. In some cases, however, massive serpentines of this kind may have been derived from the alteration of trap and greenstone rocks. The serpentines which occur in Canada, are considered to belong entirely to the Metamorphic series, and are described, consequently, under that division.

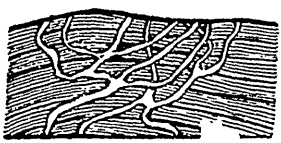
6. *Granites.*—These rocks possess normally a crystalline aspect and strongly-marked granular structure, whence their name. They are also especially characterized by the presence of free silica, or quartz, as an essential component. They occur in irregular, unstratified masses (often breaking through and tilting up the surrounding rocks), or in tortuous branching veins. Some are of very ancient date; whilst others are of comparatively recent formation, at least in a geological point of view. Hence the obvious objections which apply to the use of the terms "Primary" or "Primitive," often bestowed indiscriminately on all granitic rocks, as well as on strata of metamorphic origin—these latter, like the granites, and all other rocks, indeed, being of various periods of formation. Under a subsequent section, it will be shewn that the age of a rock is in no way indicated by mineral characters or composition. Where two granitic or other veins intersect, the intersected vein (which is generally displaced moreover, one portion being thrown up or down) will, of course, be the older of the two. In like manner, where a granitic or other eruptive rock underlies another rock of any kind, this latter will necessarily be the older of the two if veins pass into it, or if it be altered by chemical or mechanical action.

The more important rocks of this section, comprise granite and syenite

Granite, properly so-called, is composed of three minerals: Quartz, Feldspar, and Mica, full descriptions of which are given in Part II. of this Essay. The quartz is colourless and vitreous; the feldspar, usually white or flesh-red, with smooth and somewhat pearly cleavage planes; the mica, white, grey, brown, black, or sometimes green, in scales, specks, or foliæ, of a pearly-metallic aspect. In the fine-grained granites, these component minerals become so intimately blended as to be individually undistinguishable. When crystals of feldspar are distinctly imbedded in a fine or coarse-grained granitic mass, a variety termed *Porphyry*, or better, *Porphyritic Granite*, is produced. The term "porphyry" (from πορφυρα) as the name would indicate, was originally applied to rocks of this kind in which the base or imbedded crystals were of a red colour; but it is now conventionally bestowed on all rocks containing distinct crystals of feldspar or other minerals. Thus, we have porphyritic granite, porphyritic trachyte, &c. Occasionally, the mica in granite is replaced by talc, giving rise to *Talcose Granite.* Sometimes, also, the mica dies out, when a granitic mixture of quartz and feldspar results. This has been called *Pegmatite.*

Examples of intrusive granite occur amongst the strata of the Laurentian and Huronian series in the Lake Superior region and on the north shore of Lake Huron, and elsewhere, but apparently in no very prominent masses; although veins composed of quartz and feldspar, or of quartz alone, are of exceedingly common occurrence throughout the entire area occupied by the gneissoid Laurentian rocks. Fig. 53 is a sketch of some quartzo-feldspathic veins in gneiss, near the right bank of the river Severn, C. W. In the more modern metamorphic district south of the St. Lawrence, however, granitic masses (which appear to pass into granitic trachytes or diorites) constitute the Megantic mountains, and occur also in force in Hereford, Stanstead, and other townships of that district. (The localities cited by Sir William Logan, in his *Esquisse Géologique du Canada,* comprise: Stanstead, Barnston, Hereford, Marston, Megantic Mountains, Weedon, Winslow, Stafford, and Lambton.)

53.



Syenite.—This eruptive rock is composed of a granitic mixture of quartz, feldspar, and hornblende, the latter being green or black in colour. When mica is also present, the rock becomes *syenitic granite;* and when the quartz grows gradually less and less abundant, there is a transition into granitic diorite or greenstone. Some syenites are of a red colour from the prevalence of red feldspar, and many syenites are porphyritic. Intrusive syenite occurs amongst the Laurentian rocks in various localities. An enormous mass of this rock, covering an area of thirty square miles, is cited by Sir William Logan, as occurring in the townships of Grenville, Chatham, and Wentworth, in Argenteuil County, on the Ottawa.

Granitic rocks frequently become converted, by the decomposition of the feldspar, into white or light-coloured clays, largely used, under the name of *Kaolin,* in the manufacture of porcelain.

METAMORPHIC ROCKS.

The rocks thus named are *stratified rocks* of a more or less granitic, trappean, or crystalline aspect, and of various periods of formation. It has been already stated, that where a dyke, vein, or erupted mass of trap or granite traverses other rocks, these latter are very generally altered in character, and, to some extent, in composition. Earthy or common limestones are thus near the points of contact transformed, in some localities, into hard marbles or crystalline limestones, and are frequently filled with crystals of garnet, tourmaline, hornblende, and other minerals. In like manner, sandstones are changed in colour and texture, and are often converted into quartz-rock; whilst clay-slates are transformed into gneiss, mica-slate, talc-slate, and other so-called "crystalline schists." Although analogous effects are sometimes produced artificially in the walls of smelting furnaces, these metamorphic results, as seen in Nature, are probably due not so much to the simple agency of heat, as to that of various gases and heated vapours accompanying the protrusion of the eruptive mass. In many localities, on the other hand, these effects appear to have been produced without the direct intervention of eruptive rocks, in which case the alteration or metamorphism has probably proceeded from steam and gases transmitted from below, from heated chemical solutions percolating the altered rocks, or from other causes more or less immediately dependent on the presence of subterraneous heat. Be this as it may, it is now universally conceded that the crystalline stratified rocks are altered sedimentary deposits—sandstones, slates, limestones, and so forth. In Canada (as explained more fully in Part V.) there are two distinct series of metamorphic rocks. One, including the Laurentian and in part the Huronian series, belongs to the Azoic Age, and constitutes the most ancient group of rocks of this continent. The Laurentian series is made up of vast beds of gneiss, crystalline limestone, and other rocks described below, and it extends over almost the entire northern portion of the Province. For geographical limits, geological and other characters, see Part V. of this Essay. The Huronian rocks of the north shore of Lake Huron, &c., are also in part metamorphic, and include, amongst other more or less altered deposits, some remarkable quartz and jasper conglomerates. The other series of metamorphic strata are of more recent, although still of ancient, date. They belong to the Silurian and

Devonian periods of the Palæozoic Age (see the close of this PART, and also PART V.), and they occur in the Eastern Townships and adjoining district south of the St. Lawrence. On the edge of this latter metamorphic region, the passage of the unaltered into the altered strata may be traced '. .any localities.

The following are the more important metamorphic rocks of Canadian occurrence:

Gneiss.—This crystalline rock only differs (lithologically) from granite and syenite by occurring in beds or strata. It is of two kinds: *micaceous or ordinary gneiss*, and *syenitic* or *hornblendic gneiss*. The former consists of quartz, feldspar, and mica; the latter, of quartz, feldspar, and hornblende. When the mica or the hornblende predominates, and the feldspar diminishes in quantity, these pass into mica slate and hornblende slate (or hornblende rock), respectively. Gneissoid rocks of this kind prevail everywhere amongst the Laurentian strata, and sometimes contain garnets and other minerals. They constitute, moreover, the greater number of the boulders scattered so abundantly over the surface of Canada (see PART V.) Gneiss may generally be distinguished from granite, even in hand specimens, by its striped or banded aspect, the colours being usually various shades of grey and red.

Mica Slate—This rock consists normally of quartz and mica. It is more or less fissile or schistose, somewhat pearly or silvery in aspect, and usually of a white or greyish colour, though sometimes almost black. It passes into gneiss on the one hand, and into clay-slate on the other. It is often called *mica schist*. It occurs more or less, throughout the Laurentian formation (Lake Huron, north shore; French River; Baie St. Paul, &c.)

Feldspar Rock.—This is a mixture of various feldspars. It is usually of a greenish-blue or slightly-shaded white colour; or, otherwise, pale reddish, greenish, brownish-yellow, &c Fine-grained and porphyritic varieties occur. In the latter, the enclosed, grey, cleaveable masses sometimes present the green and other reflections peculiar to the characteristic examples of labradorite. (See Part II.) At other times, these enclosed masses or crystals are of a red, lavender-blue, or brownish colour. Hypersthene, also, in laminar masses of a brown sub-metallic tint, is frequently present, forming the variety sometimes called *Hypersthene Rock*. Mica, augite, garnet, titaniferous iron, and some other minerals, are likewise of occasional occurrence in those feldspathic beds. . The Laurentian deposits of the counties of Montmorenci (below Quebec), Terrebonne, &c., afford good examples of Feldspar Rock. (See Analyses, &c., in Mr. Hunt's Report for 1854.)

Hornblende Rock.—This rock, frequently of a schistose structure, and then called "Hornblende Slate," or "Hornblende Schist," is normally a compound of quartz and hornblende. Very often, however, it is nothing more than a highly hornblendic variety of syenitic gneiss It has a dark-green or black colour, and frequently contains garnets in sharply-defined crystals. Hornblende rock occurs in some abundance amongst the Laurentian strata, as in the counties of Lanark, Frontenac, Lennox, &c. Also in the valley of the Bonne-chère (Mr. Murray); on French River, Lake Huron; and at other localities in which these strata prevail. It occurs likewise amongst the more modern metamorphic series south of the St. Lawrence. In the latter district, a rock made up of greyish-green actynolite, in interlacing fibres, is found in Beauce County. (Mr. Hunt's Report for 1856.)

Wollastonite Rock.—Wollastonite, or tabular spar, is a mineral closely related to augite. (See its description in Part II. above, Vol. V. page 528) Mixed with the latter species, it forms subordinate beds, associated with crystalline limestones, amongst the Laurentian strata of certain localities.

Garnet Rock.—Beds of light-coloured massive garnet occur amongst the metamorphic series of the Eastern Townships. (Mr. Hunt's Report for 1856.) Certain subordinate beds, made up in chief part of granular garnets of a red colour, are found likewise in connexion with crystalline limestone amongst the Laurentian strata, as in the County of Argenteuil, and elsewhere. (See Part II. Vol. V. p. 524; and Sir W. E. Logan's Report for 1856.) Mr. Richardson, in his Report for 1857, describes also the occurrence of garnet rock in association with micaceous schists, at Baie St. Paul.

Chlorite Slate.—This rock, of a greenish colour, and normally of a schistose structure, occurs both amongst the Laurentian and Huronian series, and the more modern metamorphic strata of the Eastern Townships. All of these chlorite-slates contain a certain amount of water. In the Eastern Townships they pass into more or less compact "potstones." (See Part II. above, page 160.)

Talc Slate.—The rock thus named occurs principally in the Eastern

Townships, forming both semi-crystalline and compact or steatitic beds. (See Part II. above, page 158.) These are of a light-green, silvery-white, or greenish-grey colour. Some of the beds of the Laurentian series, as in the neighbourhood of Marmora, &c., are also somewhat talcose, or contain interstratified layers of talc. Talcose slates occur likewise amongst the Huronian strata.

Serpentine.—Serpentine rock, or Ophiolite, occurs in extensive beds amongst the metamorphic strata of the Eastern Townships. Its mineralogical characters have been already given (*ante*, page 159), but the rock, it may be stated here, is essentially a hydrated silicate of magnesia, more or less sectile, and of various colours, but chiefly dark-green, greenish-grey, or greenish-white, often with red or bluish veins, or variously mottled. It is very commonly mixed with carbonate of lime or dolomite, forming serpentine-marbles of green, chocolate-brown, and other colours. In Bolton, Ham, and other townships of this district, beds of chromic iron-ore are associated with these serpentine rocks; and a bed of magnetic and titaniferous ore, fifty feet in thickness, occurs in the serpentine of Beauce. A large development of serpentine rock, fit for economic purposes, occurs also with chromic iron-ore at Mount Albert, in Gaspé. According to Mr. Richardson (Report for 1850), the rock-exposure at this locality presents vertical cliffs of several hundred feet in height, and covers an area of not less than ten square miles.

Diallage Rock.—This rock consists principally of the mineral called diallage (see page 159, above), or of diallage and chlorite. It has a clear green or pale-bronze colour, is more or less fissile, and occurs in association with the serpentines of the Eastern Townships, to which, also, it is very closely allied.

Quartz Rock, or Quartzite.—The rock thus named appears to have been formed by the alteration of sandstone strata It has a more or less vitreous aspect on newly-fractured surfaces, is very hard, and is either colourless, or yellowish, greenish, pale red, brownish, &c. It occurs abundantly amongst the Huronian rocks of the north shores of Lakes Huron and Superior; and also amongst the Laurentian strata of many localities, as at St. Jérome and elsewhere. A remarkable quartz-conglomerate, containing pebbles of red jasper and white quartz in a colourless or pale-yellowish quartzose base, is met with in the Huronian formation of the Bruce Mines district; and other conglomerates of a somewhat similar character occur in the Laurentian series. These shew clearly the metamorphic origin of the rocks in question.

Crystalline Limestone.—This rock consists of carbonate of lime in a semi-crystalline condition. It is usually white or pale reddish, and is sometimes veined or clouded with yellow, blue, green, and other coloured streaks and patches. Its structure is fine or coarse granular, somewhat resembling that of loaf sugar, whence the term "saccharoidal limestone," bestowed on this rock. Crystalline limestone occurs in beds amongst the metamorphic strata of the Laurentian and Huronian series, and also amongst those of the more modern series south of the St. Lawrence. The serpentine marbles of the Eastern Townships have already been alluded to. These limestone bands are not only of economic employment,—many yielding marbles of superior quality,—but, when occurring amongst the gneissoid rocks of the Laurentian series, they impart fertility to the otherwise too generally unproductive soil. Where the gneiss rocks are uncovered by Drift deposits, it is only indeed in connexion with the crystalline limestones or beds of feldspar-rock, that soils of any depth or fertility can be expected to occur. It is perhaps needless to observe, after what has been stated in PART II. of this Essay, that crystalline limestone may be distinguished from quartz and feldspar by being easily scratched by a knife, and also by dissolving with effervescence in diluted acids. For special localities of Canadian marbles, see PART V.

Crystalline Dolomite and Magnesite.—In external characters and conditions of occurrence, the crystalline dolomites resemble the ordinary crystalline limestones, but consist of carbonate of lime and carbonate of magnesia. A fine saccharoidal variety occurs amongst the Laurentian strata of Lake Mazinaw. Beds of Magnesite, consisting of carbonate of magnesia mixed more or less with feldspathic or quartzose matters, occur amongst the altered Silurian strata of the Eastern Townships. These beds are chiefly white, greenish, or bluish-grey in colour, and generally resemble crystalline limestone. Some, by weathering, become reddish-brown. (T. Sterry Hunt, Report for 1856.)

SEDIMENTARY ROCKS.

The rocks of this division make up by far the greater portion of the Earth's surface. Having been formed by the agency of water, they are often called *Aqueous Rocks.* They are chiefly of mechanical formation, consisting of muddy, sandy, and other sediments, collected by the mechanical action of water, and subsequently consolidated by processes described a few pages further on. Various limestones, however, and certain other rock matters of this division, are of chemical origin, or, in other words, have been deposited from waters in which their materials were chemically dissolved.

These sedimentary or aqueous rocks are characterized by always occurring in beds or strata (with the occasional exception of certain irregularly-heaped masses of drift materials); secondly, by exhibiting in many instances, a more or less clearly-marked detrital or sedimentary structure; and thirdly, by often containing organic remains. These latter, comprising shells, bones, leaf-impressions, &c. (see PART IV.), are the fossilized parts of animals and plants which lived upon the Earth, or in its waters, during the periods in which these rocks were under process of formation, as indicated below.

The sedimentary rocks may be conveniently discussed under the following heads: Composition or mineral characters; Modes of formation; Changes to which they have been subjected after deposition.

(1) *Composition of Sedimentary Rocks.*—Viewed as to their composition, these rocks comprise:

Sandstones, sands, and gravels—or arenaceous rocks.
Clays and clay-slates—or argillaceous rocks.
Limestones and Dolomites—or calcareous rocks.
Conglomerates and Breccias: rocks of mixed composition (see below).
Trap tufas: stratified deposits formed out of materials derived from the denudation of trap and greenstone rocks.
Rock matters of purely organic origin, as coal, &c.

To these may be added a few other substances of subordinate occurrence, as gypsum and rock-salt.

Sandstones are nothing more than beds of consolidated sand. They are of various colours, but chiefly white, or dull shades of yellow, red, brown, or green. The harder and purer kinds, as some examples of our "Potsdam sandstone," are called *quartzose sandstones.* In other kinds, a certain amount of carbonate of lime is present, cementing together the component grains of sand, and forming calcareous sandstones. For special Canadian localities of these and other rocks mentioned under this division, consult PART V. Certain siliceous rocks, called "tripoli" and "infusorial marls," are formed entirely of the tests of diatoms and other infusoria. (See Part IV.)

Clay Slates are merely consolidated clays. They have a fissile structure, and are chiefly of a grey, greenish, brown, or black colour. Clays are also of various colours, as white, greenish, yellowish, bluish, black, and red. Those which contain little or no iron, burn white, and yield consequently white bricks. Many clays are highly calcareous; others, bituminous, &c. *Note.*—The term *shale* is often applied to fissile consolidated clays; but this term is applied equally to fissile or slaty limestones and sandstones. When the term is used, therefore, the kind of shale should also be signified: as *an argillaceous shale, an arenaceous shale,* and so forth. *Bituminous shales,* as regards their mineral base, may be also arenaceous, calcareous, &c.

Limestones and *Dolomites* are principally, perhaps, of chemical formation. Water containing free carbonic acid (derived from decaying vegetable matters, &c.) dissolves a certain amount of carbonate of lime, but the bicarbonate, thus formed, is easily decomposed by various natural agencies, even by mere exposure to the atmosphere, and a precipitation of calcareous matter takes place. In this manner, calcareous tufas (so common in many of our swamps, streams, &c.), together with stalactites and stalagmites, are produced; and similar processes, acting on a larger scale, may have given rise to extensive depositions of limestone strata in ancient seas and lakes. Some limestones, again, are formed almost wholly of the calcareous shells or tests of crinoids, foraminifera, and other organisms (see PART IV.); but others are, undoubtedly, mechanical or rock deposits, derived from the wasting of coral reefs and older limestone formations. Limestones consist of carbonate of lime, more or less pure; dolomites, of carbonate of lime and carbonate of magnesia in equal atomic proportions; and dolomitic limestones of these two carbonates in other proportions, the lime carbonate generally predominating. Dolomites and dolomitic limestones appear in many cases to have been simple chemical precipitates, and, in others, to have originated from the alteration of limestone rocks by the action of soluble magnesian salts. These calcareous rocks are of various colours: grey, white, black, yellowish, &c. Their texture is sometimes very close and uniform. At other times, the stone is made up of small spherical concretions, when the texture is said to be "oolitic." Oolitic limestones are of all geological ages. Some limestones, again, are of an earthy texture: the well-known chalk of Europe is an example; also our own "calcareous tufa," or "shell marl." Many of the dark limestones, as those of Niagara, &c., are more or less bituminous. All effervesce in acids; but the dolomites produce merely a feeble effervescence unless the acid be heated. Limestones which contain from 15 to 25 per cent. of argillaceous matter in intimate admixture, yield hydraulic or water lime. Beds of this kind occur at Thorold, Cayuga, Loughboro', Kingston, Hull, Quebec, and other localities. (See PART V.)

Conglomerates consist of rounded stones or masses of quartz, sandstone, &c., cemented together, or imbedded in a paste of finer sandstone, limestone, or other rock substance. The imbedded masses are sometimes of great size, a fine example of which may be seen at Quebec. Conglomerates, both altered and unaltered, are abundant amongst the Huronian rocks.

Breccias consist of angular masses or fragments of rock, cemented together, chiefly of some kind of limestone. Whilst conglomerates frequently consist of materials brought from a greater or less distance, true breccias are necessarily formed in place. Examples of calcareous breccias occur in the Eastern Townships. Also with imbedded trap and slate fragments, near the Bruce Mines, Lake Huron, and elsewhere.

