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DESCRIPTIONS OF SOME SPECIES OF NOCTURNAL LEPIDOPTERA, FOUND IN CANADA.

BY THE REV. CHARLES J. S. BETHUNE, M. A.
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THE following descriptions of Canadian Moths have been prepared with a view to second the efforts now being made by Professor Hincks for the accumulation of materials for a "Fauna Canadensis." In the September number of the *Journal*, he directed attention to the want of information respecting almost every department of Natural History in this country, and expressed his desire that some attempt should be made both to facilitate present investigations, and to render whatever is already known available for the production hereafter of a general work on Canadian Zoology. In the department of Entomology, one of the chief difficulties in the way of its successful pursuit,—that arising, namely, from the want of reliable books upon the subject,—has lately been lessened to a considerable extent. The Smithsonian Institution, in carrying out its great design of "increasing and diffusing knowledge among men," has during the last five years, published several valuable works on Insects, for the especial purpose of facilitating the study of this branch of natural history. These works have been prepared by some of the best authorities on the orders of which they respectively treat, and are certainly the most useful of any on the subject that have yet appeared on this Continent. The most recently published of them is a Synopsis of the described Lepidoptera of North America, by the Rev. Dr. Morris of Baltimore, containing the Rhopalocera, and the first two groups (Sphingina and Bombycina) of the Heterocera. This volume has conferred a great boon upon Entomologists in general, and especially upon those who are only beginners in the pursuit, inasmuch as it contains descriptions collected from upwards of fifty different works, many of them rare and expensive, and most of them not be met with in this country. As this Synopsis can so easily be obtained, it will be unnecessary to publish in the Journal any descriptions that have already appeared in it. Of the remaining groups, however,—at least of the Canadian species of them,—very little is known; it has occurred to me, therefore, that descriptions of, at all events, the common and more conspicuous ones would assist many in determining some of their specimens, and, at the same time, be a small contribution to Prof. Hinck's very commendable object—the formation of a "Fauna Canadensis."

NOCTUINA, *Staint.*

To this group belong the great majority of our night-flying moths, though some few genera are to be met with even in the full glare of noon-day. They may be recognized in their perfect state by the following characters:—

Body generally stout. Antennæ longer than the thorax, tapering from the base to the tip, filiform, ciliated, or pubescent, more or less bent or twisted, never terminating in a hook; those of the female nearly always simple. Palpi well developed, generally projecting beyond the head. Abdomen almost always extending beyond the hind wings. Legs of variable length, but generally long, especially the posterior pair, which are always longer than the preceding ones; hind tibiæ usually with four long spines. Wings moderately broad, rarely narrow or very broad, never elevated in repose, or rolled about the body; fore wings straight in front, rounded or angular at the tips, oblique on the exterior border; almost always marked with three, sometimes with four, transverse lines, and two spots: the hind wings are more or less folded, and generally covered by the fore wings when in repose.

A full explanation is given in Morris' Synopsis, alluded to above, of the neuration, ordinary markings, etc., of the wings, and the terms used in describing them; it need only be mentioned here therefore, to save the trouble of reference, that the transverse lines on the fore wings are thus distinguished:—That nearest the base, seldom reaching more than half across the wing, is called the *half line;* the next, before the middle of the wing, the *inner line;* then, beyond the middle, the *elbowed line*; and lastly, the *subterminal line*. Of the two spots, or stigmata, the one nearest the base of the wing, is round or oval, and is called the *orbicular spot;* the other is kidney shaped, and is called the *reniform spot;* beneath the former is sometimes a third, of a wedge-shape, called the *claviform* spot.

The Noctuina are divided by M. Guénés, into two main groups, *Trifidæ* and *Quadrifidæ*.

Of the TRIFIDÆ, the imago is generally of moderate size, sometimes small; palpi short, or of moderate length, with the third joint never long or spatulate; hind wings usually much folded under the fore wings, the inner margins of which often overlap each other in repose; median vein of the lower wing with *three branches*.

Of the QUADRIFIDÆ, the imago has generally broad, sometimes very large wings; palpi always long and ascending, with the third joint long and filiform, sometimes spatulate; hind wings but little folded; the inner margin of the fore wings seldom overlap in repose; median vein of the lower wing with *four branches*.

The TRIFIDÆ, to which belong by far the greater number of our Noctuelites, are subdivided into three sections:—

BOMBYCIFORMES.—Palpi short and stout; legs not long; fore wings rather thick; hind wings slender.

GENUINÆ.—Palpi stout and well-developed; legs robust; fore wings very thick; hind wings slender, generally of dull colors.

MINORES.—Of small size; body slender; legs long and slender; wings broad; fore wings not very thick, triangular; hind wings well developed, often with similar markings and colors to those on the fore wings.

The QUADRIFIDÆ are divided into eight sections, three of which—the *Sericeæ, Patulæ,* and *Pseudodeltoidæ,*—are not found in Canada, being confined almost entirely to tropical climates. It is only necessary, therefore, to mention the characteristics of the remaining sections.