(2) *Formation of Sedimentary Rocks*.—The manner in which the ordinary sedimentary rocks, sandstones, shales, &c., have been formed, or built up as it were, is rendered clear by the observation of certain natural processes still in action We find for example, at the present day, that sediments of various kinds are constantly being carried down by streams and rivers into lakes and seas, and are there deposited. We find, moreover, that the cliffs of many sea (and lake) coasts are being continually abraded and washed away by the action of the waves. Observation shews also, that the sedimentary matters thus obtained, are always deposited or arranged in regular layers or beds, and that they frequently enclose shells and sea-weeds, together with bones and leaves, drifted from the land, and other organic bodies. Hence it is now universally admitted, that, with the exception of certain limestones and dolomites, beds of rock-salt, gypsum, coal, and other chemical or organic deposits of small extent, all the sedimentary rocks have been formed directly out of previously-existing rock-masses,

by the wearing away or destruction of these; and secondly, that they have all been formed or deposited under water.

In pursuance of this inquiry, consequently, we have to consider, first, the origin or derivation of the sediments of which these rocks are made up; and, secondly, the processes by which the consolidation of the sediments into rock, properly so-called, was effected.

The sediments of which these rocks originally consisted, were derived from previously-existing rocks, by decomposing atmospheric agencies,—rain, frost, and so forth; by the action of streams and rivers on their beds; and by the destructive action of the waves and breakers of the sea.

Action of the Atmosphere.—All rocks, even the most solid, are constantly undergoing decomposition and decay. The exposed face of a rock of any kind, for example, soon changes colour, and becomes in general more porous than the other portions of the rock. This effect is technically termed "weathering." Its action gives rise to the production of soils, and frequently causes the fossils contained in the rock to stand out in relief, these being in many cases less easily decomposed than the mass of the rock itself. Every shower of rain that falls, takes part in this decomposing or disintegrating action, and carries off something, in solution or suspension, to lower levels—*id est*, into streams, lakes, and seas. Frost, and, in certain districts, carbonic acid and other gases issuing through crevices in the rocks, assist this destructive process.

Action of Streams and Rivers.—The action of streams and rivers in wearing their channels is both chemical and mechanical. Calcareous river-beds are wasted bit by bit by the dissolving power of the water, especially during the autumnal season, when dead leaves and other decaying vegetable matters yield the water a large supply of carbonic acid. On the other hand, a mechanical waste is also very generally taking place to a greater or less extent: and thus numerous rivers are continually cutting back their beds, and forming ravines. It is thought by many geologists, that the Falls of the Niagara River have in this manner gradually receded from the escarpment at Queenston to their present site; and there is scarcely a river, or small stream indeed, in any part of Canada, that does not exhibit in its banks indications of erosive action. Where streams wind through the sands and gravels of our Drift deposits, as in the neighbourhood of Toronto, to cite a single amongst so many instances, examples of this action are especially apparent. The River Don, it is said, during a three days' freshet, about fifty years ago, greatly enlarged its channel, and added much in places, to the steepness of its banks. The amount of detrital matters borne down by some rivers to the sea, is, at first thought, almost incredible. This is well shown by the formation of deltas. The delta of the Mississippi, on this continent, for example, like all other deltas, is formed almost entirely out of the sandy and other matters brought down by the stream. On entering the sea, the velocity of the river is necessarily checked, and the sediments are thus thrown down. Much of the coarser matter is indeed deposited on the bed of the river itself, raising this, and compelling the formation of artificial banks, or levées, to prevent inundations. Finally, as a well-known illustration of the immense amount of sedimentary matters borne seawards by certain rivers, the case of the Ganges, as described so fully by Sir Charles Lyell, in his "Principles of Geology," may be here cited. That river, it has been demonstrated, by actual observation and experiment, conveys annually to the sea an amount of matter that would outweigh sixty solid pyramids of granite, each, like the largest of the Egyptian pyramids, covering eleven acres at its base, and standing 500 feet in height. A considerable quantity of sediment is also produced by the slow movements of glaciers in Alpine and other districts in which these remarkable ice-rivers prevail. The glacier of the Aar, which covers with its tributaries an area of only six or seven square miles, thus furnishes daily, according to some recent researches of M. Collomb, at least 100 cubic yards of sand. This is carried off by its terminal stream or torrent.

Action of the Sea (and of large bodies of Water generally.)—Vast in amount as are the sediments collected by rivers, they are far surpassed by the accumulation of detrital matters obtained by the waves and breakers of the sea. All who have resided for any length of time on an exposed and rocky coast, must be well aware of the destructive action of the waves. The cliffs subjected to this action, gradually become undermined and hollowed out; and thus large masses of rock are brought down by their own weight. These, sooner or later, are broken up, and spread in the form of sediment along the shore, or over the sea-bottom. On some coasts, the amount of land destroyed in this manner almost exceeds belief.* On some

* It would obviously be out of place in an Essay like the present, to enlarge on this point. The reader unfamiliar with geological details of this character, should consult, more especially, Lyell's *Principles of Geology*, and also the *Cours Elémentaire* of the late Alcide d'Orbigny.

arts of the eastern shores of England, and the opposite or western shores of France, for example, the sea has thus carried off, within the present century, from fifty to over one hundred yards of coast—measured backwards from the shore-line—and for a distance of many miles. Grave-yards, shewn by maps of no ancient date to have been located at considerable distances from the sea, have become exposed upon the cliff-faces; and forts on the French coast, built by the First Napoleon, at two hundred metres and upwards from the edge of the cliff, now lie in ruins on the beach, or have altogether disappeared. These localities are mentioned as being more especially known to the writer; but in all parts of the world examples may be found of the same destructive process. In the clay and sandy bluffs of our own lakes, as at Scarbro' Heights on Lake Ontario, and elsewhere, the effects of this action may be equally studied.

On a subsequent page it will be shewn that these results of denudation, however striking in themselves, were greatly surpassed by those of former geological epochs; but confining our view at present to modern effects only, it must be evident to all that an enormous amount of sedimentary matter is annually, or even daily, under process of accumulation. The question then arises as to what becomes of this. The reply is obvious. The detrital matter thus obtained, is deposited in lakes or at river-mouths, or along the sea-shore, or over the sea-bed—contributing day by day to the formation of new rocks. In other words, existing rock-masses, worn down by atmospheric agencies, by streams and rivers, and the action of the sea, supply the materials for other and, of course, newer deposits. And thus, when we look upon a piece of stone derived from one of these, we may picture to ourselves the scene of its formation, and, with the poet, hear—

> The moaning of the homeless sea,
> The sound of streams that swift or slow
> Draw down Æonian hills, and sow
> The dust of continents to be—

—for truly, is it the dust of new continents that is thus being deposited, atom by atom, by these slow but continued processes.

All sediments diffused through deep or quiet water, arrange themselves, under general conditions, in horizontal or nearly horizontal beds: the latter, if deposited on gently-sloping shores. Professor H. D. Rogers, in his recently-published Report on the Geology of Pennsylvania, contests to some extent this usually-received view, and maintains that certain inclined strata of mechanical formation were originally of inclined deposition. This may be true under local or exceptional, but certainly not under general, conditions. (See proofs, further on.) Where, however, sands and gravels are thrown down by currents and running streams, an oblique arrangement commonly takes place; but this is more or less confined to the subordinate layers of which the larger beds consist, as shewn in the annexed figure. The inclined layers have sometimes different degrees of inclination, and even dip (in different beds of the same strata) in opposite directions, indicating changes in the tidal or other currents by which they were thrown down. This inclined arrangement is termed "false bedding," or "oblique stratification." It may be seen in some of the more ancient, and also in some of the more modern deposits of this continent, as in the Potsdam Sandstone of the south shore of Lake Superior, and in the Drift gravels of many parts of Canada.

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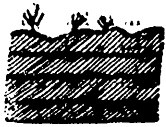

Having thus rapidly traced out the formation of the mechanically-formed sedimentary rocks up to their deposition in the state of detrital matter on the beds of seas, lakes, or estuaries, we have now to inquire how these accumulations of mud, sand, &c., become hardened into rock, properly so-called.

Consolidation of Sediments.—Most sediments hold within themselves the elements of their own consolidation, in the form of particles of calcareous or ferruginous matter, which act upon the other substances in the manner of a cement. Frequently, also, a large amount of calcareous matter is derived from the decomposition or solution of imbedded shells and other organic remains made up of carbonate of lime. In the majority of strata, and in sandstones more especially, merely casts or shell-impressions are thus left, in place of the originally imbedded shells. Masses of solid conglomerate are daily under process of formation, in places where springs containing calcareous or ferruginous matter infiltrate through the gravels and pebble-beds of our Drift deposits. Many thermal springs (and even ordinary river-water) also contain considerable quantities of silica in solution; and there is reason to believe that in former periods of the Earth's history, springs of this kind must have prevailed to a very great extent. These flowing into seas and lakes where sediments were under process of deposition, must also have lent their agency towards the consolidation of such deposits. Many of our Canadian limestones, it may be observed—as those, more especially, which occur at the base of the great Trenton group (see PART V.)—are highly siliceous.

The enormous pressure exerted upon low-lying sedimentary beds by those above them, must likewise have been sufficient in many instances to have effected consolidation. Loose materials, as graphite powder used in the manufacture of the so-called "black lead" pencils, are thus rendered solid by artificial pressure. Spongy platinum, again, by the same process, is converted into the solid metal.

The heat transmitted in earlier periods from subterranean depths, or generated amongst low-lying sediments by natural causes, may also have been concerned in the work of consolidating the originally loose materials of stratified rocks. It may be remarked, likewise, that sediments occasionally become solidified by simple desication. The shell-marl, or calcareous tufa, of our swamps, &c., becomes thus hardened on exposure to the air.

(3) *Changes to which the Sedimentary Rocks, collectively, have been subjected.*—These changes comprise, principally: (*a*) Elevation above the sea level, with alternations of upheaval and depression; (*b*) Denudation; (*c*) Tilting up and Fracturing; and (*e*) Metamorphism and Cleavage. It is, of course, to be understood that whilst certain strata may have experienced all of these effects, others, on the contrary, have been subjected to upheaval, or to upheaval accompanied by denudation, only.

(*a*) *Elevation above the Sea Level.*—The stratified rocks, it has been shown, must have been deposited originally in the form of sediments, under water; and from the marine remains which so many of them contain, it is evident that as a general rule they were laid down on the bed of the sea, either in deep or in shallow water. We find these rocks, however, now, at various heights above the sea-level, and frequently far inland. Hence of two things, one: either the sea must have gone down, or the land must have been elevated above the water.

The sinking of the sea would appear at first thought to be the more rational explanation of this phenomenon; but if we look to existing Nature, we find no instance of the going down of the sea, whilst we have many well-proved examples of the actual rising and sinking of the land. In connexion with this inquiry, it must be borne in mind that the sea cannot go down or change its level at one place without doing the same generally all over the world.

To afford a few brief illustrations, it may be observed that on several occasions within the present century, large portions of the Pacific coast of South America have been raised bodily above the sea, leaving beds of oysters, mussels, &c., exposed above high-water mark. The phenomenon, to the inhabitants of the coast, appeared naturally to be due rather to a sinking of the waters than to an actual elevation of the land; but at a certain distance north and south of the raised districts, the relative levels of land and sea remain unaltered: and hence, if the sea had gone down within the intervening space, its surface must have presented an outline of this character , a manifest impossibility.

The land is also known to be slowly rising and sinking in countries far removed from centres of volcanic activity. Careful observations have shown, for example, that the northern parts of Sweden and Finland are slowly rising, and the south and south-eastern shores of the Scandinavian peninsula are slowly sinking: whilst around Stockholm there is no apparent change in the levels of land and sea. The whole of the western coast of Greenland is slowly sinking; buildings erected on the shore by early missionaries, being now in places under water. A slow movement of depression, it is likewise inferred, is taking place along a considerable extent of the Atlantic sea-board of the United States. (See *Canadian Journal*, vol. ii. new series, p. 480.) On the shores of Newfoundland, of Cornwall, and other districts, examples occur of sub-marine forests, or of the remains of modern trees, in their normal position of growth, below low water-mark; whilst in neighbouring localities no change of level appears to have taken place. Besides which, without extending these inquiries further, we know that many fossiliferous strata are hundreds, and even thousands, of feet above the present sea-level:—on the top of the Collingwood escarpment, for example, we find strata containing marine fossils at an elevation of over 1500 feet above the sea; and on the Montreal mountain, shells of existing species occur at an elevation of about 500 feet. And hence, if these strata had been left dry land by the sinking of the oceanic waters in which they were deposited, an immense body of water, extending over the whole globe, must in some unaccountable manner have been caused wholly to disappear. It is therefore now universally admitted, that the sedimentary rocks have come into their present positions, not by the sinking and retiring of the sea, but by the actual elevation of the land.

Many strata afford proofs of having been elevated and depressed above and beneath the sea, successively, at different intervals. Many sandstones, for example, exhibit ripple-marked surfaces, and some, impressions of reptilian and other tracks, through their entire thickness. This indicates plainly that they were formed slowly in shallow water, and that they were left dry, or nearly so, between the tides. And it indicates, further, that the shore on which they were deposited layer by layer, was undergoing a slow and continual movement of depression, otherwise the process of formation would necessarily have ceased, and the strata would present a thickness only of a few inches, or of a few feet at most. Afterwards a period of upheaval must have commenced, bringing up the rocks to their present level. In certain strata, also, the upright stems of fossil trees occur at various levels; and in some localities, beds containing marine fossils are overlaid by others holding lacustrine or fresh-water forms; and these again by others with marine remains. Finally, to bring this section to a close, we have a striking example of alternations of land-upheaval and depression in the geology of Canada generally. Around Toronto, for example, we have strata of very ancient formation, belonging to the Lower Silurian series, overlaid by deposits of clay, gravel, and sand. Between the two, a vast break in the geological scale occurs. In other parts of this continent, many intervening formations are present (see the Table of Rock Groups, a few pages further on); and hence, it is concluded, that the Silurian deposits of this locality, after their elevation above the sea, remained dry land for many ages, whilst the intervening groups were under process of deposition in other spots; and that, finally, at the commencement of the Drift period, the country was again depressed beneath the ocean, and covered with the clays, sands, and boulders of this latter time. Another period of elevation must then have succeeded, bringing up both the Silurian and the Drift formations to their present levels above the sea.

(*b*) *Denudation.*—This term, in its geological employment, signifies the removal or partial removal of rock masses by the agency of water. The abrading action of the sea, of rivers, &c., acting under ordinary conditions, has already been alluded to; but the erosive effects of water, under conditions now no longer existing, may be seen in numerous localities. Sections of the kind shewn in the accompanying figure, for instance, are met with almost everywhere, producing undulating or rolling countries. Here it is evident that the strata were once continuous in the space between *a* and *b*.

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Valleys thus resulting from the removal of strata, are termed "valleys of denudation." Some of these valleys are many miles in breadth. Their excavation, consequently, could not have been caused by the streams which may now occupy their lower levels. Their formation is universally attributed to the denuding action of the sea during the gradual uprise of the land in former geological epochs. Frequently isolated patches of strata are left by denudation, or are cut off by wide distances from the rocks of which they originally formed part. These are termed "outliers." Thus in Western Canada, small isolated areas, occupied by bituminous shales of the Devonian series, occur in the townships of Enniskillen, Mosa, &c., and constitute outliers or outlying portions of the Chemung and Portage group (see Part V.), as largely developed in the adjoining peninsula of Michigan. The matter carried off in some districts by denudation, must have been of enormous amount; and when it is considered that most of the inequalities on the Earth's surface—those at least not immediately connected with mountain chains—have arisen from this action, it will readily be perceived that materials for the formation of newer strata were abundantly provided by this means alone.

(*c*) *Tilting up and Fracturing of Strata.*—Whilst some strata retain their original horizontality, others are more or less inclined, and some few occupy a vertical and even a recurved position. That strata were not originally inclined, at least to any extent, is proved by the known arrangement of sediments when diffused through water,—these (with the exceptional cases already pointed out) always depositing themselves in horizontal, or nearly horizontal, layers. The same fact

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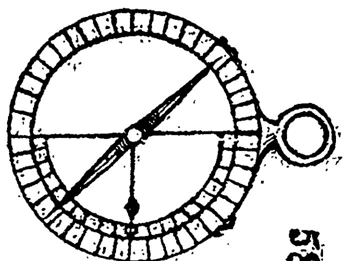
57.

is shewn also by the frequent presence of rows of pebbles, fossil shells, &c., parallel with the planes of stratification, as in fig. 56; by the occasional presence of the fossilized stems of trees (evidently in their positions of growth) standing at right angles to these planes (fig. 57); and sometimes by the presence of stalactites suspended in a similar position.

The inclination of strata is technically termed the *dip;* and the direction of the up-turned edges, the *strike.* The dip and strike are always at right angles. In observing the dip, we have to notice both its angle or amount, and its direction,—as north, north-east, N 10° E, and so forth. The direction of the dip is of course ascertained by the compass; the rate of inclination, by the eye, or by an instrument called a clinometer. The most convenient instrument for both purposes, is a pocket compass, furnished, in addition to the needle and graduated limb, with a moveable index hanging from the centre of the compass and playing round a graduated arc, as in the annexed outline (fig. 58.) When the line *A—B* is held horizontally, the index *I* hanging perpendicularly, cuts the zero mark of the graduated arc. From each side of this point, the graduation is carried up to 90°. If, consequently, the line *A—B* be placed parallel with the dipping beds of any strata, the angle of the dip will be at once shewn by the index. A contrivance of this kind, exclusive of the compass, may be easily made out of a semicircle of hard wood. The index may consist of a piece of twine extending below the graduated limb, and kept taut by a lead plumb or by a stone.



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When strata dip in two directions, the line along the culminating point of the strata is termed an *anticlinal* or *anticlinal axis* (= *a* in fig. 59); and the line from which the strata rise (= *s* in fig. 59), is called a *synclinal* or *synclinal axis.* Synclinals when of a certain magnitude, constitute "valleys of undulation." Anticlinals are also often hollowed out by denudation, forming valleys or troughs called "valleys of elevation" (= *e* in fig. 59.) The term "elevation" applies here, however, to the raised strata, and not to the actual position of the valley, as many of these so-called valleys of elevation lie in the beds of rivers, or occupy comparatively low ground. The city of Cincinnati is situated in a remarkable valley of this kind. Finally, it must be observed, that when strata lie in parallel beds (as in fig. 59),

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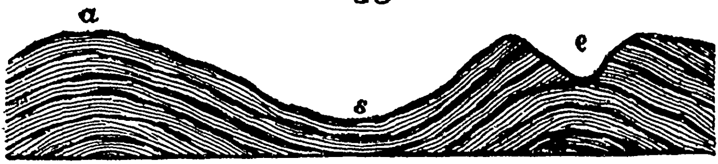

the stratification is said to be *conformable* or *concordant*. When on the other hand, the beds are not parallel, the stratification is said to be *unconformable*. The accompanying section, in which the inclined beds belong to the Laurentian, and the overlying beds to the Lower Silurian series (see PART V.), as shown on Crow Lake, north of Marmora village) is an example of unconformable stratification, or of want of concordance between these two series of rocks. As explained further on, a want of conformability always indicates a geological break, or the commencement of a new geological period.

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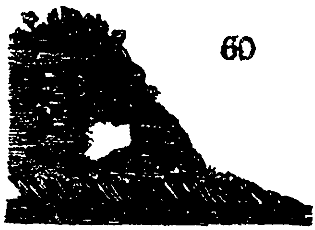

Both horizontal and inclined strata frequently exhibit fractures of greater or less extent. Mineral veins, it may be mentioned, consist essentially of cracks or fractures running through the surrounding rocks, and filled up, by various agencies, with sparry, earthy, and metallic matters. The strata on one side of a fracture are often displaced, being thrown up or down, as it were. This peculiarity is technically termed a *fault*. An example is shewn in the annexed diagram. The levels occupied by a displaced bed are sometimes only a few inches, and at other times upwards of a thousand feet, apart. At the first formation of a fault or slip, an escarpment or terrace of greater or less height must necessarily have arisen; but in very few cases (if in any case unconnected with existing earthquake phenomena) is anything of this kind now observable, the ground having

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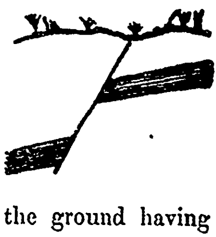


been levelled down by the agency of denudation. In mountainous districts, the fracturing of strata has sometimes given rise to narrow valleys or gorges, called "valleys of dislocation," most of which have been subsequently widened by the atmospheric disintegration of the surrounding rocks, and by the streams or torrents of which they usually form the channels.