VARIEGATÆ.—Size small or moderate. Palpi well developed, often thick. Fore wings angular or denticulate on the inner margin, or with metallic blotches; hind wings of one color, sometimes pale or yellow, with a dark border; the first inferior vein generally more slender than the others.

INTRUSÆ.—Size moderate or large. Abdomen more or less flattened; antennæ pubescent or crenulate. Fore wings large, clouded; hind wings of a different color from the fore wings, first inferior vein always rather slender, and remote from the others.

EXTENSÆ.—Size moderate. Palpi ascending, almost vertical; second joint curved, generally pilose; third joint linear. Antennæ of the male crenulate, with short bristles; of the female simple. Abdomen rather long, smooth, seldom crested. Wings thick, clouded, adorned with wavy lines; hind wings almost always of the same color as the fore wings.

LIMBATÆ.—Size large or moderate. Antennæ never pectinated. Wings broad, well developed; fore wings with flexuous lines; hind wings different from the fore wings, gaily colored with two distinct hues; the first inferior vein almost always equal to the others, and not remote from them.

SERPENTINÆ.—Size moderate or small. Abdomen smooth, not flattened. Third joint of the palpi moderately long, not spatulate. Wings thick, and rather broad.

Having now briefly enumerated the chief subdivisions of the group Noctuina, I shall proceed to the description of various genera and species, taking up the commoner and more easily identified forms first, without regard to any particular order.

The subsection LIMBATÆ, to which belong the largest and handsomest of our nocturnal moths, is only represented in this country by one genus, CATOCALA, of the family CATOCALIDÆ. Specimens of these insects are generally to be found in every cabinet, as from their large size, and gaily colored under-wings, they are very conspicuous, and do not easily escape the observation of the collector. Their favourite haunts are the trunks of apple and other trees, where they feed on the sap that exudes wherever branches have been cut off. Toward the end of August, and during September, the commoner species may be found hovering about such places, a little before sunset and sometimes even earlier in the day. In repose they form a flat gray triangle, completely concealing with their fore wings the brilliant colors of the lower ones, and often closely resembling the bark of the trees on which they rest.

Gen. CATOCALA. Ochs.

Size large. Body stout. Palpi thick, pilose obliquely ascending, moderately long; their third joint very distinct, short. Antennæ slender, pubescent in male, setaceous in female, more than half the length of the body. Thorax convex, thickly pilose. Abdomen crested, generally extending beyond the hind wings. Legs long, stout, very pilose. Wings large, slightly denticulated. Fore wings almost invariably gray, clouded with black and white; slightly convex along the costa, angular at the tips, moderately oblique on the exterior margin; the markings constant in almost all our species are, first, a series of dark points set off with white, close to the exterior margin; then the submarginal line, which is seldom clearly defined; the two following lines, however, are usually very distinct, and distant from each other: the inner line being composed of lunules or irregular arcs, the elbowed of teeth more or less sharp; of the two spots, the reniform is the only one visible, though it also is frequently much obscured; a third immediately behind it, called the *subreniform*, is more commonly apparent, being clearer than the others, and edged with black. Hind wings denticulated, crimson or luteous, with a black band and a black border, rarely wholly black, or black with a white band.

SYNOPSIS OF CANADIAN SPECIES.

A. Hind wings black, with a white band, 1. *C. relicta.*

AA. Hind wings black without bands, 2. *C. vidua.*

AAA. Hind wings red, with a black band and a black border.

B. Fore wings gray, with a whitish spot on the inner side of the reniform spot, and another behind it.

C. Elbowed line with two very prominent teeth, 3. *C. parta.*

CC. Elbowed line without prominent teeth, 4. *C. unijuga.*

BB. Fore wings with the transverse lines very much denticulated; reniform spot testaceous.

D. Fore wings with a white discal spot, 5. *C. amatrix.*

DD. Fore wings with no white discal spot.

E. Hind wings scarlet, 9. *C. Ultronia.*

EE. Hind wings rosy, 6. *C. Concumbens.*

BBB. Fore wings with a light colored patch at the apex; reniform and another discal spot testaceous or whitish.

F. Elbowed line of fore wings with two very long teeth, 7. *C. uxor.*

FF. Elbowed line with moderately long teeth, 8. *C. ilia.*

AAAA. Hind wings luteous, with a black band and a black border.

G. Fore wings gray.

H. Hind wings with the fascia not excavated. 10. *C. cerogama.*

HH. Hind wings with the fascia excavated, 11. *C. antinympha.*

HHH. Hind wings with the fascia contracted in the middle. 19. *C. neogama.*

GG. Fore wings cinereous, 12. *C. polygama.*

1. Catocala relicta, Walk.—*Cat. Brit. Mus. Noct.* 1192.

Body black, speckled with white, pure white beneath; thorax black with a few white hairs, in front white with a black band; abdomen above black, whitish between the segments and at the apex. Fore wings, ground color white, with the usual transverse lines black, and a black fascia in the middle of the wing, interrupted by the subreniform spot, which is white edged with black; marginal lunules deep black. Hind wings deep black, with a regularly curved white band, and white ciliæ; anal angle truncate. Under side of both wings white, with a series of black spots on the exterior margin; fore wings with three black bands also, which are wide on the costa, gradually diminishing toward the inner margin; hind wings with a black band, a black border, and the discal lunule deep black. Length of the body 12-14 lines; alar expansion 32 lines.

Hab. Cobourg. Toronto (Dr. Morris.) Nova Scotia.

2. C. Vidua, Smith,—Walk. *C. B. M. Noct* 1200. Guén, *Noct.* III. 94.

Body cinereous, beneath whitish; thorax with black bands in front; abdomen thickly clothed with white hairs at the base beneath. Fore wings cinereous, slightly glaucescent in the middle; the usual transverse lines well defined, black, closely approaching each other near the inner margin; elbowed line with two long sharp teeth a little before the middle, the exterior one longer than the other; subterminal line whitish, irregular, and denticulated; submarginal spots black, bordered externally with white; reniform spot light brown in the middle, edged with black. Hind wings velvety black, with a few long cinereous hairs at the base; ciliæ white, slightly interrupted by the black prolongations of the nervures. Beneath, forewings deep black, cinereous at the apex, white at the base, with two white bands extending half way across the wing from the costa, exterior one narrow, slightly curved, interior one broad and short; hind wings also deep black, with the basal half of the wing white, a white crooked fascia across the middle of the wing, and the ciliæ white. Length of the body 13 lines; alar expansion 27 lines. This species bears a strong resemblance to *C. insolabilis*, Guén. Found in the United States.

Hab. Toronto (Dr. Morris). United States.

3. *C. parta.* Guén.—*Noct.* III. 84. Walk. *C. B. M. Noct.* 1193.

Blackish, speckled with white. Abdomen cinereous, with a brownish tinge in the females. Fore wings rather oblong, very much denticulated; the two median transverse lines black, margined with white, much denticulated; the elbowed line with two prominent teeth, from which a black streak proceeds to the apex; there is also another black streak at the base, and a third parallel to the inner margin, towards the anal angle; subterminal line white, zig-zag; a whitish band between it and the elbowed line; reniform spot whitish, speckled and bordered with black; subreniform spot large, round, whitish, touching the reniform, which has also a whitish discal blotch on its inner side; submarginal lunules black, Hind wings rather pale red; the black median band moderately broad, straight, almost regularly curved, slightly abbreviated; the black border rather broad, with two slight sinuses on the inner side, and hollowed at the apex by a whitish spot. Under side of the wings cinereous on the exterior margin, with six bands, alternately black and white; of the hind wings, the first half is white, the remainder red, with the black band and border of the upper side, and a blackish discal lunule. Length of the body 12 lines; alar expansion 32 lines.

Hab. Cobourg. Very common.

St. Martin's Falls, Albany River, Hudson's Bay, (Dr. Barnston). United States.

4. C. UNIJUGA. Walk.—*C. B. M. Noct.* 1194.

Cinereous, thickly speckled with black. Thorax with black bands in front. Abdomen cinereous, first few segments tufted, lighter beneath. Four wings with a slight blueish tinge; the two median transverse lines black margined with white, (in some specimens composed of two black lines with a white one between them): the elbowed serrate, without prominent teeth, crossing the wing in a direct line; the inner wavy and thick: reniform spot blackish, indistinct, with a whitish blotch adjoining it on the inner side; subreniform, white, speckled with brown; and behind it a third spot near the inner margin, deep black; submarginal line white, serrate, distinct: marginal lunules black, edged with white exteriorly. Hind wings deep red, with fuscous hairs at the base; the black band moderately broad, narrow towards the inner margin, which it does not reach, with a slight indentation on the outer side between the submedian and the fourth inferior nervules; the black border broad, slightly wavy on the inner side towards the anal angle, where it becomes very narrow; a narrow white apical streak; ciliæ white. Under side very similar to that of the preceding species (*C. parta*). Length of the body, 12-14 lines; alar expansion, 30-34 lines.

Hab. Cobourg. London, C. W. (Mr. Saunders). St. Martin's Falls, Albany River, Hudson's Bay (Dr. Barnston). United States.