(e) Metamorphism and Cleavage.—The subject of metamorphism has already been sufficiently explained, under the head of Metamorphic Rocks, above. It is merely alluded to here as one of the changes to which strata of various geological ages have been subjected. The term "cleavage" is applied to a peculiarity affecting many clay-slates, and occasionally other strata. The rocks thus affected, are rendered eminently fissile or slaty by numerous cleavage planes which run through them in a direction generally inclined to that of the lines of bedding. The latter, in inclined strata especially, are sometimes distinguished with difficulty from the planes of cleavage, but they may be discovered by tracing out lines of fossils, or intercalated bands of a slightly different mineral composition, colour, &c., which mark, of course, the planes of deposition, and across which the cleavage lines usually pass without interruption. That cleavage is a superinduced effect, is shewn by this latter circumstance, and more particularly by the fact that imbedded fossils and stones are frequently elongated in the direction of the cleavage planes. The cause of the phenomenon is still exceedingly obscure; but it is now very generally regarded as due to long continued pressure acting at right angles, to the lines of cleavage, whilst the rock was permeated by water or steam, or whilst it still retained its sedimentary condition. Many of the slates of the Eastern Townships, as those of Richmond, Kingsey, Melbourne, Westbury, &c., owe their fissility to superinduced cleavage.

CLASSIFICATION OF ROCKS IN ACCORDANCE WITH THEIR RELATIVE AGES.

Our preceding illustrations have shewn us the distribution of rocks into three great groups—Eruptive, Metamorphic, and Sedimentary rocks—in accordance with their modes of derivation or general formative processes. But these rocks admit of another and far more interesting classification: one based on their relative ages or periods of formation.

It is now universally admitted, on proofs the most unanswerable, that the various sedimentary and other rocks which make up the solid portion of our globe, were not formed during one brief or unbroken period, but were gradually elaborated and built up during a long series of ages. In areas of very limited extent, for example, even in the same cliff-face, or in excavations of moderate depth, we often find alternations of sandstones, limestones, clays, &c., lying one above another, and thus revealing the fact that the physical conditions prevailing around the spot in question must have been subjected to repeated changes. The same thing is also proved by alternations of marine and fresh-water strata in particular localities; and of deep-sea and shallow-sea deposits, in others. Again, the sedimentary rocks are frequently found in unconformable stratification, as explained above: horizontal beds resting upon the sloping surface or upturned edges of inclined strata. (See fig. 60.). Here it is evident that the inclined beds must have been consolidated and thrown into their inclined positions before the deposition of the horizontal beds which rest upon them. In the absence of particular sets of strata in special localities, proving extensive denudation or long-continued periods of upheaval and depression—in the vast metamorphic changes effected throughout many districts—in the upward limitation of faults (fig. 62), as sometimes seen—and, briefly, in the worn and denuded surface which a lower formation often presents in connexion with strata resting conformably upon it,—we have additional evidence of the lapse of long intervals of time during the elaboration of these rocks generally.

62.

But a still more conclusive proof of this fact is to be found in the limited vertical distribution of fossil species of plants and animals, the remains of which are entombed in so many of the sedimentary rocks. The sediments now under process of deposition in our lakes, river-estuaries, and seas, frequently enclose, it will be remembered, the more durable parts, if not the entire forms, of various plants and animals belonging to existing creations. In like manner, the sedimentary deposits of former geological periods have enclosed also various organic forms peculiar to those periods. Each group of strata has thus its own characteristic fossils, except that in the lowest or earliest-formed series of deposits we meet with no traces of ancient life. These deposits belong to the *Azoic Age* of geological history. All the succeeding periods have left us, in the rocks then under process of formation, vestiges, at least, of their organic types—those of each period differing more or less entirely from the forms which occur in both underlying and overlying strata. These facts are brought out more fully in the succeeding part of this Essay, in which the leading questions connected with the subject of Organic Remains, come under review. For present purposes, it will be sufficient to observe that by the careful study and comparison of these remains, geologists have subdivided the rock-groups into a certain number of formations, indicating the bygone ages and periods of the Earth's history. Without entering at present into minute or controverted subdivisions, we may group these various formations as in the annexed tabular view:

<table>
<tr><td colspan="2">Modern Formations.</td></tr>
<tr><td colspan="2">Drift Deposits.</td></tr>
<tr><td colspan="2">CAINOZOIC OR TERTIARY ROCKS.</td></tr>
<tr><td rowspan="3">MESOZOIC or SECONDARY ROCKS.</td><td>Cretaceous Series.</td></tr>
<tr><td>Jurassic Series.</td></tr>
<tr><td>Triassic Series.</td></tr>
<tr><td rowspan="4">PALÆOZOIC ROCKS.</td><td>Permian Series.</td></tr>
<tr><td>Carboniferous Series.</td></tr>
<tr><td>Devonian Series.
(For Canadian Sub-divisons, see PART V.)</td></tr>
<tr><td>Silurian Series.
(For Canadian Sub-divisions, see PART V.)</td></tr>
<tr><td rowspan="2">AZOIC ROCKS.</td><td>Huronian Series.</td></tr>
<tr><td>Laurentian Series.</td></tr>
</table>

Notes on the above Table.

(1) The formations enumerated in this table, are never found altogether: that is to say, they never exhibit a complete series at any one locality. But they are known to occur in this order, by a comparison of their relative positions at different places. Thus, in one district, we find (in ascending order) the Silurian and Devonian series; in another, the Devonian and Carboniferous, and so on.

(2) In Canada proper, the following series alone occur:

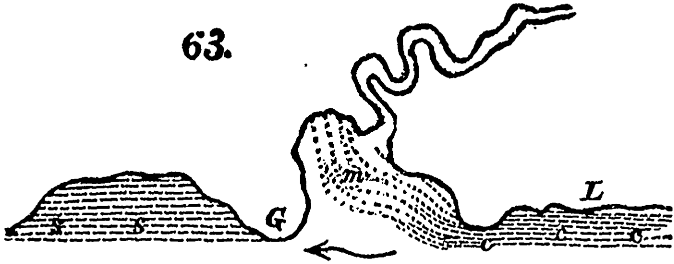
Modern formations.
Drift deposits.
Carboniferous series (in part only, in Gaspé.)
Devonian series.
Silurian series.
Huronian series.
Laurentian series.

These comprise, lithologically, various sedimentary and metamorphic strata, with, in some cases, accompanying eruptive rocks, as described fully in PART V.

(3) One or more of several consecutive formations (as shewn in Note 2) are often "wanting" or absent at a given spot. The Carbonifeorus rocks may thus, in certain districts, be found resting on the Silurian, without the intervention of the Devonian series. But the relative positions of these groups are never reversed. The Devonian beds are never found under the Silurian, for example, nor the Cretaceous under the Jurassic. The absence of particular strata, at a given locality, is accounted for by the elevation of the spot above the sea-level during the period to which the strata in question belong; by denudation, or by the district having been situated beyond the area of deposition to which the sediments extended. (See some of the preceding observations under "Formation of Sedimentary Rocks," "Denudation," &c.)

(4) A formation of a given age may be represented in one place by a limestone; in another, by a sandstone; in a third, by argillaceous shales, and so on. This will be easily understood, if we reflect that at the present day these different kinds of rock are being formed simultaneously at different places. Many of our preceding observations have amply illustrated this, but the fact may be rendered still clearer by the accompanying diagram. In this sketch, the dark outline is intended to represent a somewhat extended line of coast, with a river debouching into a deep bay. In the latter, the argillaceous or muddy sediments (*m*), brought down by the river, may be deposited. At G, we may suppose a granitic headland. The arenaceous or siliceous sediments (*s*) derived from the disintegration of this, will be arranged along the shore beyond it, by the set of the current. Finally, at L, we may suppose the occurrence of exposed cliffs of

63.



limestone, yielding calcareous sediments (*c*). These various sedimentary matters will be also in places more or less intermingled, producing rocks of intermediate or mixed composition. But these rocks will be shewn to be of the same period of formation, by the identity of some, at least, of the organic bodies enclosed in them. As recent formations, moreover (although many of the enclosed shells, &c., would necessarily be distinct, owing to the diverse nature of the sediments, the more or less exposed character of the coast, the varying depths of water prevailing at different parts, &c.,) we might expect to find in one and all, coins, pieces of pottery, and other objects of human workmanship, proving their contemporaneous origin. Hence, the age of a rock is in no way indicated by mineral composition: sandstones, limestones, &c., are of all geological periods.

(5) From time to time, during the gradual deposition of these sedimentary formations, various eruptive rocks were driven up amongst them, producing (in general) chemical or mechanical alterations of greater or less extent. This action is still going on, as witnessed in volcanic phenomena.

(*To be continued.*)

ADDITIONAL NOTE ON THE CRYSTALS OF LAZULITE DESCRIBED IN THE JULY NUMBER OF THIS JOURNAL, PAGE 363.

Since the publication of my remarks on the American variety of Klaprothine or Lazulite in the last number of the Journal, I have received a communication from Professor George J. Brush, of Yale College, New Haven, informing me that the crystals in question do not come from North Carolina, but from Georgia. They occur at

Graves' Mountain in Lincoln County of that State. The North Carolina examples analysed by Smith and Brush have not been met with in crystals.

Professor Brush also informs me that these Georgian crystals have been described and figured in a paper by Professor Shepherd (by whom they were discovered) in the *American Journal of Science and Arts*, Vol. XXVII. (2nd series), page 36. This paper has quite escaped my notice, and I have at present no means of referring to it. I hasten, however, in apologising for past negligence, to point out the fact of its publication. As regards the assumed trimetric character of these crystals, my views, I may venture to observe, remain unchanged.—E. J. CHAPMAN.

Orillia, C. W., August 15, 1861.

SELECTED ARTICLES AND TRANSLATIONS.

ON THE OCCURRENCE OF FERMENTATION-PRODUCING INFUSORIA, CAPABLE OF LIVING WITHOUT FREE OXYGEN.

BY M. L. PASTEUR.

(Translated from the Comptes Rendus, of February 25, 1861.)

[As this communication has attracted much attention in France, we venture to lay a translation of it before the readers of the *Canadian Journal.* We should remark, however, that the animal nature of the infusoria discovered by M. Pasteur, does not appear to be absolutely proved.]

The formation of a great variety of products in lactic fermentation is a well known fact. Lactic acid, a peculiar gum, mannite, butyric acid, alcohol, carbonic acid, and hydrogen, make their appearance either simultaneously or successively, and in extremely variable and uncertain proportions. I have been led gradually to the conclusion, that, the vegetable ferment which transforms sugar into lactic acid differs from the ferments,—for two exist—which give rise to the gummy matter; and that these latter again, do not ever engender lactic acid. I have found, also, that these different vegetable ferments, *if perfectly pure*, cannot under any conditions originate butyric acid.

A special butyric ferment must therefore exist. On this point I have fixed for some time my undivided attention; and the present communication is devoted to this question, that is to say, to the origin of butyric acid in the so-called lactic fermentation. Without entering here into all the details of my experiments, I may state at once the following result, namely: that the butyric ferment consists of a species of infusoria. So far was I from expecting this result, that for some time I did my best to prevent the development of the infusoria, fearing that these minute creatures lived upon the supposed vegetable ferment which I thought gave rise to the butyric fermentation, and which I sought to discover in the liquid media employed in my researches. But failing to make out the origin of the butyric acid, I finished by being struck with the remarkable coincidence between the presence of this acid and the infusoria, the one always accompanying the other; and since then, an extended series of experiments has convinced me that to these infusoria is exclusively due the transformation of sugar, mannite, and lactic acid, into butyric acid. We must therefore, consider these minute animals as the true butyric ferment.

With regard to their description, it may be stated that they form small and usually straight cylindrical lines, rounded at the extremities, and either free, or united in chains of two, three, four, or even a larger number of individuals. The isolated forms are about 0·002 of a millimeter in breadth, and are from 0·002 to 0·05 or 0·02 in length. They move with a gliding (or jerking) motion, the body either remaining rigid, or exhibiting slight undulations. At times also, they turn upon themselves, and cause the extremities of their body to vibrate rapidly. The undulatory movements of the body become very evident when the length reaches 0·015 of a millimeter. One extremity is frequently curved, and occasionally both ends of the body exhibit a curvature, but curved forms are rare at the commencement of life.

The reproduction is fissiparous; and to this mode of generation the chain-like groupings are evidently due. In these chains, the last individual may frequently be observed in comparatively violent motion in its attempts to detach itself from the rest.

Although, as I have said, the body of these *Vibrionidœ* is cylindrical in form, it often appears to be made up of a faintly-marked series of very short articulations. These undoubtedly represent the first stage in the development of the infusoria.

The propagation of these forms may be effected as in the case of yeast. They multiply readily if the medium be appropriate to their nourishment. It is a remarkable fact, indeed, that they may be propagated in a liquid containing merely sugar, ammonia, and phosphates: crystallizable and, in a manner, mineral substances. Their reproduction goes on with the appearance of butyric fermentation, the presence of which is always clearly manifest; and although the weight of the ferment thus produced (as in other ferments) is always small as compared with the total weight of the butyric acid, it is still sufficiently marked.

The exist ce of infusoria possessing the character of a ferment is a circumstance in itself well worthy of attention; but in this instance it is rendered the more striking by the fact that these infusoria live and multiply without requiring the smallest quantity of atmospheric air or free oxygen. It would occupy too much space to explain here, the means by which I have guarded against the entrance of free oxygen into the solutions and vessels in which these creatures swarm and multiply by myriads, but the complete exclusion of this element has been thoroughly proved. I will merely add in confirmation, that before presenting my results to the *Académie*, I have obtained the testimony of several of its members, before whom I have exhibited my experiments, as to the correctness of this assertion.

Not only do these infusoria live without air, but its presence actually destroys them. So long as a current of pure carbonic acid is transmitted through the liquid in which they live and multiply, their development is in no way affected; but if, under exactly similiar conditions, the carbonic acid be replaced by a current of atmospheric air for the space of two or three hours only, all perish; and the butyric fermentation, connected with their presence, ceases at the same time.

We arrive therefore at these two conclusions:

1. *The butyric ferment is an infusorial animal.*

2. *This infusorial species lives without free oxygen.*

The present example is, I believe, the first recorded case of an animal ferment, and also of an animal capable of existing without the presence of oxygen in the free state.—E. J. C.

ON THE OCCURRENCE OF AMERICAN BIRDS IN EUROPE.

BY H. GÄTKE, OF HELIGOLAND.

(*From the Proceedings of the Zoological Society of London.* 1860.)

The route by which American birds proceed to Europe is, as Yarrell justly terms it, "an interesting problem, of difficult solution." For years this solution has occupied my attention, and although I have myself always been convinced that such of these entirely American birds as occasionally visit Europe *do* reach us by a passage across the Atlantic, this remains a mere opinion, carrying no weight if unsupported by facts, or by at least sufficient argument to make good the question at issue.

The mere comparative review of the occasional visitors among the birds of Great Britain and of Germany will lead to the conclusion that the route of American birds to Europe must needs be a voyage across the Atlantic, for almost all the additions to the birds of Europe, of species *purely American*, have been obtained in Great Britain—which could not have been the case if they had proceeded in any other than an eastern direction—whilst the additions by Germany, furnished to the European Ornis, consist nearly entirely of birds belonging to Asia.

However striking the result of such a comparative review may be, one question will always present itself, namely:—Whether it be possible for a bird to sustain an *uninterrupted* flight sufficient to carry it across the wide expanse of the Atlantic. I am convinced that this is possible, and shall endeavour to prove such possibility.

This purpose necessitates a measure for the rate of locomotion of a bird through the atmosphere. For a long time I vainly endeavoured to obtain reliable data upon which to found an estimation of the rate of flight of birds—when at last I hit upon a passage in Yarrell's "British Birds," ii. p. 295, where, speaking of the Carrier Pigeon, he mentions the fact of one of these birds having performed a flight of 150 miles in an hour and a half: it was on the 24th of June, 1833; the Pigeon flew from Rouen to Ghent; sixteen others flew the same distance in two hours and a half.

Wonderful as this instance of swiftness of the flight of a bird may appear, it certainly is still surpassed by birds when on their periodical migrations; for the above feat was accomplished by an individual hatched and reared in at least semi-confinement, whose powers of flight consequently could not be nearly so well developed as in a bird grown up wild and free, which nearly every hour of his life has to depend on the utility of its wings, either for the purpose of overtaking its prey, or for that of escaping from being caught.

Laying down, therefore, 100 geographical miles per hour as the rate of flight of birds during distant migration, one keeps—after the above—quite within safe bounds, and, at this rate, the 1600 geographical miles from Newfoundland to Ireland would be effected in sixteen hours. No ornithologist will doubt for a moment the capability of a healthy bird to sustain a flight of that duration; during the long summer days many of the *Hirundinidæ* are on the wing for as long a period, and although their flight may be interrupted by occasional rests of very short duration, it is performed in the lower, less buoyant atmosphere, and consists of so many evolutions, that most decidedly it must on the whole be much more tiresome than the straight path, in the pure upper regions, of a bird bent on the performance of one long pilgrimage.

Even supposing that birds become exhausted before accomplishing the passage across the ocean, observations I have made in the vicinity of this island have fully convinced me that small birds, such as Thrushes, Buntings, Finches, &c., are able to rest on the sea—even when a little in motion—and afterwards to resume and pursue their flight with fresh vigour. Of this I shall give the particulars further on; but, for the present, return to the above question, by giving an instance of endurance on the wing of a species which, with pretty good certainty, may be said every spring to perform in the period of one night, a flight of more than 1200 geographical miles; namely, from Egypt to Heligoland—the bird in question being a particular form of Blue-throated Warbler, *Sylvia cœrulecula*, Pallas.

This pretty little bird, noted not at all either for rapidity or great endurance of flight, has its summer quarters in the high northern latitudes of Sweden, Finland, and Siberia, whereas during the winter months it is staying principally in Egypt. On its spring migration, which takes place during the earlier half of May, the first place north of Egypt where it is to be found with certainty in pretty considerable numbers is Heligoland. Nowhere in the whole intermediate distance is it met with but as a great rarity—not even on the neighbouring north coast of Germany—while here in Heligoland I have oftentimes obtained it in such numbers that more than twenty of the finest adult male birds have been bought by me in one day, and perhaps the same number by the bird-stuffers of the island. The foregoing admits of one conclusion only, namely, that this little bird performs the passage from Egypt to Heligoland in one uninterrupted flight, travelling—as many of the other small *Insectivoræ* do—during the night, starting towards sunset and arriving here about sunrise, or a little later, the time occupied being from twelve to fourteen hours. The distance from Egypt to Heligoland being about 400 geographical miles less than that between Newfoundland and Ireland, the rate of flight of this delicate little bird may be put down the same as that rendered by the above-mentioned Carrier Pigeon, and consequently furnishes a further proof that a healthy, well-flying bird is able to cross from the nearest point of America to Ireland without rest or any extraordinary support whatever.

In the foregoing I alluded to the aptness of non-natatorial birds of resting, in case of exhaustion, on the sea, and of rising from it after having recovered sufficient strength to resume their flight; and that at times, too, when the water is far from being unruffled. This statement is based on the following observations. One day, when out in a boat shooting, about two or three miles from Heligoland, I observed a very small bird swimming on the water. Neither the boatman nor myself being able to discern what species it belonged to, we became very eager to secure the stranger—conjecturing that it would turn out to be some wonderful rarity. When preparing to fire, I fortunately discovered that the expected prize was nothing but a Song-thrush! Immediately our desire to kill was changed into compassion: the "*poor Thrush*" in so piteous a situation was to be "*saved.*" But how great was our astonishment, when, upon the approach of the boat, the bird without any apparent difficulty rose from the water and flew towards Heligoland in first rate style! Another time we saw a Snow-bunting, evidently exhausted very much, because it was floating scarcely 500 yards from the island. At the approach of my boat, this bird also very lightly rose from the water, but it was so weak that it had to resume its unnatural resting-place after proceeding about thirty or forty yards towards the rocks. We went after it again, and for a third time, but with the same result, whereupon we refrained from all further attempts at forcing our well-intended assistance upon so obstinate a fellow—the more so as we entertained no doubts that after a little rest he would obtain a more solid footing without any help of ours.

I will give one more instance of this propensity in birds—in all my experience the most striking: this time it was a Mountain-Finch which had been compelled to alight for rest on the water of the sea; it was about three miles west of Heligoland. When this bird was approached by the boat, it rose very easily, mounted into the air to a great height—as birds do when starting for their migratorial excursions—and then struck out steadily in a southern direction, *without taking any notice whatever of the island.*

Although I believe in the foregoing to have proved sufficiently the *possibility* of birds being capable to cross on the wing from the United States of America to Great Britain, the greatest *probability* that they do so is still shown by the proportion the number of American birds obtained in Great Britain bears to that of those obtained in the whole of Europe. Yarrell, in his "British Birds," 1845, mentions more than forty instances of that description; *Tringa rufescens* and *Scolopax grisea* having been obtained six times each! whereas Germany, Holland, and France together, offer but very few instances—some of which scarcely rest on good authority.