5. C. AMATRIX, Hübn. Walk.—*C. B. M. Noct.* 1195. Guén. *Noct.* III. 86.

Brownish cinereous. Thorax with black bands in front, and dark lines on the tegula. Abdomen testaceous cinereous. Four wings almost rectangular at the apex, the denticulations much rounded; with a black shade proceeding from the middle of the base to the extremities of the first two superior nervules, on the exterior margin, interrupted in the middle by the subreniform spot, which is whitish marked with testaceous; reniform spot dark testaceous; the two median lines exceedingly sinuous, the elbowed has two very long teeth on the black shade, then it retreats gradually till it reaches the fourth inferior nervule, where it forms a deep sinus enclosing the subreniform spot, and almost touching the inner line, to which it is united by a black dash; subterminal line very faint; usual marginal lunules represented by small black points. Hind wings rosy red; the black band curved, rounded, and abbreviated, with a notch on the outer side, a little before the middle; the black border very broad on the costa, gradually narrowed to the anal angle; ciliæ white, sometimes interrupted with black. Under side of the four wings white, cinereous on the exterior margin, with a blackish submarginal band, a deep black median one, and another near the base; of the hind wings, part red and part white, with a deep black median band, notched as on the upper side, a discal lunule, and a submarginal band, blackish. Length of body 12-14 lines; alar expansion 30-32 lines.

Hab. Toronto, (Dr. Morris). London, C. W., (Mr. Saunders). Montreal and Sorel, (Mr. D'Urban). Orillia, (Mr. Bush). Nova Scotia and United States.

6. C. CONCUMBENS. Walk.—*C. B. M. Noct.* 1198.

"Whitish, speckled with black. Thorax brownish in front. Abdomen pale brownish cinereous. Fore wings glaucous-cinereous, with a very slight brownish tinge; transverse lines incomplete, very slender, with indistinct whitish borders, the interior one with a very prominent tooth; reniform spot almost obsolete; the subreniform with an incomplete black border; submarginal line whitish, indistinct; marginal dots, whitish, pointed with black on the inner side. Hind wings bright rose-color; band broad, curved, nearly regular in its outline, abbreviated towards the interior margin; border broad, gradually decreasing in breadth towards the interior angle, with a narrow rose-tinted space between it and the white ciliæ. Length of body 9-10 lines; alar expansion 26-28 lines." (*Walk.*)

Hab. Cobourg. London, C. W., (Mr. Saunders). Orillia, (Mr. Bush). Montreal and Sorel, (Mr. D'Urban).

7. C. ILIA. Cram.—Walk. *C. B. M. Noct.* 1198. Guén. *Noct.* III. 91.

Dark cinereous. Thorax with black marks. Abdomen slightly crested, whitish beneath. Fore wings dark cinereous shaded with brown and black; a light colored patch at the apex; elbowed line thick, black, partially edged with white, with two moderately long teeth; the two interior lines not very distinct; the subterminal whitish, serrate, well defined; a not very distinct triangular black spot joined to the basal mark; reniform spot testaceous with a whitish margin edged with black; subreniform spot round, light colored, encircled with black. Hind wings deep red, with the base and inner margin covered with black hairs: the black median band very irregular, twice contracted, broad on the costa, attenuated on the inner margin; border rather broad, black, with two sinuses near the middle on the inner side; ciliæ testaceous, reddish at the apex. Under side of the fore wing whitish tinged with red, with the three black bands of the hind wing red, in front whitish, with a black band and border corresponding to those on the upper side, ciliæ of both wings white edged with black, and scalloped. Length of body 12 lines; alar expansion 27 lines.

Hab. London, C. W., (Mr. Saunders). United States. Jamaica.

8. C. UXOR. Guén. *Noct.* III. 92. Walk.—*C. B. M. Noct.* 1199.

Brownish cinereous. Abdomen cinereous white beneath, crested on the first three or four segments. Fore wings powdered with a yellowish gray, clouded with black and white; near the apex on the exterior margin there is a dark cloud, black in some specimens, extending as far back as the elbowed line; the whole of the inner margin is covered with a similar blackish cloud which occupies about a third of the wing; transverse lines rather indistinct; the elbowed with two very long teeth, projecting into the exterior cloud; subterminal line white edged with brown internally, zig-zag; reniform spot margined with blueish white; subreniform paler, of an irregular shape, sometimes indistinguishable. Hind wings of a bright rich red color, with black hairs at the base and on the inner margin; the black median band broad on the costa, with a regular sinus in the middle, then dilated and hollowed again, and very much narrowed towards the margin of the wing; black border broad, diminishing regularly to the anal angle; ciliæ dark, white at the apex. Under side of the fore wings cinereous at the base, then a red band, next a black one, a narrow white one, and a broad black border, cinereous towards the apex; of the hind wings red, with a narrow black band which is irregularly curved till it passes the middle, when it suddenly forms a V-like mark; discal lunule black, well-defined. Length of body 7-10 lines; alar expansion 18-24 lines.

Hab. London, C. W., (Mr. Saunders). Toronto, (Dr. Morris).

*9. C. ULTRONIA. Hübn.—Walk. *C. B. M. Noct.* 1197. Guén. *Noct.* III. 89.

Cinereous fuscous. Fore wings whitish cinereous, with a very broad black posterior fascia, and a black marginal patch; a bluish shade on the disc: reniform spot hardly visible. Hind wings bright vermillion red, with a broad black border, and a very much curved black median band, reaching the inner margin; ciliæ blackish, white at the apex.

Hab. Orillia, (Mr. Bush). United States.

10. C. CERROGAMA. Guén. *Noct.* III. 96. Walk. *C. B. M. Noct.* 1202.

Cinereous, clouded with black and white. Abdomen cinereous. Thorax with brown bands in front. Fore wings slightly powdered with ferruginous scales; two broad oblique whitish bands proceeding from the costa about half way across the wing; median transverse lines black, distinct; the inner one flexuous; the elbowed denticulated, with two prominent teeth; the subterminal white, running parallel to the elbowed line; marginal lunules black; edged with white exteriorly; reniform spot blackish, with ferruginous scales, and a light margin; subreniform oblong, white. Hind wings black, with dark luteous hairs at the base; a bright yellow fascia across the middle, slightly flexuous, and of equal width throughout; a narrow oblong luteous spot at the apex; ciliæ luteous, with three black bands on the

*The species marked with an asterisk (*) in the present paper have not come under the observation of the writer; should any one, therefore, recognise the descriptions, he will be much obliged for specimens of those so marked.

fore wings, of which the basal one is paler than the other; and two on the hind wings, discal lunule indistinct. Length of body 11-13 lines; alar expansion 30-32 lines.

Hab. Cobourg. London, C. W., (Mr. Saunders). Orillia, (Mr. Bush). Montreal, (Mr. D'Urban). Trenton Falls, New York.

†19. C. NEOGAMA. Abbot.—Walk. *C. B. M. Noct.* 1202. Guén. *Noct.* III. 96. Westw. *Nat. Libr.* xxxvii. 1202, pl. 26.

Cinereous speckled with black. Abdomen lutescent. Fore wings cinereous, clouded with fuscous and black; the two median transverse lines well defined black; the elbowed commences above the reniform spot, then proceeding outward, forms two nearly equal prominent teeth, between the first superior and the second inferior nervules; it next retreats a little, forming three short rounded teeth, after which it recedes just above the sub-median nervure, nearly as far as the inner line, returning again parallel to it. The subterminal line whitish, irregularly flexuous, with a narrow brown space between it and the elbowed line; submarginal lunules black, edged exteriorly with white; reniform spot brownish, edged with white; subreniform white with a few dark scales, and a black margin: there is also a rather vague oblique black stripe proceeding from the upper tooth of the elbowed line to the exterior margin and forming a lighter gray apical patch. Hind wings of a rich ochre-yellow color, dull towards the base and inner margin; the black median band very much contracted on the disc, and afterwards twisted almost like an S, and very narrow, near the sub-median nervure, and towards the inner margin, which it does not reach, the black border is very broad on the costa, narrowed posteriorly, with a sharp sinus between the fourth inferior and the sub-median nervures; ciliæ and apical spot luteous. Under side of the fore wings like that of *C. cerogama*, but rather more yellow, with the median band narrow, very much twisted, almost interrupted on the independent nervure, and abbreviated at some distance from the inner margin; the black border rather narrow, flexuous on its inner edge, abbreviated, with dirty-yellow space, sprinkled with black, between it and the exterior margin. Length of body, 12 lines; alar expansion, 35 lines.

Hab. Kingston, C. W., (Mr. Rogers). New York.

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†Since this article was prepared, the writer received specimens of two species of Catocala, from Mr. R. V. Rogers, Jr., of Kingston, C. W. One C. PARTA, described above on page 7, the other C. NEOGAMA, of which a full description is now given.

*11. C. ANTINYMPHA. Hübn.—Walk. *C. B. M. Noct.* 1203. *Melanympha,* Guén. *Noct.* III. 98. *Paranympha,* Drury. *Affinis,* Westw.

Blackish cinereous. Abdomen black ferruginous. Fore wings with a black transverse angled line: reniform spot fuscous with a black margin; subreniform brownish gray, encircled with black; subterminal line cinereous. Hind wings broadly fuscous at the base and at the inner margin; with two very undulating luteous fasciæ, and an elongated luteous spot at the apex; ciliæ pale.

Hab. Canada. New York.

*12. C. POLYGAMA. Guén.—*Noct.* III. 105. Walk. *C. B. M. Noct.* 1207.

"Whitish. Fore wings with a slight pale glaucous-green tinge from the base to the exterior line, the latter having two prominent teeth, of which the fore one is more prominent than the hind one; a broad ferruginous line near the base bordered by two black lines, and a diffuse band of the same hue beyond the exterior line; space between the latter band and the black marginal dots gray, including the indistinct brownish submarginal line; reniform spot partly bordered with black and inclosed in a white space; subreniform spot bordered with black. Hind wings luteous, brown along the interior border; band excavated in the middle, much curved, joining the brown part; border with the usual hindward notch, a small apical luteous streak; ciliæ pale, with brown marks.