Heligoland seems to form a happy centre. Here the gulls of the Arctic Sea, *Larus rossii* and *sabinii,* meet the Numidian Crane, *Grus virgo, Lanius phœnicurus,* and other African birds; whilst the United States send *Mimus rufus* and *T. lividus, Sylvicola virens, Charadrius virginicus,* and others, to meet deputations from the far east of Asia, consisting of *Turdus rufficollis* and *T. varius, Sylvia javanica, S. caligata,* and *S. certhiola, Emberiza rustica, E. pusilla,* and *E. aureola, Pyrrhula rosea,* and a great many others.

All these birds, together with a great number of acquisitions quite as valuable for the European Ornis, *all captured on this island,* are preserved in my collection—a collection which, although scarcely approaching to three hundred specimens, has, by Blasius, been pronounced to be "the most interesting between Paris and Petersburg."

AGRICULTURAL MANUFACTURES.

BY S. COPLAND.

(From the Journal of Agriculture, July, 1861.)

The discovery of sugar in the plants of Europe is of modern origin, dating not farther back than the middle of the last century. It was in 1747 that M. Margraaf, a Prussian Chemist, made this discovery in analysing the Silesian beet-root, and the fact was communicated by him to the scientific world, as one of the curiosities of nature, but not as likely to lead to any beneficial practical result. It made some noise at the time amongst men of science, and without any immediate important action. Like the discovery of steam power, the electric telegraph, and many other useful inventions, it was kept in abeyance for half a century, and only brought out into public notice and utility through a political necessity.

About the close of the last century, France had been denuded of most of her sugar colonies. Domingo, the principal one, had become free by the insurrection of the slaves, who had cleared the island of their former masters, and would no longer make sugar. This alone deprived France of a supply of upwards of 150,000,000 pounds per annum of that condiment; other of the colonies had been wrested from her by the British, and so low was the supply of sugar reduced, that the French chemists were directed by the Government to investigate the subject of indigenous sugar, and see whether the discovery of Margraaf could not be turned to national advantage. One of the chemists thus employed, M. Achard, also a Prussian, stimulated by the high price of sugar on the Continent, and by the proposed rewards of the French Government, directed his attention solely to this subject. He published a treatise on the cultivation of the Silesian beetroot, and the mode of manufacturing sugar therefrom. Such, however, was the imperfection of the processes then used, that not only was the product so small as to amount to only $3\frac{3}{4}$ per cent, but the quality of the sugar was such that nothing but the necessity of the case would have tolerated its use.

From this period the attention of the people of continental Europe was directed to the subject. In France, the Government ordered that 100,000 hectares should be devoted to the cultivation of the sugar or Silesian beetroot, and the highest encouragement was held out to those who should most promote the native industry.

The interruption of the trade with those colonies which still remained to France, and which they soon after lost by the conquest of the British, induced the French directory, and afterwards the Imperial Government, to push forward the manufacture as much as possible. The price of sugar, indeed, on the Continent, was of itself a sufficient inducement. The issuing of the Berlin and Milan Decrees by Napoleon, by which all intercourse with England was as strictly interdicted as so extended a seaboard would admit of, raised the price of raw sugar to five francs (4s. 2d.) per kilogramme, or about 2s. per pound. On the other hand, by the aid of science, not only was the quality greatly improved by the employment of chemical agents in its purification, but the product was increased from 3¾ to 4, 5, 6, and eventually 7 per cent.

The existence of saccharine matter is not confined, amongst our domestic and other plants, to the beetroot. It is found in them all to a greater or less proportion, but greatest in that of the Silesian beet and its varieties. All the mangold-wurzel tribes possess it, but only the Silesian and its varieties in sufficient quantity to render its manufacture profitable. The Chinese sugar-cane, or sorgho, has, however, been recently introduced, and is now extensively cultivated in the south of France for the same purpose, and is found to yield a full proportion of sugar, below a certain latitude. It is a remarkable provision of nature, that, taking the latitude of 45° as the line of demarcation, the quantity of saccharine in bulbous plants rises as you advance towards the north, and decreases towards the south; and that, on the other hand, the gramineous plants, such as the cane, maize, sorgho, &c., increase their saccharine properties as they advance towards the south, and lose it towards the north. In the neighbourhood of Marseilles, for instance, the sorgho is found to yield fully 7 or 8 per cent. of sugar, whilst in the neighbourhood and latitude of Paris it does not contain more than 4 or 5 per cent. On the other hand, no beet sugar factories are to be found on the Continent below 45°.

It is proper to state here, that there are in commerce two descriptions of sugar, possessing different characteristics, and requiring different processes in their production. The first and best of these is extracted in its perfect state, by mechanical means alone, from the cane and its varieties, the beetroot, and the maple. This sugar crystallises after condensation by boiling, and is identically the same in these three substances in properties and composition when similarly manufactured. That from beetroot, however, is said by chemists to be the strongest in saccharine power, and forms the finest crystals.

The second kind is what is termed a *factitious sugar*, the product of the grape and other ripe fruits, and starch or farina. This kind is something similar to the common East India sugar, soft and weak, not forming regular crystals, as at present manipulated, but settled into tufted concretions, like the head of a cauliflower. The product of these is greater than that of the former, the grape containing about forty per cent. of saccharine matter; whilst the farina, being itself already a residuum reduced by a simple mechanical process, requires only the addition of a chemical agent—sulphuric acid—to convert the whole mass into sugar, weight for weight. In fact, by the addition of the chemical agent, and the water necessary to dilute it, 1 cwt. of farina willl produce 1¼ cwt. of sugar. Both these factitious sugars, upon being tested by the saccharometer, prove to be greatly inferior to the first description, containing a proportion of not more than 60 to 100 of saccharine power. It is, therefore, only when the potato is cheap enough to be manufactured into farina that it will be profitable to make sugar from it. The sulphuric acid is used in the proportion of 1 part to 100 of water. The process is too long to be inserted here; but it may be stated that diseased potatoes will yield starch as well as those that are sound. In the fatal years of 1846, 7, and 8, an immense quantity of diseased potatoes, in all stages of decay, were brought from the country into Dublin, and purchased by a starch maker, who made a fortune by extracting the farina. The process is so simple and inexpensive that we are surprised it has not been adopted by the English and Scotch potato-growers, in those seasons when the disease is general.

Whilst the Napoleonic wars continued, and foreign produce was excluded, the price of sugar was sustained, and the manufacturers having a monopoly, made but little progress in improving the quality of their article. It was neither properly clarified nor perfectly crystallized, and nothing but the absence of competition with colonial sugar enabled the manufacturers to sell the wretched stuff they made; and when the peace of 1815 returned, and it had to sustain the competition, the manufacture rapidly declined, notwithstanding a high protecting duty, and the desire of the Government to support it as a permanent branch of national industry. In 1828 the quantity produced was only 4800 tons, being the lowest ebb to which it was reduced.

Since that period, not only has the manufacture recovered itself, but it has been firmly established amongst the industrial pursuits of the country, as one of its most profitable branches of commerce and of rural economy. In 1829, Count Chaptal, who was the most extensive grower of beetroot and manufacturer of sugar, being at the same time an eminent chemist and agriculturist, published his process in a work entitled *Chimie appliquée à l'Agriculture.* From that period the manufacture has steadily advanced; and such have been the improvements effected in the processes, that the quality of the produce now equals that from the West Indies, except that a slight taste of the beetroot still remains. This, however, does not apply to the refined or loaf sugar, which is perfectly free from any taste of the root. There are now in France, according to Lavergne, about 350 sugar works, of which 150 are situated in the department of the Nord, to supply which 20,000 hectares (49,350 acres) of land are under beetroot; producing an average of about 36 tons per hectare (or 15 tons per acre), which, if we reckon 14 tons of roots to each ton of sugar, yields about 51,430 tons of that article.

With respect to the profitableness of the manufacture, the best proof of it is the vast extension it has taken, not only in France but throughout the Continent. For some years it was protected in the former country by a high duty upon colonial sugar; but since the year 1852, the duties on indigenous and on French colonial sugars have been equalized, and the manufacture has been found quite capable of standing the competition. The following statement is the actual result of an experiment, made at Tournay, in Flanders, of a patent process, upon 120,000lb., or 53 tons 11cwt. 2qrs. 40lb. of beetroot, the net produce of sugar from which was 8400lb., or 7 per cent. of uniform quality:

53 tons 1qr. 40lb. beetroot, at 15s. per ton..........				£40	3	6
Labour, coals, &c				39	7	6
Rent, interest, insurance, &c				10	0	0
Cartage, brokerage, &c				7	10	0
				£97	1	0
Deduct 45cwt. molasses, 8s	£18	0	0			
" 29 " pulp for cattle, 6s.......	7	6	0			
" 9 " skimmings, 1s..........	0	9	0			
				25	15	0
Cost of 3¾ tons sugar, ...				£71	6	0
or £18, 7s. 11d. per ton.						

This also agrees with a statement given by Sir K. Kane, in his *Industrial Resources of Ireland,* in which he makes the cost of sugar from beetroot to be £19 per ton, the difference arising from his charging the beetroot at 16s. 8d. instead of 15s. Thus, it is agreed on all hands that sugar can be made from beetroot at 2d. per lb., and with duty paid at 3d. per lb., which is considerably lower than it can be made for at the West Indies. It has also been discovered that, by a peculiar process, refined or loaf sugar can be made as well and as speedily from the syrups as from the raw sugar, which latter is the old practice. By this improvement, expense, time, and labour are greatly economised, and a much quicker return made of capital employed. It would be foreign to the object of this paper to go into the details of the manufacture; but I may observe that, so much has the process been accelerated, that the beetroot that is taken into the factory in the morning is converted into loaf sugar before night. The writer has seen a loaf of sugar that was made from the juice of the root in five or six hours; whilst, by the old process, it required a fortnight or more to drain the molasses from it in a perfect manner.

Whilst, however, this branch of industry has received a wide extension on the Continent, being introduced into all the German States, as well as France, Prussia, and Russia, we must notice a remarkable change that has occurred in its history; that is, that all the small factories have been abandoned, so that, although the quantity of sugar made has greatly increased, the number of sugar-works has decreased considerably. Since the protective duty was taken off colonial sugar, it has been found that the private establishments formed by the beet-growers themselves did not pay, and they have consequently been abandoned; whilst the larger ones, which are under the management of firms or companies, have flourished in a remarkable manner, and extended their operations up to the year 1858–9, when, from some cause which has never been fully explained, a falling-off in the produce of sugar took place. In 1857–8, the quantity of sugar made was 1,517,435cwt.; but in the following season of 1858-9 it amounted to only 1,303,796cwt. A still further reduction took place in 1859–60, when, up to the 1st January in the latter year, the quantity was 1,101,734cwt., against 1,124,016cwt. in the previous corresponding season. Thirteen small factories had suspended their operations, which accounts in a great measure for the falling off: whilst the injury done to the beetroots by the early frosts in the autumn of 1859 accounts for the unprofitableness of the manufacture with the smaller works. The present season, too, is not likely to prove much more favourable than, if equal to, the last, in that respect—the entire summer having been unfavourable to the proper development of the saccharine in the roots, from the absence of sunshine. These however are temporary derangements of the manufacture, to which all branches of industry are liable, and which will doubtless be surmounted; and the question is, will the manufacture be profitable in the long-run in France and the other Continental states? because, if the affirmative can be established, there is no reason why it should not be equally so in this country.

By the price-current of the last few days, I find the value of Madras sugar is 39s. per cwt., duty paid (10s. per cwt.), which gives 28s. net, or 3d. per pound. From this must be deducted brokerage and other charges, amounting to (say) 2s. per cwt., leaving 2¾ths per pound, or 26s. per cwt. as the net return. This affords a large profit, assuming that the former estimate is anything like correct. The following will place it in the most unfavourable position that can be supposed:—

14 tons beetroot at 15s. per ton	£10	10	0
Cost of labour, coals, &c	10	10	0
Rent, interest, insurance, &c	3	0	0
Brokerage, cartage, &c	1	15	0
	£25	15	0

13cwt. sugar, best crystalized, 26s	£16	18	0
7 " do. middling, 21s	7	7	0
12 " molasses, 6s	3	12	0
7½ " pulp, 6s	2	5	0
	£30	2	0

This account shows that sugar can be made from beetroot to yield a handsome profit. The prices given are below the market value, and the beetroot is charged at its full value, in the country at least, in ordinary years, although this season the prices will probably range higher. The following passage from M. Lavergne on the subject is of considerable importance: "It was feared, in the first instance, that the cultivation of the sugar-beet would lessen the production of cattle and wheat by occupying the best lands. But this fear was ill-founded, at least relative to the best-cultivated regions. It is now demonstrated that the manufacture of sugar, by creating a new source of profit, contributes to increase the other products of the soil. The extraction of saccharine matter deprives the root only of a part of its elements. Its pulp and foliage supply the animals with an abundance of food; and the returns of the sugar-works enable them to add commercial manures which indefinitely increase the fertility of the soil. In 1855, the city of Valenciennes, the principal seat of the manufacture, was able to inscribe upon a triumphal arch these significant words: "Produce of wheat in the arrondissement before the manufacture of sugar, 353,000 hectolitres, (120,146 quarters 5 bushels); number of oxen, 700. Produce of wheat since the manufacture of sugar, 421,000 hectolitres (144,782 quarters); number of cattle, 11,500."

The question, however, as M. Lavergne candidly admits, still remains to be decided, whether a still greater progress would not have been made if the manufacture had not existed, and the same capital and skill had been applied to agriculture and grazing; and he refers to the case of England as a proof of what may be done without allying manufactures to agriculture. There is, however, no doubt that in France the sugar manufacture has greatly stimulated the cultivation of land, and that far more manure has been made by the consumption of the pulp and the preserved foliage of the beet root than would have been raised had the manufacture never existed. On the other hand, the cultivation itself of 20,000 hectares (49,275 acres) of beetroot, producing to the grower, according to M. Lavergne, from £14 to £50 per acre, according to the quality of the soil, must have placed agriculture upon a very different footing from that which it occupied when there was no manufacture connected with it.*

The pulp or solid residue of the beetroot, divested of the juice, contains still from two to three per cent. of saccharine, and is greedily eaten by cattle and pigs, which fatten quickly upon it. Milch cows, although equally fond of it, will soon lose their milk, and go dry, if fed upon it, and their calves will die of inanition. This is probably owing to the small quantity of sugar and moisture it contains, which renders it unprofitable for the production of milk, which, as is well known, contains a large proportion of sugar.† The proportion of starch also, the basis of sugar, is only one per cent. on the residue, so

* The quantity of pulp is about 20 per cent. of the entire root; thus 1000 tons of the latter will yield 200 tons of pulp.

† In Tartary the natives convert milk into a species of sugar by the action of frost in the following manner: The milk, when new, is exposed in winter in broad shallow pans to the blast of the east wind. In a short time the aqueous parts of the surface are evaporated, and a white crispy crust forms, which is perfectly dry. This is scraped off, and the action of the frost is repeated; and so on from time to time, till the whole of the milk is thus converted into a dry powder, which, if kept from the air, may be preserved any length of time. It possesses all the properties of milk, and when mixed with water answers the same purpose.

that the quantity remaining in it is strictly confined to the 2 or 3 per cent., as above stated.

Having thus given the history of the beet-sugar manufacture, as conducted on the Continent, the question presents itself next, Whether it would be advantageous to introduce it into this country; not as an adjunct to the farm, as was attempted in France, and in every case proved a failure, but under the auspices of a company or firm, with adequate capital to carry it on upon an extensive scale, and with all the modern improvements and appliances, as it is now conducted on the Continent. We are aware that several attempts have already been made in England and Ireland to introduce it, all of which have failed. But having made myself acquainted with the history of each of these establishments, I am able to show that their failures were owing, not to the impossibility of making the manufacture profitable, but, in the first instance, to the conduct of the Government in suppressing it, and in the last, to the mismanagement and misconduct of those who had the oversight of the concern.

The first of these was established in Essex, by a respectable and well-known milling firm at Chelmsford. At that period (1832) the West India "Interest" was all-powerful with the Government; and there being no law to impose a duty on indigenous sugar—it never having been contemplated that it could or would be manufactured here—the "Interest" took the alarm, and prevailed upon the Government to interfere by imposing a prohibitory duty, which at once broke up the establishment. The proprietors, however, claimed and obtained compensation for the loss they sustained on the occasion.

About the same time a similar attempt was made at Hillsborough, near Belfast, Ireland, and it was under precisely the same circumstances as that in Essex—the absence of any duty on indigenous sugar, which previously was unknown in this country. The measures of the Government in imposing a prohibitory duty, as in the former case stopped the works. The proprietors were entitled, as well as Messrs. M., to compensation; but their demand upon the Treasury (about thrice the amount of their loss) was considered so extravagantly unjust, that it was indignantly rejected, and we believe that they never received a shilling from the Government.

In reference to se two attempts it is proper to state, that although, while there was no duty imposed upon it (that on colonial sugar being about 3d. per lb.) there was a large margin for a handsome profit, irrespective of the quality; yet so inferior was the article produced—half treacle and half candy—and so imperfect was the machinery employed, that it was at once seen to be impossible to come into competition upon equal terms with West India produce, and the enterprises were therefore at once abandoned.

The third attempt was that of the Beet-sugar Company, formed in Ireland in 1850, under the most favourable circumstances, and with every prospect of a successful result, so far as the capabilities of the country for raising the raw material, and the perfection of the machinery employed, could insure it; but, however this may be, the enterprise failed through the folly of the beet-growers on the one hand, and the consummate dishonesty of those who had the management of the company's affairs.

The manufactory was established at Mount Melick, in Queen's County; and in respect to the soil and its adaptation for growing the beetroot, no district could have been better selected for a site for the plant. The premises, too, were suitable, but there appears to have been old instead of new utensils and machinery introduced by the engineers, and they were found to be so defective that they could not be worked: the consequence was, that the greater part had to be replaced by new works, at an expense that absorbed a large portion of the capital: for, notwithstanding the enthusiastic favour with which the introduction of the manufacture was received in Ireland, not 500 shares out of 20,000 had been taken by residents in that country, and the Board of Directors were all residents in London; Mr. John Gwynn, of British Bank celebrity, being the managing director of the company.

At length, after much delay, the factory was ready to commence working; but now arose another difficulty: The beet-growers, who had been supplied with seed gratis, under a written contract to sell the produce at a given price, refused to deliver it except at an advance of several shillings per ton. Their demand was rejected by the manager, upon which threatening letters were sent to him, and it was currently known in the neighbourhood that *Ribbon law* was to be administered to him. This, however, was averted by the spirited conduct of a large employer at Mount Melick—a *friend*—who signified to his numerous dependants that if any outrage was committed he would turn off every man in his employ. Through his friendly intervention, a compromise was effected with the farmers, and the factory set to work. A skilful superintendent from Valenciennes was employed, who certainly well understood his business; but, on the other hand, he managed the concern so much to his own advantage, that the whole of the working capital speedily disappeared, and the factory was shut up. The finale was most disastrous to the shareholders, who were called upon to pay up in order to meet a deficiency wholly owing to the mismanagement and neglect of the directors and employes of the company. We believe, however, that a large portion of the loss fell upon the right shoulders, namely, the man who, assuming the management of the concern, retained the dishonest overseer long after his delinquencies had been denounced to him. The whole of the plant was afterwards sold by auction; and there being no one to purchase it for Irish or English use, it of course fetched but little. And thus concluded the third attempt to establish the beet-sugar manufacture in the United Kingdom.