Var.—Fore wings with the ferruginous hue almost obsolete; subreniform spot larger. Hind wings with the border interrupted. Length of body 8 lines; of the wings 18 lines." (*Walk.*)

Hab. Orillia, (Mr. Bush).

The following species are found in the neighbouring States, many of them, therefore, are likely to be met with in Canada.

BB.

*13. C. NURUS.—Walk. *C. B. M. Noct.* 1195.

"Cinereous with a very slight brownish tinge. Thorax with brown bands in front. Abdomen with a slight testaceous tinge. Fore wings slightly and partly clouded with brown; a broad dark brown basal streak; the usual transverse denticulated black lines distinct, and the exterior one with two very prominent teeth; a brown streak in the disc towards the exterior border, being a continuation of the basal streak; reniform and hinder spots indistinct. Hind wings rosy red; band broad, curved, excavated on the fore part of its exterior side, not extending to the interior margin; border broad, becoming narrower hindward to the interior angle; ciliæ and the adjoining apical part of the wing, whitish. Length of the body 13-15 lines, of the wings, 32-36 lines.

This species is nearly allied to *C. amatrix*, but may be at once distinguished by the broader and more curved band of the hind wings." (Walk.)

Hab. United States.

*14. C. JUNCTURA.—Walk. *C. B. M. Noct.* 1196.

"Dark cinereous. Thorax speckled with white. Abdomen pale cinereous. Fore wings very slightly and partly clouded with black; the usual transverse denticulated lines indistinct, slightly and diffusedly bordered with brown; reniform spot blackish, slightly marked with brown, as is also the adjoining hinder spot; marginal lunules black. Hind wings red-lead colour, margin red towards the base; band rather narrow, nearly straight, with some slight excavations, curved near its hind end, terminating at some distance from the interior margin, but with its extension indicated by a few black hairs; border moderately broad, including a large elongated apical red spot, and some hinder red marginal lunules; ciliæ whitish. Length of the body 14 lines; of the wings 34 lines." (Walk.)

Hab. United States.

*15 C. SELECTA.—Walk. *C. B. M. Noct.* 1197.

"Brown. Thorax in front with blackish bands. Abdomen pale ferruginous brown. Fore wings with incomplete denticulated transverse lines, and with black submarginal dots which have pale exterior borders, reniform spot with a slight ferruginous tinge. Hind wings bright rose-color; band curved, rather narrow, abbreviated at some distance from the exterior border, somewhat excavated before the middle on its exterior side; border very broad, but gradually decreasing in breadth hindward, not extending to the interior angle; ciliæ and contiguous parts of the border pale luteous, with a few brown streaks. Length of the body 15 lines; of the wings 36 lines." (Walk).

Hab. United States.

AA.

*16. C. LACRYMOSA. Guén.—*Noct.* III. 93. Walk. *C. B. M. Noct.* 1199.

Cinereous, speckled with black. Thorax with black bands in front. Fore wings varied with white, partly clouded with black; transverse lines distinct; subterminal one white margined with black exteriorly; submarginal spot black, edged with white. Hind wings black; ciliæ white, with black indentations.

Hab. United States.

*17. C. EPIONE. Drury.—Guén. *Noct.* III. 93. Walk. *C. B. M. Noct.* 1200.

Blackish cinereous. Fore wings with the usual transverse lines black; an exterior fuscous fascia; subterminal line white; marginal lunules black, edged with white. Hind wings black; ciliæ white; under side with a very short white fascia.

Hab. New York. Philadelphia.

*18. C. INSOLABILIS.—Guén. *Noct.* III. 94. Walk. *C. B. M. Noct.* 1200.

Male.—Cinereous, subglaucescent. Fore wings with the transverse lines incomplete; the elbowed forming two very long teeth; subterminal line white; reniform spot indistinct; subreniform incomplete: submarginal spots black. Hind wings black; ciliæ blackish.

Hab. North America.

*20. C. PALÆOGAMA.—Guén. *Noct.* III. 97. Walk. *C. B. M. Noct.* 1202.

Fuscous, speckled with white. Thorax with black bands. Abdomen ferruginous, cinereous. Fore wings with two short oblique white fasciæ; the transverse lines black, denticulated; the subterminal white, angled; margin of the reniform spot black; subreniform black; submarginal lunules black, edged with white exteriorly. Hind wings luteous, fuscous at the base, and on the inner margin; with a black band and broad black border; ciliæ pale.

Hab. United States.

*21. C. MULIERCULA, Guén.—*Noct.* III. 97. Walk. *C. B. M. Noct.* 1203.

Ferruginous fuscous. Fore wings clouded with blackish, glaucescent in the middle; the two median lines distinct, black, approaching each other; the elbowed with two elongate teeth. Hind wings bright luteous, with an interior black vitta, a black band, and a broad sinuous black border: ciliæ stained with black.

Hab. North America.

*22. C. INNUBENS.—Guén. *Noct.* III. 98. Walk. *C. B. M. Noct.* 1203.

Fuscous. Thorax with a rather deep band. Abdomen cinereous. Fore wings with a diffuse black discal longitudinal stripe, including a white spot margined with black; costa white at the apex; a posterior white streak; median transverse lines black, denticulate; subterminal white; submarginal spots black, paler exteriorly. Hind wings rich luteous, with a black band and broad black border; ciliæ paler, marked with blackish luteous at the base.

Hab. United States.

*23. C. MICRONYMPHA.—Guén. *Noct.* III. 102. Walk. *C. B M. Noct.* 1204.

Chesnut-brown. Fore wings varied with hoary and blackish; the two median lines distinct, remote on the costa, approaching each other posteriorly; the elbowed forming two teeth, the posterior one of which is almost obsolete: reniform spot composed of a black streak; central shade well-determined; subterminal line angled, white. Hind wings luteous, with two blackish basal streaks; a narrow subangular band, and a broad, curved, interrupted border.

Hab. North America.

*24. C. AMASIA. Abbot.—Guén. *Noct.* III. 103. Walk. *C. B. M. Noct.* 1204. Westw. *Nat. Libr.* xxxvii. 205, pl. 26.

White. Thorax speckled with black. Abdomen lutescent. Fore wings with two fasciæ, of which the basal one is brown, the exterior one ferruginous; costa with black marks: median transverse lines incomplete, angled, black; margin of the reniform spot black; submarginal dots black, edged with white exteriorly. Hind wings luteous, with a black abbreviated band, and a black interrupted border: apical spot luteous.

Hab. North America.

*25. C. ILLECTA.—Walk. *C. B. M. Noct.* 1205.

Pale cinereous. Abdomen luteous. Fore wings with the transverse lines, slender and distinct; elbowed line much denticulated with two prominent teeth, the fore one twice as long as the other; reniform spot white in the disc, edged with black; subreniform white with an incomplete black margin. Hind wings luteous; the band almost abbreviated towards the inner margin, excavated on the outer side; border broad; apical spot elongated luteous; ciliæ whitish. Length of the body 13 lines; alar expansion 30 lines.

Hab. United States.

*26. C. NUPTULA.—Walk. *C. B. M. Noct.* 1205.

Cinereous with a slight testaceous tinge. Abdomen testaceous. Fore wings with ferruginous costal marks; median lines obsolete, except the elbowed, which is ferruginous, and has a prominent tooth marked with black; a broad ferruginous streak along the inner margin, attenuated exteriorly; subterminal line and the margin of the reniform spot whitish, indistinct; submarginal dots black. Hind wings luteous; with a fuscous stripe near the inner margin; a black band contracted in the middle; a broad black margin with two indentations on the inner side near the anal angle; ciliæ whitish-testaceous, marked with fuscous. Length of the body 7-8 lines; alar expansion 18-20 lines.

Hab. North America.

*27. C. NUPTIALIS.—Walk. *C. B. M. Noct.* 1206.

"Whitish cinereous. Thorax with a brown band in front. Abdomen testaceous above. Fore wings minutely speckled with black, with a very slight fawn-colored tinge on the exterior part, which includes the indistinct whitish subterminal line; the usual tranverse lines obsolete, excepting some black or dark brown costal marks, the elbowed line visible for nearly half its length from the costa; reniform spot black, curved, subpyriform; submarginal dots black. Hind wings luteous, with a black slightly curved band, which is abbreviated towards the anal angle, near which it has a notch on the inner side; ciliæ pale. Length of the body 9 lines; alar expansion 22 lines." (Walk.)

Hab. United States.

The remaining species found in North America, are the following:—

B.

*28. C. ELECTILIS. Walk. Mexico.

BB.

*29. C. CARA. Guén. Baltimore.

AA.

*30. C. DESPERATA. Guén. Baltimore.

AAAA.

*31. C. CONSORS. Abbot. Georgia.

*32. C. GRYNEA. Cram. Virginia.

*33. C. CONNUBIALIS. Guén. ?

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*34. C. AMICA. Hübn. Georgia, Florida.

*35. C. MESSALINA. Guén. ?

A POPULAR EXPOSITION OF THE MINERALS AND GEOLOGY OF CANADA.

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PART IV.

(Continued from Vol. VII. page 121.)