Are we, then, to conclude from these failures that the manufacture of sugar from beetroot cannot succeed in this country? or that there are climatic or other natural obstacles to prevent its success? No such thing. It has been proved that at 45° of north latitude the beetroot contains amply sufficient saccharine power to render the manufacture profitable, and that the higher we advance the larger the proportion of that element. Now, the British Isles range from 50° at the Land's End, to between 59° and 60° at the Orkneys, and are consequently quite as well adapted to produce the Silesian beetroot with a sufficient amount of saccharine as any part of France or Germany—the former ranging from 42° to 51°, the latter from 44° to 55°, of north latitude. Besides, the cultivation of the beetroot is well known and understood here, although that of the Silesian variety has not received that attention from the English farmer for fattening purposes it deserves. It is otherwise on the Continent, where, such have been the efforts and skill of the farmers, that one of them has produced a new variety that contains 17½ per cent. of saccharine matter, being quite equal to that contained in the cane of the West Indies. This is wholly due to the sugar manufacturers, who have instituted experiments and combinations for its improvement. An association, called *Association pour l'industrie sucrière du Zolverein*, has been formed, composed of agriculturalists, manufacturers and men of science. The object is the promotion of the prosperity of the manufacture in the States of the Zolverein, and the increase of the proportion of saccharine in the beetroot. There are 240 sugar-works in those states, which in 1857, produced 110,000,000 kilogrammes (110,000 tons) of sugar; whilst in the same year, 338 factories in France, made only 80,000,000 kilogrammes (80,000 tons). A very significant fact connected with this subject may as well be stated here, namely, that upwards of 30 sugar-works, which a short time since were converted into distilleries, have again resumed the manufacture of sugar. We shall have occasion to revert again to this fact in speaking of that second branch of agricultural manufacture.

Resuming the subject of improvement: In Germany the Committee of Beet-sugar manufacturers have proscribed all inferior varieties of the beetroot, and allow only the cultivation of the very best kinds. The consequence is, that the German roots excel those of France in saccharine power to the extent of from 30 to 50 per cent. Another fact of a singular character has been elicited by the investigations, with respect to the juice of the beet, that in proportion to its density is that of the sugar it contains. Thus, a root whose juice weighs 5° Baumè, contains only 4 per cent. of real sugar, and 5 per cent. of foreign matters; whilst a root marked 10° Baumè, contains 15 per cent. of sugar, and only 5 per cent. of foreign matters. The perfection to which the root has been brought is evinced by the fact already stated. M. Knauer, a cultivator of Grobermur Halle, is the party who produced the variety, to which he has given the name of the *Imperial Beetroot*, and which contains 17¼ per cent. of the entire weight of the root of sugar. "He has arrived at this result," says the writer from whom I quote, "by a system of selection. He improves his variety from year to year, by attention and minute observation. He sells a certain quantity of this seed every year, and although its richness goes on increasing yearly, he reduces in an inverse proportion the price of his imperial seed. He began selling at the enormous price of 816 francs (£34) per 100 kilogrammes (2cwt.), and has now reduced it to 225 francs (£9 7s. 6d.) per 100 kilogrammes." The produce is small, but the intrinsic value of the root amply makes amends for any deficiency in the weight of the crop. Our English and Scotch farmers would do well to take a lesson from this German gentleman, who has proved the possibility of increasing, and even doubling, the amount of saccharine properties of this plant, which constitute its chief value, whether for sugar-making or for grazing.

This improvement will more than enable the maker of indigenous sugar to compete successfully with the West India planter. The cultivation of the sugar cane occupies from 12 to 15 months, and it must then be all manufactured *instanter*, and on the spot; whereas the beetroot requires only 130 days to arrive at maturity, and can then be stored and manipulated at any time. This is an important advantage the beetroot manufacturer has over the colonial, especially if there is any equality in the amount of produce. On this point, too, the following information is derived from statements by the planters themselves, and is corroborated by other persons of undoubted authority on West Indian affairs.

In 1849 a Committee was appointed by Parliament to inquire into the question of the sugar duties. Before this committee several of the West India planters were examined *on oath*, and they all agreed that, although the cane contained from 16 to 20 per cent. of saccharine, not more than from 4 to 6 per cent. was obtained from it, although it is well known by scientific men that the whole of the saccharine is convertible into crystallised sugar. Since that period, improvements have been introduced into the machinery department, and it is probable that the proportion of sugar obtained is now larger—possibly 7 or 8 per cent. Still a large amount of saccharine is wasted and thrown into the fire with the megass or refuse of the cane. A considerable quantity of it is crystalised by the sun in the plant itself whilst ripening, and cannot therefore be extracted. The two manufactures, therefore, are much upon a par in respect to the quantity of sugar obtained from the two plants.

Dr. Davis, in his work on the West Indies, states that 100 hhds. of sugar, weighing 15cwt. each, cost 6672 dollars cultivating; and deducting 2000 dollars for the molasses, the sugar costs 14s. per cwt. To this must be added 4s. for freight and insurance, and 3s. landing, warehousing, and brokerage, &c. But besides this, the loss by drainage on the voyage is estimated at 2cwt per hhd., which makes the cost amount to 24s. per cwt., besides interest of money, and other incidental charges and deductions. These bring the cost of West India sugar much higher than that of indigenous sugar made from the beetroot on the Continent, which at the market price yields a good profit when manufactured in the best manner and upon a large scale.

There is no doubt, however, that the West Indian estates are capable of being worked to much greater advantage than is the present practice in Jamaica at least. In Barbadoes the planters have adopted the new scientific system, and are reaping the benefit of it in the increased amount and improved quality of the produce. In Demerara also, a spirit of enterprise has been evinced, and steam-power and machinery of the newest description introduced into the manufacture. Still the colonial sugar-planters labour under disadvantages and drawbacks, from which the European sugar-makers are free, and the latter will always be able to make a profitable trade when the West Indian is losing money.

Having thus given a history of the manufacture of indigenous beet-sugar on the Continent, and its comparative advantage over that of Colonial sugar in point of profit, we shall now describe one which, although using the same raw material, is of a very different character in respect to its product. We refer to the distillation of ardent spirits from the beetroot and the potato, which has for some years been extensively carried on in several of the Continental countries; and, so far as profit is concerned, with great success, in some of them at least. An attempt has been made by a French firm (Messrs. Champonnois and Co.) to induce the English farmers to establish similar works in connection with their farms, and a model distillery was erected upon the best principle at Fulham. Fortunately the attempt was a failure; fo · assuredly it would have ended in the ruin of all persons concerned, and inflicted injury upon the agricultural interests of the kingdom, had it been extensively adopted. As the most favourable instance in which it has been so, we shall give a brief account of its rise and progress in Austria, where it has had a greater development than in any other country.

It was, we believe, in Austria that the idea of uniting the distillation of ardent spirits with the estates of the nobles was first suggested. It is a country so far isolated from the great grain markets of Western Europe, as to possess only one direct port, Trieste, at the head of the Adriatic, and the tedious route of the Danube, and the Black and Mediterranean Seas. On the other hand, at the period to which this paper refers (1830), there were no public roads or railways in Austria capable of assisting the farmer to convey his produce to market, except at such an expense as would have swallowed up the whole value. The long continuance of extreme low prices, after the peace of 1815 (with the exception of two seasons), reduced the Austrian landowner to the brink of ruin, and it was a question with them, whether they should abandon the cultivation of the land altogether, unless some mode were adopted of rendering the produce available by establishing agricultural manufactures. That of sugar was at once adopted; and nearly at the same time the idea of distillation was started as a last resource.

In many respects Austria is more favourably situated for the prosecution of these branches of industry than France, being the only Continental state (with the exception of Russia) in which the subdivision of the land has not been adopted. The estates of the aristocracy are very large, and although imperfectly cultivated, and embracing a great extent of forest, the incomes derived from them are immense. Thus Prince Esterhazy can travel fifty miles from Vienna on his own property,* besides large estates possessed by him in Hungary and other parts. Austria also, is purely an agricultural country, although destitute, or nearly so, of the means of disposing of her produce beyond the home consumption. It was therefore easy, when once the change was determined on, for the landowners to establish the sugar-works, and distilleries upon an extensive scale; and this was in fact the case.

At first the distilleries were set to work upon grain, the price being at that time (1830) very low, and the foreign demand *nil.* But in a few years the corn market recovered its activity, and prices of cereal produce rose throughout Europe, so that it was found more profitable to employ potatoes on account of the largeness of the average produce. In 1857 there were 16,000 distilleries connected with the land in the Austrian dominions. The quantity of potatoes consumed, according to the statement in the *Journal d'Agriculture Practique* amounts to 1,250,000 tons annually, which, reckoning a produce of three tons per acre, requires an extent of land equal to 416,666 acres. The quantity of raw spirits extracted from them is 63,828,039 gallons (imp.), being 20 per cent. of the raw material. The residue is estimated at 462,203,028 gallons, and is employed in fattening cattle and pigs, for which it is well adapted. It is estimated that the above quantity is sufficient to fatten 60,000 head of cattle of the average size, the manure from which will amply suffice to dress 50,000 acres of land. This, however, falls far short of the land employed in the cultivation of the tubers, as above stated, which shows that the continuance of the system must, without a large addition of purchased manure, exhaust and deteriorate the soil.

It is assumed by the advocates of the system that these two manufactures have alone saved the landed interest of Austria from utter ruin. This may have been the immediate effect resulting from it, but whatever advantages the land owners may have derived from it—and they certainly have been enriched by it—the effect is injurious both to the occupiers of land and to the country at large,

* Prince Esterhazy has immense flocks of sheep on his estate. The writer was present at the Holkham sheep-shearing in 1808 or 1809, when the Earl of Leicester, (then T. W. Coke) introduced the Prince, and referred to his being a large flock-master, upon which the Prince offered a bet of ten guineas that he had *more* shepherds than Mr. Coke had sheep. The bet was accepted, and upon receiving the account subsequently from the steward, or head shepherd, the Prince won the bet by one shepherd over Mr. Coke's flock. The Prince is still living, and the writer was recently informed by Mr. Smallbones, his consulting steward, that his present flock consists of 250,000 sheep, besides lambs.

by the exhaustion of the soil, and the diversion of capital from its improvement, to the pursuit of a branch of industry certainly not the best calculated to promote the material prosperity; nor is it a less favourable feature that the attention of the husbandman is divided between two incongruous occupations, which, although dependent the one on the other for success, were never intended to be united. The proof of the injury sustained by agriculture from the system is to be found in the smallness of the return of the three cereal crops (wheat, barley, and oats), which, taken together, does not average more than four and three-fifths of the seed sown; and by the inattention manifested of late years to the races and breeding of cattle and sheep.* The temptation of an immediate profit, and a certain market for their potatoes and beet-roots, has led the farmers to neglect the more important cultures, to the destruction of good farming, and, as a consequence, the material prosperity of the country.

But the system adopted by the great Austrian distillers for the disposal of these spirits is still more injurious to the welfare of the country. Having contracted with the farmers for the growth of a certain extent of potatoes, they advance money to them, and also spirits. Every inducement is held out to them to purchase this latter, upon the faith of the growing crop, and the consequences prove most injurious both to the moral and physical character of the rural population. A French writer (M. Marie), himself an advocate for the principle of agricultural distilleries, has borne the following testimony to its effect in Austria. "As to the consequences of the inordinate use of alcohol, they speak for themselves. Galitia exhibits an example which deserves to be studied; and they have been amply exposed and brought to light in the publications of those authors and temperance societies who have undertaken to struggle against the use of alcoholic liquors."

With regard to the attempt to introduce the system of agricultural distilleries into the United Kingdom, although hitherto it has proved unsuccessful, and the last two seasons have proved adverse to the profitable working of the system, we have reason to believe that another attempt will be made to overcome the scruples of the Eng-

* Notwithstanding that Aust[illegible] possesses the finest grazing lands in Europe, the supply of butcher's meat is much below the consumption, and it requires an importation to the amount of one million sterling to supply the deficiency. Even the breeding of horses is now very little attended to, as well as of cattle, which is carried on without any regard to excellency of race. The breeders are said to be guided in their choice by size rather than form and symmetry.

lish farmers, and to induce them to adopt it. We shall point out the evils that would, as we believe, inevitably attend and follow its adoption.

In the first place, by absorbing a large amount of the capital now engaged in agriculture, the means of the farmer would be restricted, and the improvement of the land retarded; whilst, by the distraction of his mind between two incongruous employments—both of which, to be successful, requires an individual attention—he would generally lose that steadiness of character which has been one of the principal means of his success. Whatever temptation there may be in seasons when low prices prevail, to deviate from the regular cultivation of the land, and to divert it in part, and the capital employed, to manufacturing purposes, for the sake of an immediate advantage, the return thus obtained would not compensate for the injury that would be permanently inflicted upon the land, and, therefore, upon the occupier in the deterioration of the soil, as in Austria.

But, however profitable this system may, at its commencement, prove to the distiller, its extension would certainly prove ruinous to all engaged in it. The increased supply would inevitably lower the price of the produce till it yielded no profit, or even left a loss. This has actually been the case in France, where, for the last two years, most of the distilleries have been stopped on that account; and all the efforts of the Champonnois party to make out that they yielded a fair profit, have failed to convince those who actually suffered a loss on the working. The fact, too, that in the states of the Zolverein upwards of thirty works that had been changed from the production of sugar to that of alcohol have again reverted to the first purpose, is too significant to require any comment.

SCIENTIFIC AND LITERARY NOTES.

GEOLOGY AND MINERALOGY.

COAL DEPOSITS OF BRITISH COLONIES IN THE SOUTH.

(From the Mining Journal of April 27, 1861.)

"Among the numerous mineral products that will be shown at the International Exhibition of 1862, there can be none of greater interest than the samples of coal. Every information as to quality, extent of deposit, facility of working, and market price, with statistics of the quantity mined, will be of great importance. The supply from our own coal beds at home is indeed enormous, and the export trade, as we have already shown, considerable; but the economic products of coal are every day being enlarged by obtaining oil, dyes, and other chemical products therefrom. The great extension of steam navigation, ocean and coasting, the increase of steam motive-power for manufactures and machinery of various kinds, the demand for coal in different quarters for illuminating purposes, and even for fuel in many of our rapidly progressing colonies in Africa, Australia, and the East, render the more general discovery and working of fossil fuel in those dependencies of immense importance to their future successful advancement. Fortunate, therefore, is it that coal exists in our South African colonies, in New South Wales, Victoria, Tasmania, and New Zealand; in Labuan, Nova Scotia, New Brunswick, and Vancouver. In many parts of British India, too, coal has been discovered and successfully worked. Although the supply of this valuable mineral is no doubt illimitable, yet with the extension of trade and settlement, of manufacturing industry and steam navigation, it may be useful to point out the various and increasing sources of supply, and to direct more prominent attention to them in a commercial point of view. Analyses of the special qualities of the coal would also be especially useful.

It is chiefly within the last quarter of a century that the immense increase in the factories of England, in her railways, steam-vessels, steam engines, gasometers, and foundries, have rendered coal of such great value to the advancement of our country's commerce, comfort and civilisation. In the year 1772, Pennant gave as a grand feature in the national commerce that 351,890 chaldrons of coal were shipped that year at Newcastle, of which about 260,000 chaldrons formed the London supply. Now the export from that port to London alone reaches 1,250,000 tons; the foreign exports exceed 7,300,000 tons; while the annual produce in the kingdom amounts to nearly 70,000,000 tons. A consideration of these figures will serve to convey some idea of the immense present and daily increasing consumption of coal. Coal is the indispensable aid to all industrial progress; and even in this metropolis we require now about 5,000,000 tons annually.

In the Cape colony deposits of coal have been found near Burgher's Dorp, and on the surfaces of several farms in the Albert district, but is too high in price to warrant much being done with it; 3s. being the lowest price paid for a muid, or sack of 2¾ bushels. It is of good quality, and burns well, but being taken from the surface is not so good as that obtainable by digging to a depth of some feet, an experiment which the Dutch farmers are loth to try, on account of the trouble. Some specimens obtained by digging are stated to have been found equal to many descriptions of English coal. It is found of a fair quality in the hills to the north of the Tugela River; and anthracitic coal, probably as good as that in general use in the United States, is in considerable quantities near Washbank and Sunday Rivers. This coal, in other parts of the world, has lately acquired a considerable degree of importance, and a high value, being almost pure carbon, and burning without smell or smoke. There is also coal found in Natal of excellent quality, of the ordinary bituminous description, in the ravines between Biggarsburg and Umzinyati River, 63 miles only distant from Maritzburg, the capital; and there is another in a small river near Biggarsburg, in lat. 28°7′, long. 29°25′, which is intersected by a vein of trap. Bishop

Colenso speaks of coal being found in Natal in abundance, and of the finest quality, but as yet too far from the sea coast, with the present means of land carriage, to make it worth while to transport it in large quantities. At a farm-house on the Tugela, the Bishop saw excellent bituminous coal, the produce of the colony, which cost nothing where it was found, but which sold for £5 the ton at Maritzburg, from the great expense of transit. In county Victoria, to the north of Durban, there is a place on the sea shore where a vein of coal crops out, and is quarried and used by the neighbouring sugar-planters. It is a surface coal, and, of course, the quality of a lower stratum would be, in all probability, vastly superior.

The Borneo and Labuan coal is chiefly absorbed in China and Singapore. The Labuan coal is of excellent quality, and lies so near the sea that it can be carried on board ship from the pit's mouth. There seems, however, of late years, to have been some stoppage in the company's operations; for, while 5539 tons of coal were sold from the mines there in 1856, the sales dropped to 1100 tons in 1857, and in 1858 there were no sales at all. Whether this arose from want of labor, or from some other cause, we cannot learn.

In New South Wales, the Australian Agricultural Company are in possession of a valuable coal field at the south entrance of Port Hunter. In 1836 the total amount of coals raised in the colony was but 12,646 tons, which had increased to 67,660 tons in 1851, and 216,397 tons, of the value of £162,182, in 1858. This quantity was obtained from nineteen coal mines. The high price of labor has somewhat stayed the progress of colliery operations. The whole area of this great Australian coal field cannot be less than 16,000 square miles; much of this is situated at too great a depth for profitable working, but at Newcastle, and on Hunter River, it crops out to the surface in seams of from four to ten feet in thickness. The Rev. W. B. Clarke, a geologist of repute, states that from his own surveys and actual knowledge, as compared with its gold fields, the carboniferous portion of New South Wales is of infinitely greater value. It has been said of North America that "no part of the known world offers so great a development of carboniferous rocks;" but Australia presents a close parallel with that rich coal-bearing region, and there are enormous areas of tens of thousands of square miles occupied by these carboniferous ore beds in New South Wales and Queen's Land. Several workable and valuable coal seams exist on the Bremer and Brisbane Rivers, and along the shores of Moreton Bay. On the Brisbane River steamers can load by lying literally at the mouth of the mines, as is the case at Lake Macquane; this phenomenon is characteristic of the coal of New South Wales. In the colony of Victoria veins of coal of superior description have been found in many localities—Western Port, Gipps Land, Moonlighthead Coast, and other places. There is also a field extending from the Barrabool Hills to Cape Otway, which presents many characteristics similar to that of Western Port. In both those fields the only seams of coal of workable thickness have been found on the sea shore between low and high-water mark. The place where the coal crops out, on the Cape Otway shore, is within four miles of Loutit Bay; and in respect of proximity of harbour has the advantage over the Western Port field. Coal has also been discovered at Cape

Patterson, about 150 miles from Melbourne, on the south-east coast. A good workable coal field would be of the greatest importance to Victoria for the operations of its railways, factories, and steam-vessels. In South Australia the geological formation at Mount Gambia holds out the promise that coal might be found in abundance in that district by means of the needful appliances, properly directed. Coal is reported to exist in considerable quantities at King George's Sound, Western Australia; it is said to cover a space of 30 miles, and to commence at Doubtful Island Bay, close to the sea shore. There is also a good coal stratum on the Preston, near that colony. A fine field exists in the north at 28°57' south latitude, and 113°30' east longitude. The mine is 45 miles from Champion Bay, 42 miles from the mouth of the Irwin, and about 200 miles north of Perth.

The whole island of Tasmania is interspersed with coal formations, either bituminous or anthracitic, and labor alone is required to secure good and cheap fuel. Mining operations have been carried on in the island on a small scale. It requires something more than a mere acquaintance with the mechanical processes of mining in pits that have long been worked, to open new seams, and direct the necessary operations for extracting the mineral without waste or injury, so as to send it to a profitable market. The demand for coal that now exists in Australia, and is likely to grow every year, is far in excess of the requirements of the colonies prior to that accession of population and expansion of commerce in all its branches which was occasioned by the gold discoveries. The timber supply hitherto depended on for fuel in all the great centres of population is partially exhausted, and we have already shown the extensive use that has sprung up of steam-power in machinery and locomotion both on land and sea.

"No reasonable doubt can be entertained," writes Dr. Milligan in his very elaborate Report on the Coal Fields of the East Coast of Tasmania, "that for all practical purposes of the present day, an inexhaustible supply of good coal exists at Mount Nicholas and Fingal. Whether it may be profitable to send it to market, or practicable to consume it productively on the spot, is for capitalists and speculators to consider, and probably for unforeseen circumstances to decide." These words were written in the year 1848. At that time Melbourne was a small village, and the River Yarro and Hobson's Bay frequented only by a few ships, taking home their annual cargoes of tallow and wool, the early, and for many years the only, staples of the district of Port Phillip, now become the important colony of Victoria. The gold fields were undreamt of; the interior of the country unoccupied, except by sheep runs; and the River Murray and its tributaries unexplored, while they are now traversed by steam-boats. At that time railroads were unknown in Australia; steam-machinery had no place, save in the shape of an occasional flour-mill, and none of the great ocean steamers, which now serve the uses of a developed commerce, had visited the Australian waters.

It seems, therefore, an opportune time to call attention more prominently at home to the vast deposits of coal that are lying unused in many of the southern colonies, to stimulate further examination and to throw together a few notes with respect to existing information and enquiry on the subject. Dr. Milligan, whose report gives proof of a very careful survey and inspection of what he terms "the magnificent coal seams of the east coast," says they extend over a large area. Of the quality of this coal, he states in general terms that "it is first-rate, and will be found equal to any or all of the purposes to which the best English coal is applied." He says, again, "the coal is of the finest quality, of a deep black colour, with a rich, bright, and splendent lustre, like that of resin or jet. It is easily frangible, and ignites readily, burning in the mass with a wild ruddy flame, and a strong glare." In the immediate vicinity of Fingal lies the Steiglitz coal field, at a very practicable distance from the two shipping places of George's Bay and Falmouth. Steiglitz main stream, in the Mount Nicholas range, which is twelve feet in thickness, is a distance of twelve miles from the sea by a road already made.

The island of Tasmania resembles Wales in the character and position of its coal, which is anthracite in the southern part of both countries. Extending northerly, it gradually loses that character, by becoming semi-bituminous. It is, however, important for colonial interests that the use and value of anthracite coal should be properly made known. Mr. Taylor, in his "Statistics of Coal,' states "that the researches of scientific men have proved that anthracite coal was formerly bituminous, having been deprived of volatile matter by the action of internal heat; leaving a greater amount of carbon, the excess of which stamps the value of coal for general purposes, except in the manufacture of gas;" and he adds that in the smelting of ores anthracite is preferred to bituminous coal, which cannot be used in the furnace in a crude state, but must first be converted into coke. Anthracite coal is obtained on Schonter Island, on the coast, where vessels may anchor within 200 feet of the coal pit. The seam is from six to seven inches thick, and consists of layers of anthracite, of a porous and coke-like character, with small layers in succession of bituminous coal. The miners state that they could afford to deliver it at the water's edge for 4s. or 5s. per ton. At South Cape a seam from eighteen to twenty inches thick is found, but not worked. The coal is highly carbonaceous, but largely mixed with iron pyrites. At Richmond it crops out on the west bank of the Coal River, about one mile from a point on the estuary where vessels of twenty tons may load. The seams vary from two to two and a half feet in thickness. At Newtown, within two miles of Hobart Town, the capital, anthracitic coal is obtained in six shafts, at depths varying from thirty-five to eighty feet, and the supply sent into town is considerable. It sells from 25s. to 27s. per ton. At Tasman's Peninsula, known in market as Port Arthur coal, it has been worked largely for nearly thirty years, and, though a coarse anthracite coal, it throws out great heat, and is much valued for furnaces. It sells from 30s. to 35s. per ton. Bituminous coal is found at Douglas River, on the north-east coast, about four miles from the sea. Some of the seems are eight feet thick, and so close do they often run to the surface that in a fifty-feet shaft six seams of coal were cut. A seam of twenty inches has been worked for the Hobart Town market, where the coal is sold at 30s. to 40s. per ton. In the interior this coal crops out in the bed of the Ouse River, where the seam is four feet thick, under a four-feet bed of pipe-clay. Bituminous coal is also obtained in the North, at the Mersey, on Port Frederic, the seams being from two to three feet thick. On the River Don, in the same neighbourhood, it crops out of the earth in many places from twenty-six to thirty inches thick, and this coal is stated by Mr. Selwyn to be the best in the island. In two places where shafts have been sunk, twenty-seven inch seams have been found less than twenty feet from the surface. For many of these particulars we are indebted to the official colonial reports of Dr. Milligan and Mr. Selwyn, both eminent geologists.

An extensive bed of shale has been found at the great bend of the River Mersey, near La Trobe, which is estimated to cover 490 acres, and to have a depth of from eighteen to twenty feet, equal to a quantity of 20,000,000 tons. Making, however, a liberal allowance for waste, and for walls to support the ground in mining, it is calculated that at least 10,000,000 tons might be quarried and mined with ease. This shale is found close to the surface. Where it has been exposed to the atmosphere it is of a light brown colour, but taken from a greater depth it is of the colour of dark grey; and a small piece of it the flame of a candle lights easily and burns brilliantly. The extraction of oil from shales and coal has been largely extended of late years, not only in the United Kingdom, but in France, Germany, and the United States. The demand for lubricating oil on railways, and in machinery, and for many manufacturing purposes, is constantly increasing. Its great recommendation consists in the fact that it remains limpid and pure after exposure to the atmosphere, and never thickens or clogs on the machinery, as ordinary oils do. The manufacture of this oil is not attended with any difficulty that would prevent its becoming a colonial industry. The process is very simple, at least as much so as the manufacture of gas.

In New Zealand much enterprise has lately been displayed in coal mining, a matter of some importance now that there are so many coasting steamers, intercolonial steam-vessels running to Sydney and Melbourne, and that a Pacific line is projected thence to Panama by the Otago Government. At the Motupipi coal field the fuel improves as the seam is worked; the coal is rather sulphurous, and burns rapidly, leaving a good deal of ash, but does well for steamers, if mixed with an equal quantity of English coal. At Pakawan coasters can load coal, but vessels above 200 tons have to load in the offing, or at the Pata Islands.

The preliminary step to all manufacturing enterprise is the development of the coal beds where they exist. The furnace and the steam-engine are the great industrial forces of the age; and to these coal is the staff of life. That many of our principal colonies possess this substance in abundance, should satisfy them more than if they had great gold fields. With it they can create gold by direct exchange, and by manufacture. Both by exporting the produce of their mines, and by using it in the creative processes of manufacture, they have it in their power to make a vast addition to their public wealth, and greatly augment their capability of supporting an industrial population. The collection of samples or foreign coal may be made one of the most interesting in the Exhibition, having regard to its important uses. Full details with respect to the seams, accompanied by maps and geological sections and reports, statistics of production, existing for land transport or shipment, and authentic analyses, would render the collection a medium of reference of the highest interest. Especially should samples of all varieties from different localities be placed side by side for comparison, independent of the special colonial collection of objects of which they would form a part.

We have confined our observations here to the coal deposits of our southern colonies, but will direct attention hereafter to those important coal fields we possess in the western world.

NOTES ON CANADIAN CHLORITOID.—BY T. STERRY HUNT, F.R.S.

(From the American Journal of Science and Arts, May, 1861.)

"Among the crystalline Palæozoic schists of the Notre Dame Mts., which are the Canadian prolongation of the Green Mts., of Vermont, is a rock characterized by the presence of a mineral which has been designated in the Reports of the Survey by the name of phyllite, from the supposition of its identity with a similar mineral from Massachusetts, described, named and analyzed by Thompson. The mineral in question is abundant in a fine grained grayish wrinkled micaceous schist from Brome, and in larger specimens from Leeds; where it occurs in a similar rock which is pearl gray in colour, passing into greenish gray, and contains a large proportion of quartz with a mineral talcose in aspect, but aluminous in composition, and apparently micaceous. Similar micaceous schists containing the mineral in question may be traced in the continuation of the Notre Dame Mts., as far as Gaspé. In the rock of Leeds the phyllite occurs in small lamellar masses rarely more than one-fourth of an inch broad and one-eighth of an inch thick. In some specimens it forms spherical aggregations half an inch or more in diameter composed of radiating lamellæ and sometimes making up one-half the volume of the rock. In most localities however the masses are smaller and less abundant. The mineral has a perfect cleavage in one direction and two less distinct transverse cleavages, 'the lamellæ are often curved and are not easily separable. Hardness 6·0, density 3·513, colour dark greenish-gray to black; brilliant black on the surfaces of perfect cleavage, which have a vitreous lustre; the cross-fracture is granular and exhibits a feeble waxy lustre. The streak and powder are greenish gray. The mineral resembles somewhat a dark coloured variety of hypersthene.' The analysis of a carefully selected specimen from Leeds gave as follows :*

Silica	26·30
Alumina	37·10
Protoxyd of iron	25·92
Protoxyd of manganese	·93
Magnesia	3·66
Water	6·10
	100·01

This analysis shows the mineral to be chloritoid, with which its specific

* Report of Geol. Survey of Canada, 1858, p. 194.

gravity and other characters agree. It is the *barytophyllite* of Breithaupt, the *masonite* of Jackson and the *sismondine* of Delesse. All of these minerals occur in argillaceous, micaceous or chloritic slates and having a hardness of 5·0—6·0, and a density of 3·45—3·57. have been united with chloritoid, with which they agree in composition. (Dana, *Mineralogy*, ii. 298.)

The phyllite of Thompson, according to the analysis of that chemist contains a larger amount of silica than chloritoid together with more manganese, and 6·80 p. c. of potash, but having had occasion to repeat several analyses of this chemist, I have found that his determinations of alkalies are entirely erroneous. Thus in the case of raphyllite a tremolite containing only traces of alkalies, he indicated more than ten per cent of potash and in his retinalite, a pure serpentine, nearly nineteen per cent of soda.* In both cases the error was at the expense of the magnesia of the mineral. The substance examined by Thompson has not so far as I know been examined or identified by American mineralogists, but in the mineralogical cabinet of Laval University at Quebec, is a specimen from the collection of the late Mr. Heuland; said to be phyllite from Massachusetts, which is evidently chloritoid, and cannot be distinguished from the specimens of that mineral just described; the rock is also apparently identical.

The ottrelite of Haüy, to which Dana has referred the phyllite of Thompson, occurs in an argillaceous slate in Belgium, and in a specimen before me cannot be distinguished from the phyllite from Massachusetts or the chloritoid of Canada. This mineral has however been analyzed by Damour, whose name is a guarantee for accuracy, and differs from chloritoid in containing a considerable excess of silica, which might possibly be derived from the gangue. The specific gravity which Damour has assigned to ottrelite is 4·4—which is so extraordinary for a mineral of that composition that we are led to suspect some error probably of the press or pen. The question of the identity of ottrelite with chloritoid is one which requires farther examination. Meanwhile the latter mineral assumes some importance to the lithologist as characterizing over wide areas considerable masses of schists, which we have elsewhere described as chloritoid slate."

NOTICES OF BOOKS, &c.

Lovell's General Geography. By J. George Hodgins, LL.B., Quarto, pp. 100, with numerous maps and illustrations. Montreal, J. Lovell; Toronto, R. & A. Miller. 1861. It must be well known to all engaged in the duties of tuition, that works compiled essentially for teaching purposes rarely succeed in meeting all the requirements of their special cases. Something is generally omitted or but slightly touched upon in this place, or too much elaborated in that; and treatises in which one would least expect it, are often made a vehicle for the

* Report of Geol. Survey of Canada, 1850, p. 40.

expression of partial or peculiar views. It is therefore with the greatest satisfaction that we call attention to the very ably compiled and exceedingly well got up manual, entitled "Lovell's General Geography." Both author and publisher merit the warmest commendations. Although intended mainly for primary schools, and thus illustrated with numerous engravings of characteristic animals, important cities, &c., most useful in fixing the attention and aiding the memory of the young—the work, from its careful condensation and statistical and other tables, may be consulted with profit as a book of reference by those who have long bid the schoolmaster good-bye. The engravings are far in advance of those with which elementary geographical works are usually supplied; and the views, judging from sketches of some twenty or more European and American cities with which we are well acquainted, are really fair representations of what they profess to be. The maps likewise, although necessarily upon a small scale, are amply sufficient for general purposes. We may therefore truthfully recommend this School Geography as the best and most useful manual of its kind that we have yet met with.

On the Pre-Carboniferous Flora of New Brunswick, Maine, and Eastern Canada. By J. W. Dawson, LL.D., F.G.S., &c. In this important communication, reprinted from the *Canadian Naturalist* for last May, Professor Dawson describes various new species of land plants from Lower and Upper Devonian rocks of this continent; and he gives in conclusion a general summary of the pre-carboniferous genera and species at present discovered in British America and the State of Maine. The land plants, of which thirteen or fourteen are due to Dr. Dawson's own determinations, amount to about twenty-one species. These according to the author, belong to the Coniferæ, Sigillariæ, Calamiteæ, Asterophylliteæ, Lycopodiaceæ, and Filices. Of the latter (Ferns) only two species, *Cyclopteris Jacksoni*, Dawson, and an undetermined *Sphenopteris*, are known. The Calamiteæ furnish also but one form, the *Calamites transitionis* of Goeppert, likewise met with in the Devonian beds of Silesia, and in the Lower Carboniferous rocks. By adding to these the Devonian flora of New York and Pensylvania, the list of species, all belonging to Cryptogamous or Gymnospermous types (Dawson), amounts to about thirty. Professor Dawson observes however, that additional forms have been discovered in New Brunswick subsequently to the drawing up of his paper.

The Metals in Canada: A Manual for Explorers, &c. By James L. Willson and Charles Robb, Mining Engineers. 12mo. pp. 81. Montreal: Dawson and Son, 1861. The compilers of this little work have just established themselves as mining engineers in Montreal, and they take this method of introducing themselves (in this capacity at least, for otherwise they are well-known) to the notice of the Canadian public. The work treats usefully of the various conditions of occurrence of metalliferous deposits generally, and gives directions for the carrying on of preliminary and other explorations with regard to these. It contains also brief notices of the more common metallic ores and economic minerals, with some hints on the chemical examination of these bodies. A few inadvertencies have crept into the compilation, such as that which states that "iron cannot be reduced to the metallic state by the blowpipe, whilst all other metals (except manganese) can;" but, passing over these, the work will be found useful to land-owners and others interested in mining pursuits.

Sur l'Unité des Phénomènes Géologiques dans le Système Planétaire du Soleil. Par L. Sæmann. Paris, 1861. A notice of this interesting memoir will appear in our next Number.

Tables of Measures: English, Old French, and Metrical. By Arthur Wurtele, Provincial Land Surveyor and Civil Engineer. Montreal: B. Dawson and Son. 1861. In this useful little brochure, a series of Tables of corresponding French and English weights and measures, amounting to thirty-three in number, are given in a portable and convenient form. These tables should find a place in every engineer's and surveyor's office. In the Lower Province more especially, where the old French measures are still obstinately retained in spite of the modern system, they will be found quite indispensable, and will meet undoubtedly with a ready sale.

Journal of Education: Lower Canada. Our best thanks are due to the able conductor of this Journal for the regular transmission of copies. We hope to notice more fully in another issue the volumes for the present year, and in the mean time we may sincerely congratulate their editor on the success which has attended his efforts in promoting the cause of education in the Eastern Province.

Remarks on Upper Canada Surveys, with Extracts from the Surveyors' Reports, containing a description of the soil and timber of the Townships in the Huron and Ottawa Territory. Appendix No. 36 to the Report of the Commissioner of Crown Lands for 1860. Quebec, 1861. In issuing this Report in an easily accessible shape, the commissioner of Crown Lands has acted most judiciously. It contains a large amount of valuable information on the newly arranged districts of the Huron and Ottawa Territory, and it is furnished in addition with a carefully prepared map. Intended settlers and others interested in this extensive region, will do well to procure copies without delay. The notices of the townships are briefly and clearly given, and are confined to really useful details—describing the soils, minerals, timber, streams, mill-sites, and other matters of practical interest. For the copy kindly sent to us, we are indebted to Thomas Devine, Esq., of the Crown Lands office, by whom the map which accompanies this Report, has been compiled.

Map of the United Counties of Prescott and Russell. By J. S. Abbot Evans, P.L.S. This valuable map, of which a copy has been forwarded by Mr. Evans to the Canadian Institute, shews in addition to general topographical features, the positions of all the town-halls, post-offices, schoolhouses, mills, and more important inns throughout the area embraced within its Survey, thus rendering it of more than ordinary utility.

Other publications, received at a late date, will be noticed in our next issue.

E. J. C.

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST—JUNE, 1861.

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 Average	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 P.M	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 P.M	Resul't.	ME'N		
1	29.804	29.771	29.738	29.7670	49.7°	64.5°	54.4°	57.82°	+ 0.87°	.278	.262	.308	.273	.77	.43	.72	.60	Calm.	S S W	Calm.	S 45° E	0.0	1.0	0.0	0.60	1.35	...	...
2	.728	.628	—	—	50.4	64.1	—	—	—	.299	.435	—	—	.81	.73	—	—	N E b E	E b S	E S E	S 56 E	1.0	4.5	3.0	3.03	5.15	0.541	...
3	.286	.366	.400	.3912	64.5	73.1	64.1	66.93	+ 9.38	.532	.499	.473	.497	.88	.61	.78	.76	S W	N W b W	N N W	N 65 W	10.0	29.4	6.0	10.68	15.04	...	...
4	.616	.619	.685	.6520	53.3	54.0	49.0	52.20	— 5.65	.291	.292	.264	.278	.71	.69	.76	.71	N N E	S E b E	E N E	N 88 E	5.2	8.6	4.5	6.77	7.72	...	...
5	.692	.673	.686	.6763	51 8	51.5	49.3	51.10	— 7.05	.208	.274	.293	.260	.53	.71	.83	.69	E N E	E b N	E N E	N 75 E	17.2	20.5	6.0	11.63	11.66	0.598	...
6	.702	.716	.685	.6992	51.1	60.1	51.8	54.47	— 3.98	.342	.388	.310	.348	.91	.74	.80	.81	E N E	E S E	E N E	N 80 E	2.0	6.8	1.7	3.22	4.11	...	...
7	.686	.701	.691	.6948	54.7	66.6	55.1	58.68	— 0.07	.358	.479	.398	.403	.84	.73	.91	.82	N b E	S b W	Calm.	N 52 E	4.8	6.0	0.0	0.73	3.94	Inp.	...
8	.717	.705	.717	.7105	60.5	71.3	68.1	67.60	+ 8.53	.349	.442	.511	.437	.66	.57	.75	.64	N N W	S W b S	Calm	N 16 W	9.2	1.5	0.0	4.08	5.19	..	...
9	.708	.691	—	—	68.8	86.5	—	—	—	.359	.306	—	—	.51	.24	—	—	N b W	N N W	N N W	N 20 W	3.3	10.0	13.5	9.74	10.08	..	...
10	.690	.591	.540	.6007	64.5	80.3	71.0	72.22	+12.43	.480	.596	.528	.516	.78	.58	.69	.65	W b N	S W b S	N N W	N 35 W	1.0	4.0	2.8	3.72	4.42	...	...
11	.531	.436	.348	.4317	61.6	78.9	71 7	72.40	+12.42	.441	.627	.477	.549	.81	.63	.60	.69	Calm.	S S W	W b S	N 76 W	0.0	4.3	1.0	3.68	4.94	0.006	...
12	.413	.465	.548	.4847	64.1	72.4	58.3	65.00	+ 4.73	.398	.364	.355	.375	.66	.46	.73	.61	W N W	N W	N W b W	N 49 W	13.5	19.0	14.2	15.05	15.31	...	...
13	.692	.709	.733	.7203	54.5	64.6	54.4	57.90	— 2.68	.307	.228	.308	.286	.72	.37	.73	.61	N N W	N W b N	N b E	N 35 W	14.0	12.8	0.4	4.75	5.62	...	...
14	.731	.628	.406	.5777	51.5	59.8	52.6	55.28	— 5.55	.274	.347	.321	.315	.71	.67	.80	.72	Calm	E	N E b N	N 83 E	0.0	1.8	6.5	2.10	2.46	0.140	...
15	.284	.208	.216	.2283	58.7	73.1	65.5	65.42	+ 4.28	.412	.627	.455	.520	.90	.78	.72	.83	S W b S	S W	N W b W	S 71 W	3.0	8.3	14.2	5.98	8.10	0.191	...
16	.280	.490	—	—	60.9	64.5	—	—	—	.450	.308	—	—	.85	.51	—	—	N N W	W N W	N N W	N 14 W	11.8	15.8	11.5	14.11	14.33	...	...
17	.706	.713	.677	.6998	49.0	58.7	51.8	54.08	— 7.57	.197	.272	.300	.253	.55	.55	.78	.60	N b E	S S W	Calm.	S 13 E	10.5	5.0	0.0	0.26	2.94	..	...
18	.626	.562	.498	.5487	48.6	58.3	54.4	54.60	— 7.35	.249	.344	.298	.308	.72	.70	.69	.71	Calm.	S W b S	S W b W	S 30 W	0.0	3.0	0.5	1.58	1.63	Inp.	...
19	.512	.434	.447	.4718	53.6	70.2	64.1	61.98	— 0.15	.308	.538	.524	.452	.74	.73	.87	.80	Calm.	Calm.	N W	N 55 W	0.0	0.0	6.8	2.73	4.85	0.299	...
20	.576	.625	.570	.5780	58.0	65.6	54.7	60.33	— 2.12	.360	.453	.358	.389	.74	.71	.84	.74	N	S b W	E S E	S 86 E	11.0	6.6	1.0	1.78	5.42	0.312	...
21	.333	.314	.434	.3682	54.4	69.2	56.2	59.12	— 3.63	.396	.498	.360	.406	.93	.70	.80	.81	E N E	W b N	Calm.	N 70 W	6.6	13.2	0.0	3.87	5.68	...	...
22	.453	.418	.437	.4357	56.5	78.2	63.4	66.75	+ 3.80	.390	.365	.334	.371	.86	.37	.57	.60	W	W	Calm.	N 76 W	2.0	16.0	0.0	6.12	6.62	...	...
23	.384	.400	—	—	54.0	70.2	—	—	—	.362	.233	—	—	.87	.31	—	—	Calm.	N	N N W	N 33 W	0.0	16.0	8.5	8.02	8.87	0.038	...
24	652	.635	.622	.6338	54.4	66.3	57.3	59.68	— 3.57	.298	.343	.335	.321	.69	.53	.71	.63	Calm.	S b W	S b W	S 76 W	0.0	7.0	1.0	3.26	3.33	...	...
25	.667	.599	.493	.5710	60.6	68.8	63.7	64.35	+ 0.80	.408	.424	.440	.428	.77	.60	.75	.71	Calm.	S E b E	Calm.	S 55 E	0.0	4.6	0.0	1.56	2.16	...	...
26	.340	.448	.591	.4700	67.0	78.5	62.3	68.97	+ 5.08	.639	.347	.325	.398	.82	.35	.58	.58	S W b W	W b N	N N W	N 68 W	6.0	16.4	8.4	8.38	9.24	Inp.	...
27	.708	.623	640	.6537	55.4	69.5	60.1	62.30	— 1.77	.339	.428	.401	.309	.76	.59	.77	.71	Calm.	S S E	Calm.	S 39 W	0.0	4.3	0.0	3.20	4.01	...	...
28	.627	.586	.610	.6063	58.3	69.5	56.5	61.52	— 2.77	.367	.428	.270	.344	.75	.59	.59	.62	Calm.	S S E	Calm.	N 86 W	0.0	1.2	0.0	1.14	2.56	Inp.	...
29	.633	.564	.538	.5742	54.4	69.5	57.2	61.58	— 2.87	.287	.351	.304	.311	.67	.48	.64	.57	Calm.	S S E	Calm.	S 18 W	0.0	7.2	0.0	3.40	4.32	...	...
30	.482	.408	—	—	59.4	65.2	—	—	—	.398	.497	—	—	.78	.80	—	—	Calm.	S W	Calm.	N 13 W	0.0	2.5	0.0	1.12	2.23	0.204	...
M	29.5871	29.5656	29.5616	29.5698	56.42	67.70	58.68	61.29	+ 0.26	.354	.409	.370	.377	.75	.59	.74	.69	....	....	....	....	4.40	8.58	3.72	......	6.11	2.329	...

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR JUNE, 1861.

Highest Barometer........................ 29.810 at 8 a. m. on 1st } Monthly range =
Lowest Barometer .... 29.176 at 4 p. m. on 15th } 0.634 inches.

Self-registʼing Thermom.:
- Maximum Temperature .... 87°8 on p.m. of 9th } Monthly range=
- Minimum Temperature .... 41°6 on a.m. of 14th } 46°2
- Mean maximum Temperature .... 70°36 } Mean daily range=
- Mean minimum Temperature .... 51°26 } 19°11
- Greatest daily range .... 29°5 from a. m. to p. m. of 10th.
- Least daily range.................. 3°2 from a. m. to p. m. of 4th.

Warmest day......... 11th... Mean temperature......... 72.40 } Difference = 21°30.
Coldest day........... 5th... Mean temperature......... 51°10 }

Maximum { Solar.............................. 102°0 on p. m. of 22nd } Monthly range =
Radiation. { Terrestrial...................... 33°0 on a. m. of 14th } 69°0

Aurora observed on 2 nights, viz.: 12th and 13th.
Possible to see Aurora on 18 nights; impossible on 12 nights.
Raining on 13 days,—depth 2.329 inches; duration of fall 32.3 hours.
Mean of cloudiness = 0.45. Below average 0.08.
Most cloudy hour observed, 4 p. m., mean = 0.53; least cloudy hour observed, 6 a.m., mean, = 0.37.

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

North.	South.	East.	West.
2080.19	797.85	852.23	1887.51

Resultant direction N. 39° W.; Resultant velocity 2.29 miles per hour.
Mean velocity.......................... 6.11 miles per hour.
Maximum velocity .... 33.2 miles, from 11 a. m. to noon on 3rd.
Most windy day ....12th......... Mean velocity, 15.31 miles per hour. } Difference=
Least windy day......... 1st......... Mean velocity 1.35 ditto. } 13.96 miles.
Most windy hour......11 a.m. to noon.........Mean velocity 9.13 ditto. } Difference =
Least windy hour...midnight to 1 a.m......Mean velocity 3.52 ditto. } 5.61 miles.

2nd. Afternoon very foggy and gloomy.
3rd. Solar Halo at 5.30 p. m.
4th. Solar Halo at 7.30 and 8 a. m.
9th. Bright Meteor in S. E. at 8.45 p. m.
11th. Sheet Lightning in W. at 9.15 p. m.
13th. Brilliant Meteor in N. W. at 0.20 a.m.
15th. Thunderstorm, rain and hail, 8 a.m. to 5 p. m. Pollen of Plants fell in this day's rain.
19th. Thunderstorm, lightning and rain, 3.45 to 10 p. m.
24th. Solar Halo at noon. Fire Flies numerous at night.
30th. Thunderstorm from 1 to 7 p. m.

Heavy Dew recorded on 12 mornings during the month.

The Resultant Direction and Velocity of the Wind for the month of June, from 1848 to 1861 inclusive, were respectively N. 69 W. and 0.81 miles.

COMPARATIVE TABLE FOR JUNE.

YEAR.	TEMPERATURE.					RAIN.		SNOW.		WIND.		
	M'n.	Diff. from Aver.	Max. ob'd.	Min. ob'd.	Range.	No. of days.	Inch's.	No. of days.	Inch's.	Resultant Direction.	Resultant V'y.	Mean Force or Velocity.
	°	°	°	°	°							
1840	59.8	−1.6	78.5	37.1	41.4	11	4.860	...	...	...	...	....
1841	65.6	+4.2	92.8	45.7	47.1	9	1.560	...	...	...	...	0.36 lbs.
1842	55.6	−5.8	73.9	28.0	45.9	15	5.755	...	...	...	...	0.31
1843	58.4	−3.0	81.3	28.5	52.8	12	4.595	...	...	...	...	0.27
1844	59.9	−1.5	82.8	33.1	49.7	9	3.535	...	...	...	...	0.19
1845	61.0	−0.4	83.6	40.9	42.7	11	3.715	...	...	...	...	0.27
1846	63.3	+1.9	83.3	41.5	41.8	10	1.920	...	...	...	...	0.32
1847	58.4	−3.0	78.3	36.7	41.6	14	2.625	...	...	...	...	0.30
1848	62.9	+1.5	92.5	38.3	54.2	8	1.810	...	...	N 61° W	1.90	4.51 mls.
1849	63.2	+1.8	84.9	45.2	39.7	7	2.020	...	...	S 71° E	0.49	[illegible].32
1850	64.3	+2.9	83.2	49.0	34.2	10	3.345	...	...	S 60° W	0.38	[illegible].74
1851	59.2	−2.2	79.2	41.2	38.0	11	2.695	...	...	S 2° W	1.26	[illegible].12
1852	60.8	−0.6	86.1	43.6	42.5	10	3.160	...	...	S 76° W	1.49	4.09
1853	65.5	+4.1	86.3	43.3	43.0	9	1.550	...	...	N 1° W	0.10	3.73
1854	64.1	+2.7	88.7	47.4	41.3	9	1.460	...	...	N 24° E	0.71	4.15
1855	59.9	−1.5	90.7	40.6	50.1	17	4.070	...	...	N 69° W	1.33	5.70
1856	62.1	+0.7	82.6	48.3	34.3	13	3.200	...	...	S 21° W	0.90	5.30
1857	56.9	−4.5	75.1	40.9	34.2	21	5.060	...	...	N 49° W	1.15	7.60
1858	66.2	+4.8	86.3	48.7	37.6	12	2.943	...	...	S 20° E	0.25	5.53
1859	58.3	−3.1	85.2	33.9	51.3	16	4.085	2	Inap.	N 77° W	1.95	7.19
1860	63.2	+1.8	81.1	50.0	31.1	14	2.136	...	...	N 44° W	3.13	7.61
1861	61.3	−0.1	86.5	48.2	38.3	13	2.329	...	...	N 39° W	2.29	6.11
M	61.36	...	83.77	41.37	42.40	11.9	3.100	...	...	....	...	5.27 Ml.
Diff from av'g.	− 0.07	...	+ 2.73	+ 6.83	− 4.10	+ 1.1	− 0.771	...	...	....	...	+ 0.84

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST,—JULY, 1861.

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°.				Temp. of the Air.				Excess of mean above Average	Tens. of Vapour.				Humidity of Air.				Direction of Wind.			Result't. 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	10PM	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 PM.	10 P.M.	Result'.	ME'N		
					°	°	°	°	°												°							
1	29.514	29.536	29.630	29.5622	59.8	63.7	55.4	59.23	− 5.53	.369	.353	.285	.337	.72	.60	.64	.67	N	N b W	N N W	N 21 W	3.8	9.0	12.0	6.17	6.33	...	...
2	.657	.665	.652	.6570	50.0	59.0	51.8	54.47	−10.53	.283	.280	.290	.277	.78	.56	.75	.66	N W b N	W b N	Calm.	N 44 W	9.0	5.8	0.0	9.16	9.25	..	...
3	.691	.676	.710	.6903	59.4	77.1	61.6	66.90	+ 1.75	.286	.432	.393	.378	.56	.47	.71	.58	N W	S	Calm.	N 87 W	11.0	3.5	0.0	1.99	3.40	...	...
4	.738	.685	.641	.6820	60.9	76.0	63.4	67.53	+ 2.23	.378	.601	.404	.480	.70	.67	.69	.70	Calm.	S E	Calm.	S 1 E	0.0	7.0	0.0	2.08	2.37	...	...
5	.631	.571	.565	.5895	60.9	77.4	66.3	69.77	+ 4.38	.389	.585	.415	.477	.73	.62	.68	.65	Calm.	S S E	Calm.	S	0.0	9.2	0.0	3.00	3:32	...	...
6	.569	.572	.557	.5610	65.2	78.9	64.1	69.93	+ 4.33	.458	.535	.459	.500	.73	.54	.76	.69	Calm.	S	Calm.	S 9 W	0.0	8.2	0.0	1.89	1.90	...	...
7	.596	.547	—	—	65.5	80.3	—	—	—	.559	.657	—	—	.89	.63	—	—	Calm.	S	Calm.	S 18 W	0.0	8.6	0.0	2.11	2.17	Inp.	...
8	.522	.394	.378	.4273	71.7	78.2	70.2	73.85	+ 8.07	.603	.636	.666	.658	.78	.65	.91	.79	Calm.	S W b S	Calm.	S 24 W	0.0	10.0	0.0	4.76	4.91	0.035	...
9	.312	.314	.339	.3187	68.4	80.7	65.6	72.05	+ 6.07	.618	.702	.493	.596	.90	.66	.77	.75	S W b W	W N W	Calm.	N 81 W	1.5	7.0	0.0	4.86	5.29	Inp.	...
10	.357	.344	.395	.3707	60.9	71.5	60.1	64.38	− 1.70	.415	.493	.476	.458	.78	.64	.92	.77	Calm.	S E b S	N E b N	N 12 E	0.0	7.0	8.0	5.91	8.30	0.875	...
11	.388	.390	.473	.4207	53.6	59.0	53.3	55.27	−10.92	.351	.358	.323	.336	.85	.71	.79	.77	N N W	N W b N	N W	N 39 W	12.0	4.6	1.2	8.01	8.35	0.013	...
12	.520	.551	.679	.5890	52.2	62.7	55.1	57.98	− 8.32	.315	.379	.331	.352	.80	.66	.76	.73	W b N	S b W	N W b N	N 42 W	5.5	4.0	9.0	8.87	9.67	...	...
13	.733	.764	.830	.7790	56.9	65.9	56.9	59.92	− 6.47	.384	.398	.374	.390	.83	.62	.80	.76	N b W	S W b S	Calm.	N 19 W	5.2	1.5	0.0	0.45	1.94	...	...
14	.824	.771	—	—	58.7	70.2	—	—	—	.396	.417	—	—	.80	.57	—	—	N	S b E	Calm.	S 16 E	3.6	3.2	0.0	0.69	1.35	...	...
15	.614	.565	.476	.5453	58.7	63.0	59.0	59.75	− 6.73	.407	.450	.476	.441	.83	.78	.95	.86	Calm.	N b E	Calm.	N 38 W	0.0	2.0	0.0	0.63	0.90	0.135	...
16	.444	.393	.504	.4565	63.0	72.0	60.1	64.30	− 2.28	.526	.542	.266	.439	.91	.69	.51	.71	Calm.	S b W	N W	N 69 W	0.0	3.0	10.0	2.35	3.35	0.245	...
17	.588	.546	.558	.5630	52.9	67.7	59.8	61.88	− 4.80	.296	.452	.417	.409	.74	.67	.81	.73	Calm.	S E	Calm.	S 21 E	0.0	9.2	0.0	1.95	2.14	...	...
18	.570	.493	.458	.5058	58.0	72.4	69.1	67.28	+ 0.60	.416	.579	.553	.522	.86	.73	.77	.78	S W	S S W	W b N	S 28 W	0.5	12.8	2.0	3.90	4.58	0.007	...
19	.409	.361	.350	.3688	63.7	71.0	64.5	66.63	− 0.15	.491	.513	.560	.521	.83	.67	.92	.80	Calm	Calm.	N b W	N 19 W	0.0	0.0	3.0	1.58	3.60	0.400	...
20	.317	.381	.505	.4107	59.8	71.0	58.7	63.38	− 3.38	.428	.513	.361	429	.83	.67	.73	.72	N W b W	N W	W N W	N 44 W	13.4	18.5	5.8	10.01	10.08	...	...
21	.565	.573	—	—	58.0	65.2	—	—	—	.370	.497	—	—	.77	.80	—	—	N W b N	S W b S	Calm.	N 40 W	3.0	1.0	0.0	3.65	4.50	0.010	...
22	.606	.622	.645	.6270	56.2	64.1	58.3	60.77	− 6.10	.371	.435	.344	.389	.82	.73	.71	.73	N	S S W	N N W	N 36 W	3.4	5.8	5.8	2.72	4.87	Inp.	...
23	.654	.647	.715	.6755	58.7	73.1	61.6	65.87	− 1.02	.345	.385	.381	.354	.69	.48	.69	.57	N N W	S b E	Calm.	N 1 E	7.0	5.5	0.0	4.03	4.79	...	...
24	.746	.723	.712	.7293	61.9	72.0	61.9	66.12	− 0.75	.413	.569	.489	.511	.75	.73	.88	.80	Calm.	S	E S E	S 31 E	0.0	4.5	0.8	1.65	1.88	...	...
25	.765	.683	.652	.6962	58.3	75.7	67.4	67.85	+ 0.87	.390	.541	.416	.453	.80	.61	.61	.67	Calm.	S E b S	S	S 7 E	0.0	11.3	3.6	3.92	4.15	...	...
26	.599	.546	.535	.5572	65.9	74.6	68.4	70.30	+ 3.33	.514	.550	.662	.577	.81	.63	.95	.78	Calm.	S b W	Calm.	S 17 W	0.0	6.5	0.0	3.66	4.12	0.085	...
27	.561	.572	.555	.5627	66.3	72.8	66.6	68.68	+ 1.70	.603	.574	.504	.558	.93	.71	.77	.80	N	E	E	N 83 E	0.6	8.0	3.5	4.39	4.57	...	...
28	.423	.269	—	—	66.6	73.1	—	—	—	.599	.658	—	—	.92	.81	—	—	E b N	S E b S	S W b S	S 13 E	4.0	15.0	9.0	7.19	9.35	0.590	...
29	.335	.428	.534	.4503	62.7	71.7	65.9	66.57	− 0.38	.504	.618	.540	.537	.88	.79	.85	.82	S S W	W S W	Calm	S 56 W	8.5	14.0	0.0	5.30	5.75	Inp.	...
30	.501	.561	.520	.5580	61.6	79.6	68.4	71.20	+ 4.25	.456	.605	.561	.558	.83	.60	.81	.73	Calm.	S	S W	S 15 W	0.0	6.5	2.2	3.30	3.82	0.230	...
31	.519	.468	.516	.5058	67.4	79.3	71.7	73.02	+ 6.07	.632	.704	.646	.663	.94	.69	.84	.82	S S W	N N E	N W b N	N 26 W	1.2	4.2	1.0	1.85	3.51	0.010	...
M	29.5541	29.5352	29.5590	29.5505	60.56	71.49	62.41	65.37	− 0.88	.431	511	.449	.467	.80	.65	.78	.73	....	....	....	....	3.01	6.98	2.50	....	4.66	2.635	......

Highest Barometer . . . . 29.830 at 10 p. m. on 13th. } Monthly range=
Lowest Barometer . . . . 29.269 at 2 p. m. on 28th. } 0.561 inches.

Self-registering Ther.:
- Maximum temperature . . . . 84°5 on p.m. of 7th } Monthly range=
- Minimum temperature . . . . 47°0 on a.m. of 2nd } 37°5
- Mean maximum temperature . . 74°67 } Mean daily range=18°44.
- Mean minimum temperature . . 56°23 }
- Greatest daily range . . . . . . 29°1 from a. m. to p. m. on 3rd.
- Least daily range . . . . 8.0 from a. m. to p. m. on 11th.

Warmest day . . 8th ... Mean Temperature . . .=73°85 } Difference=19°38.
Coldest day . . . 2nd ... Mean Temperature . . .=54°47 }

Maximum { Solar . . . . 99°8 on p. m of 9th } Monthly range=
Radiation { Terrestrial . . . . 37°0 on a. m. of 17th } 62°8.

Aurora observed on 1 night, viz: on 9th; possible to see Aurora on 17 nights; impossible on 14 nights.

Snowing on — day: depth, — inches; duration of fall, — hours.

Raining on 16 days; depth, 2.635 inches; duration of fall, 34.7 hours.

Mean of cloudiness=0.56, above average 0.11; most cloudy hour observed 4 p. m., mean =0.67; least cloudy hour observed mid., mean=0.42.

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

North.	South.	East.	West.
1482.96	1190.32	383.47	1410.04

Resultant direction, N 74° W; Resultant Velocity, 1.43 miles per hour.
Mean velocity 4.66 miles per hour.
Maximum velocity . . . 20.0 miles, from 3 to 4 p.m. on the 20th.
Most windy day . . 20th—Mean velocity 10.08 miles per hour. } Difference
Least windy day . . 15th—Mean velocity, 0.90 do } 9.18 miles.
Most windy hour, 4 to 5 p. m.—Mean velocity, 8.07 miles per hour. } Difference
Least windy hour, 11 p. m to mid.—Mean velocity, 2.34 do. } 5.73 miles.

1st. Distant thunder at 8 p. m.—4th. Fireflies very numerous at night.—8th. Thunderstorm, lightning and rain from 3.40 p. m.—10th. Thunderstorm from 3.40 p.m. Heavy rain from 4 p. m., continuing all night.—15th. Thunderstorm, lightning and rain from 9 to 11.40 p. m.—16th. Thunderstorm, vivid lightning, and heavy rain from 2.10 to 2.50 p. m.—18th. Thunderstorm, lightning, and slight rain, 2 p. m. to midnight.—19th. Thunderstorm from 2 p. m. to 10.15 p. m.—26th. Indistinct solar halo at 6 a. m.—28th. Thunderstorm, with very heavy rain, 8.30 a.m. to 0.30 p. m.—30th. Severe thunderstorm from 10 p. m. to 2 a. m. of 31st.—31st. Sheet lightning in S.E. at 10 p. m. Shooting stars numerous at night.

Heavy dew recorded on 10 mornings during the month.

The Resultant Direction and Velocity of the Wind for the month of July, from 1848 to 1861 inclusive, were respectively N. 65° W., and 0.49 miles.

COMPARATIVE TABLE FOR JULY.

YEAR.	TEMPERATURE.					RAIN.		SNOW.		WIND.		
	Mean.	Difference from Average.	Maximum observed.	Minimum observed.	Range.	No. of days.	Inches.	No. of days.	Inches.	Resultant Direction.	Resultant Velocity.	Mean Velocity
	°		°	°	°					°		
1840	65.8	— 1.0	79.4	48.2	31.2	6	5.270	...	...	...	...	...
1841	65.0	— 1.8	86.3	43.2	43.1	10	8.150	...	...	...	...	0.27lbs
1842	64.7	— 2.1	90.5	42.0	48.5	4	3.050	...	...	...	...	0.33 "
1843	64.5	— 2.3	86.1	40.2	45.9	5	4.605	...	...	...	...	0.44 "
1844	66.0	— 0.8	86.1	40.5	45.6	12	2.815	...	...	...	...	0.19 "
1845	66.2	— 0.6	94.6	45.6	49.0	7	2.195	...	...	...	...	0.30 "
1846	68.0	+ 1.2	94.0	44.9	49.1	9	2.895	...	...	...	...	0.29 "
1847	68.0	+ 1.2	87.5	43.8	43.7	8	3.355	...	...	...	...	0.19 "
1848	65.5	— 1.3	82.7	46.7	36.0	10	1.890	...	...	N 14 W	0.18	4.94ms.
1849	68.4	+ 1.6	89.1	51.0	38.1	4	3.415	...	...	S 5 W	0.75	3.52 "
1850	68.9	+ 2.1	84.9	52.8	32.1	12	5.270	...	...	N 81 E	0.59	4.56 "
1851	65.0	— 1.8	82.7	52.1	30.6	12	3.625	...	...	N 60 W	0.88	4.13 "
1852	66.8	— 0.0	90.1	49.5	40.6	8	4.025	...	...	N 43 W	0.93	3.33 "
1853	65.6	— 1.2	85.4	49.4	36.0	10	0.915	...	...	S 58 E	0.24	3.69 "
1854	72.5	+ 5.7	93.6	53.0	40.6	9	4.805	...	...	S 49 W	0.37	4.03 "
1855	67.9	+ 1.1	88.4	53.1	35.3	13	3.245	...	...	S 19 W	0.73	6.47 "
1856	69.9	+ 3.1	92.0	51.4	40.6	8	1.120	...	...	N 79 W	1.57	5.84 "
1857	67.8	+ 1.0	85.4	52.4	33.0	15	3.475	...	...	S 68 E	0.81	4.74 "
1858	67.9	+ 1.1	83.4	55.9	27.5	13	3.072	...	...	N 15 E	1.13	5.73 "
1859	66.9	+ 0.1	87.7	50.5	37.2	12	2.611	...	...	N 56 W	1.48	5.81 "
1860	63.9	— 2.9	85.8	47.5	38.3	13	4.336	...	...	N 60 W	2.15	7.29 "
1861	65.4	— 1.4	82.9	49.4	33.5	16	2.635	...	...	N 74 W	1.43	4.66 "
Mean	66.85	...	87.21	48.32	38.89	10.0	3.490	...	...	...	...	4.91
Diff. from Av'ge.	—1.48	...	—4.31	+ 1.08	—5.39	+ 6.0	—.855	...	...	...	...	—0.25

MONTHLY METEOROLOGICAL REGISTER, ST. MARTIN, ISLE JESUS, CANADA EAST—JUNE, 1861.

(NINE MILES WEST OF MONTREAL.)

BY CHARLES SMALLWOOD, M. D., LL.D.

Latitude—45 deg. 32 min. North. Longitude—73 deg. 36 min. West. Height above the Level of the Sea—118 feet.

Day.	Barom. corrected and reduced to 32°			Temp. of the Air.—F.			Tension of Vapor.			Humidity of Air.			Direction of Wind.			Horizontal Movement in Miles in 24 hours.	Mean of Ozone. (tenths)	Rain in Inches.	Snow in Inches.	WEATHER, &c. A cloudy sky is represented by 10; A cloudless sky by 0.		
	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.					6 A.M.	2 P.M.	10 P.M.
1	30.042	29.995	29.905	54.6	79.9	65.6	.335	.567	.413	.80	.37	.66	s w	s w	s w	88.44	3.0	...	...	Clear.	Cum. 2 S. Ha.	Cirr. 2. L. H.
2	032	938	800	55.7	81.2	67.0	.349	.547	.450	.81	.52	.67	N E b E	N E b E	s E	139.50	3.0	...	...	Cirr. Str. 4.	Lt. Cir. 2 S. H.	Cirr. Str. 2.
3	29.474	311	564	60.1	77.0	63.7	.449	.685	.510	.85	.75	.88	s s E	W S W	W N W	333.70	3.5	2.333	...	Rain.	C. C. Str. 8.	Do. 3.
4	850	717	921	49.0	65.8	53.8	.278	.436	.367	.81	.80	.88	N N W	W S W	N	218.70	2.0	...	...	Clear.	Light Cirr. 4.	Clear.
5	30.117	30.063	30.126	48.4	72.3	59.0	.260	.340	.387	.78	.45	.79	s s E	s E b E	s E b E	85.30	2.0	...	...	Do.	Clear.	Cirr. Str. 6.
6	041	29.993	29.937	52.3	67.7	57.6	.334	.418	.343	86	.62	.72	s s E	s E	s E	169.30	2.0	...	...	C. C. Str. 10.	C. C. Str. 8.	C. C. Str. 8.
7	29.904	870	800	59.6	72.8	70.6	.433	.450	.586	.85	.48	.80	E S E	s b E	s s E	28.00	2.5	0.100	...	Cu. Str. 8.	Cirr. 4.	Clear.
8	862	772	898	58.7	80.4	63.0	.452	.567	.485	.94	.57	.86	s E	s b E	s b w	5.70	2.0	...	...	Clear.	Clear.	Cu. Str. 8.
9	768	785	892	67.0	89.8	74.9	.556	.990	.673	84	.71	.79	s s E	s w	s w	54.90	2.0	...	...	Do.	Do.	Str. 4.
10	843	770	630	70.9	95.8	76.7	.621	.949	.614	.85	.78	.68	s b w	s b w	s s w	35.70	2.0	...	...	Do.	Do.	Clear.
11	625	472	462	70.1	94.9	75.5	.516	.814	.597	.70	.54	.71	s w	s s w	sw b w	10.20	1.5	...	...	Do.	Do.	Cirr. 4.
12	435	472	632	69.5	79.2	60.3	.628	.581	333	.88	.60	.63	w s w	w s w	N b w	211.10	2.5	...	...	Cu. Str. 10.	Cu. Str. 4.	Clear.
13	788	755	790	56.2	63.0	51.0	.342	.229	.270	.78	.41	.72	w	w	w	253.50	3.0	In'p.	...	Nim. 10.	Do. 4.	Cu. Str. 4.
14	822	755	750	58.0	68.5	54.0	.337	.343	.341	.70	.49	.83	W S W	W S W	s w b s	306.80	2.5	...	...	Clear.	C. C. Str. 6.	Nim. 10.
15	500	363	434	56.1	64.2	58.1	.420	.464	.452	.94	.77	.94	E S E	N E b E	s w	72.40	4.0	0.989	...	Rain.	Rain.	Cu. Str. 8. L'g.
16	477	567	790	56.6	73.0	52.0	.391	.383	.264	.87	.48	.69	N N E	N N E	N b E	264.90	2.5	0.700	...	Nim. 10.	Clear.	Clear.
17	833	856	842	58.1	69.5	56.5	.255	.437	.357	53	.63	.78	s E b E	s E	s s w	118.00	1.5	...	...	Clear.	Do.	Do.
18	791	814	869	50.2	64.7	57.6	.328	.427	.372	.89	.71	.78	s w	s w	s w	162.00	1.0	...	...	Do.	Do.	Do.
19	689	576	697	60.4	80.9	63.2	.433	.599	.510	85	.50	.88	s b w	s s w	w s w	157.80	2.5	0.236	...	C. C. Str. 10.	C. C. Str. 4.	C. C. Str. 4. D.
20	662	747	811	58.4	64.1	58.3	.372	.433	.394	.78	.73	.82	w b N	w s w	w s w	230.39	2.5	...	...	Nim. 10.	Do. 8.	Cllear. [Thu.
21	675	546	562	60.9	61.2	59.1	.419	.442	.439	80	.83	.88	s s w	s s E	s E b E	26.20	2.5	In'p.	...	Heavy dew.	Cirr. 10.	Cu. Str. 10.
22	574	564	555	59.3	62.4	69.0	462	.399	.564	.91	.72	.79	w b s	w b s	s s w	222.50	2.0	...	...	C. C. Str. 9.	Cu. Str. 4.	Do. 8.
23	420	423	640	67.6	67.2	51.0	.591	.556	.302	89	.84	.82	w s w	w b s	w b s	393.70	3.0	0.010	...	Do. 4.	Do. 8.	Do. 8.
24	616	735	850	43.2	69.6	57.0	.209	.336	.302	.75	.47	66	w b N	w b N	w N w	200.60	2.5	...	...	Clear.	Cirr. 2.	Clear.
25	842	772	700	55.0	87.9	63.7	.328	.921	.571	.77	.71	.82	s w b w	s s w	s s w	66.30	2.0	...	...	Cu. Str. 8.	Clear.	Do.
26	583	584	614	68.4	77.0	65.9	.612	.685	.444	.90	.75	.71	s s w	w	w	275.10	3.5	0.200	...	Do. 8.	Cu. Str. 9.	Cu. Str. 8.
27	720	715	751	64.2	73.6	64.3	.471	.504	.464	.81	.61	.77	w b N	w b N	w b N	156.70	3.0	...	...	Clear.	Clear.	Do. 4.
28	660	565	732	61.2	69.7	66.0	.383	.490	509	.71	.68	.81	w s w	s	w s w	218.70	2.0	0.300	...	Do.	Nim. 9.	Clear.
29	733	704	706	60.1	78.2	62.4	.376	.450	.422	.73	.67	.75	s w b s	w s w	w s w	177.80	2.0	...	...	Do.	Cirr, 4.	Do. Au. Bor.
30	568	684	661	64.6	78.7	61.0	.444	.588	.419	.75	.62	.80	w b s	w s w	s E	177.10	1.0	...	...	C. C. Str. 8.	Cu. Str. 10.	Cu. Str. 8.
...		...	...	...	...	...	...	...	...	...			...	...	...	...	...	...	...	...	...	Com. first seen

MONTHLY METEOROLOGICAL REGISTER, ST. MARTIN, ISLE JESUS, CANADA EAST—JULY, 1861.

(NINE MILES WEST OF MONTREAL.)

BY CHARLES SMALLWOOD, M.D., LL.D.

Latitude—45 deg. 32 min. North. Longitude—73 deg. 36 min. West. Height above the Level of the Sea—118 feet.

Day.	Barom. corrected and reduced to 32°			Temp. of the Air.—F.			Tension of Vapour.			Humidity of Air.			Direction of Wind.			Horizontal Movement in Miles in 24 hours.	Mean of Ozone. t'nths	Rain in inches.	Snow in inches.	Weather, &c. A Cloudy sky is represented by 10; A cloudless sky by 0.		
	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.					6 A.M.	2 P.M.	10 P.M.
1	29.701	29.742	29.76[illegible]	56.6	71.4	59.4	.385	.509	.358	.84	.08	.73	S S E	S S E	N E b E	439.20	2.0	0.170	...	Cu. Str. 10.	C. C. Str. 4.	Cirr. Str. 8.
2	701	670	675	54.5	58.3	56.9	383	394	429	90	82	91	N E b E	N N E	N E b E	495.00	3.0	3.210	...	Rain.	Rain.	Rain.
3	720	849	831	61.0	76.0	65.0	449	652	516	85	73	84	N N E	S S W	S S E	218.22	2.0	0.300	...	Cu. St. 10.	Cu. Str. 10.	Clear. Comet
4	862	875	89[illegible]	61.0	85.1	66.3	433	577	470	85	49	73	S W	S S W	S S W	211.60	1.0	...	...	Clear.	Clear.	Do. [visible.
5	840	770	794	71.8	91.0	72.0	566	894	601	74	64	78	S S W	S S W	S	92.60	1.0	...	...	Do.	Do.	Do.
6	781	713	806	70.0	93.5	75.0	557	793	507	77	50	71	S	S S E	S b W	77.80	1.0	...	...	Do.	Do.	Do.
7	888	775	722	72.4	89.6	77.0	681	798	765	81	63	84	S b W	S W	S W	121.10	1.5	...	...	Cirr. Cum. 6.	C. C. Str. 4.	Rain.
8	683	783	550	74.0	89.7	66.5	686	714	529	83	52	82	S S W	S S W	S E	177.00	2.0	...	...	C. C. Str. 6.	Cirr. 4.	Nim. 10.
9	475	511	400	70.2	81.0	67.7	557	717	584	77	70	87	S S W	S S W	W N W	70.84	2.0	1.310	...	Cu. Str. 8.	C. C. Str. 4.	Cu. Str. 4.
10	470	574	702	67.0	76.0	65.1	529	652	549	82	73	80	E S E	N E	N N E	84.00	1.0	...	...	C. C. Str. 4.	Clear.	Clear.
11	590	528	577	51.3	57.4	57.0	341	400	385	89	84	84	N E b E	N E b E	E b S	427.50	2.5	0.863	...	Rain.	Cu. Str. 4.	Do. Au. Bor.
12	633	599	781	54.1	62.1	55.2	362	376	376	87	69	87	S S W	S W	W b S	208.60	2.5	...	...	C. Cum. 4.	Do. 3.	Str. 2. do.
13	882	976	987	58.5	77.6	58.0	429	457	423	91	49	88	S W	S W	N E b E	55.40	3.0	0.074	...	Do. 4.	Do. 3.	Clear. do.
14	30.037	869	902	56.4	72.4	60.1	385	483	456	84	61	88	N E b E	E S E	E S E	58.30	2.0	...	...	C. C. Str. 6.	C. C. Str. 4.	C. C. Str. 4.
15	29.776	709	714	56.1	62.3	60 0	420	523	469	94	94	94	N E b E	S W b S	S W b S	94.20	2.5	0.696	...	Rain.	Rain.	Rain.
16	656	603	660	63.2	69.9	60.3	510	577	456	88	85	88	S	S S W	S b W	166.10	2.5	0.603	...	C. C. Str. 10.	Do.	Cu. Str. 4.
17	688	705	854	53.2	73.2	59.0	321	416	416	80	52	85	W S W	S W	S S W	150.60	1.0	...	...	Clear.	C. C. Str. 4.	Clear. [light.
18	752	713	688	61.1	83.3	70.4	390	505	516	74	51	90	S S W	S S W	E S E	99.90	1.0	...	...	Cirr. Str. 2.	Do. 4.	Cirr. 10. dist.
19	696	582	568	64.0	70.4	65.2	497	530	542	83	69	87	W S W	W S W	N E b E	79.30	1.5	1.126	...	Cu. Str, 10.	Do. 4.	Cu. Str. 10.
20	420	405	470	63.0	74.1	60.0	503	442	456	86	55	88	E	N W	W b S	67.10	2.0	0.576	...	Rain.	Cu. St. 9.	Do. 4.
21	575	588	632	60 1	72.6	58.5	426	483	387	82	61	79	W b N	W b N	W b N	364.00	2.0	0.131	...	Do.	Do. 4.	Clear.
22	600	612	760	60.0	66.0	57.0	345	353	385	68	56	84	S W	W	W	230.40	1.0	...	...	Clear.	C. C. Str. 8.	Cu. Str. 4.
23	762	782	853	60.0	72.1	61.5	433	455	460	85	56	85	E b N	N N E	W S W	75.00	1.0	...	...	Cu. Str. 4.	Cu. Str. 10.	C. C. Str. 10.
24	921	869	976	56.7	77.2	61.7	385	534	436	84	59	80	W S W	S W b W	S S E	6.20	1.0	...	...	C. C. Str. 10.	C. C. Str. 4.	Clear.
25	930	942	980	57.6	74.2	65.8	349	436	509	74	53	81	S	S S E	S S E	0.70	1.5	...	...	Clear.	Cu. Str. 4.	Do. Au. Bor.
26	904	904	875	66.1	84.1	69.1	542	590	536	87	51	77	S b E	S S E	S S E	0.50	1.5	...	...	Do.	Clear.	Cu. Str. 2.
27	835	832	838	71.9	78.0	71.0	537	671	688	71	71	92	S S E	N W	E S E	53.60	2.5	0.200	...	Cu. Str. 10.	C. C. Str. 6.	Rain.
28	891	735	712	69.0	85.0	71.3	571	691	615	82	57	83	S S E	S S E	S S E	50.80	1.0	...	...	Clear.	Do. 4.	C. C. Str. 2.
29	688	760	833	69.0	79.0	69.4	642	907	380	92	93	56	S	S S E	S S E	204.70	2.0	0.163	...	Rain.	Cu Str. 6.	Cu. Str. 4.
30	748	722	755	70.4	88.9	69.0	621	908	536	85	68	77	S S W	S S W	S	87.20	1.0	...	...	C. C. Str. 8.	C. C. Str. 4.	Clear.
31	844	800	736	67.6	79.7	68.2	584	724	584	87	72	87	S b E	S b W	S S E	76.40	1.5	0.766	...	Rain.	Do. 8.	Str. 4.

REMARKS ON THE ST. MARTIN, ISLE JESUS, METEOROLOGICAL REGISTER FOR JUNE.

Barometer	Highest, the 5th day	30.126
	Lowest, the 3rd day	29.311
	Monthly Mean	29.720
	Monthly Range	0.815
Thermometer	Highest, the 9th day	99°.7
	Lowest, the 17th day	40°.1
	Monthly Mean	65°.83
	Monthly Range	59°.6
Greatest Intensity of the Sun's Rays		104°.3
Lowest Point of Terrestrial Radiation		36°.4
Amount of evaporation		3.73
Mean of Humidity		.735

Rain fell on 10 days, amounting to 4.868 inches; it was raining 56 hours and 18 minutes, and was accompanied by thunder on 3 days.

Most prevalent wind, the W. S. W.

Least prevalent wind, the N.

Most windy day, the 23rd; mean miles per hour, 1[illegible].23.

Least windy day, the 8th; mean miles per hour, 0.23.

Solar Haloes visible on 2 days.

Lunar Halo visible on 1 night.

Aurora Borealis visible on 1 night.

The Electrical state of the Atmosphere has indicated moderate intensity.

REMARKS ON THE ST. MARTIN, ISLE JESUS, METEOROLOGICAL REGISTER FOR JULY, 1861.

Barometer	Highest, the 14th day	30.037
	Lowest, the 9th day	29 400
	Monthly Mean	29.734
	Monthly Range	0.637
Thermometer	Highest, the 6th day	90°2
	Lowest, the 23rd day	47°4
	Monthly Mean	67°66
	Monthly Range	51°8
Greatest intensity of the Sun's rays		104°1
Lowest point of Terrestrial Radiation		47°0
Mean of Humidity		.765
Amount of Evaporation		2.72

Rain fell on 14 days, amounting to 10.188 inches; it was raining 79 hours and 49 minutes, and was accompanied by thunder on 4 days.

Most prevalent wind, S. E. byE.

Least prevalent wind, E.

Most windy day, the 2nd day; mean miles per hour, 20.60.

Least windy day, the 26th day; mean miles per hour 0.02.

Aurora Borealis visible on 4 nights.

Comet visible.

Earthquake felt here at 9.03 p. m. 11th day.

Tornado in Montreal 9th day.

The Electrical state of the Atmosphere has indicated moderate intensity.