The various classes and orders of molluscous animals, with the exception of the class *Cephalopoda*, were described in reference to their fossil relations, in the last article of this series. In the present article we resume and complete our rapid sketch of the more prominent features of Canadian Palæontology, bringing Part IV. of our Essay to a close. The concluding portion, or Part V., of the series, embracing a general view of our rock groups, in their topographical, economic, and other relations, will appear in an early number of the *Journal.*

Cephalopoda.—The Cephalopods are the most highly organised representatives of the molluscous type. They possess a distinct head, furnished with large eyes and with a central mouth. The latter contains a pair of horny jaws or "beaks," (somewhat resembling, although in reversed position, the beaks of a parrot), and is surrounded by eight or ten arms, or by a greater number of tentacles, serving partly for locomotion, but chiefly for prehensile purposes. It is from the possession of these arms or tentacles, viewed as organs of locomotion, that the class derives its name of *Cephalopoda* or "head-footed." Its species are entirely marine. The Nautilus, the Argonaut or "Paper Nautilus," and the Sepia or Cuttle-fish, may be cited as characteristic living types.

The Cephalopods fall into two orders or leading groups, viz.: (1.) *Tetrabranchiata* or *Tentaculifera;* and (2.) *Dibranchiata* or *Acetabulifera.* The tetrabranchiate or tentaculiferous cephalopods possess four branchiæ or organs of respiration, numerous simple or unarmed tentacles, and a many-chambered shell. The dibranchiate or acetabuliferous cephalopods have only two branchiæ, and eight or ten arms; but the latter are provided on the inside with special organs of prehension in the form of *acetabula* or "suckers." These forms also possess a so-called "ink-bag," or internal sack, containing a dark fluid secretion which the animal can eject into the surrounding water when pursued or otherwise alarmed. A single genus, the Argonaut, inhabits a one-chambered shell. All the other genera are "naked," or without external shells, as seen in the Cuttle-fish. These dibranchiate cephalopods exhibit the higher organization, and approximate in some respects to the class of Fishes. Our Canadian rocks offer, however, no fossil representatives of this group, so abundant in existing Nature, and also to some extent so characteristic of the Mesozoic periods of the Earth's history. The tetrabranchiate cephalopods, on the other hand, are almost extinct. The Nautilus is the only remaining type; and of this, no more than two or three living species are known; whilst from rocks of various ages, upwards of 150 fossil species have been collected.

The shell in the tetrabranchiate group is divided into a number of compartments or chambers, by concave, sinuous, angulated, or highly-lobed partitions, called "septa"—the animal inhabiting the outer chamber—and it is traversed, throughout its entire length, by a tube or "siphuncle" of variable form and position. In the Nautilus, according to Professor Owen, this siphuncle opens into the cavity which contains the heart; and its use, although still doubtful, is thought to be to keep up the vitality of the shell in parts distant from the creature's body. It passes through the various chambers without affording any communication between these, so that the old idea respecting the use of the tube, and according to which the animal was thought by its means to be able to fill the chamber with water, or to eject this, in order to sink or rise at will, is now altogether exploded. Under ordinary conditions the nautilus appears to creep on the sea-bed, head downwards, at moderate depths, and to feed on holothuriæ, star-fishes, crustacea, &c. The accompanying diagrams, fig. 126, exhibit the marginal outline of the more general kinds of septa presented by the shells of this group. A simple septum of the *orthoceratites* and *nautilus* are represented by *a*; an angulated septum of the *goniatites* by *b*; a lobed and denticulated septum of the *ceratites* by *c*; and a foliated septum of the *ammonites*, *baculites*, *hamites*, &c., by *d*.

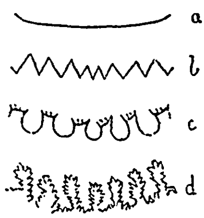


Fig. 126.

In accordance chiefly with these characters, the Tetrabranchiata, or chambered cephalopods, may be classed as follows:

Family I., NAUTILIDÆ.—Septa with entire or slightly sinuous margins. Siphuncle, variable.

Sub-Family 1, *Gomphoceratidæ.*—Aperture of shell partly closed, or much contracted.

Sub-Family 2, *Orthoceratidæ*, or *Nautilidæ proper.*—Aperture more or less open.

Family II., AMMONITIDÆ.—Septa prominently lobed. Siphuncle "external," or along the apparent back of the shell.

Sub-Family 1, *Goniatidæ.*—Septa angulated, *i. e.*, with angular lobes.

Sub-Family 2, *Ceratidæ.*—Septa lobed and denticulated.

Sub-Family 3, *Ammonitidæ proper.*—Septa foliated.

The Ceratidæ and Ammonitidæ proper are entirely restricted to rocks of Mesozoic age, and are consequently unknown among Canadian fossils. (See the Table of Formations given at page 453 of Vol. VI., and also those of Canadian occurrence on the succeeding page). The sub-families of the Gomphoceratidæ, Orthoceratidæ, and Goniatidæ present Canadian examples; but those belonging to the first and last of these sub-families, are few in number and of comparatively rare occurrence; and even the Orthoceratidæ, though rich in examples, are confined, with us, to a small number of genera. It is not necessary, therefore, in describing these forms, to adhere to any close system of classification, more especially as the fragmentary or otherwise imperfect condition in which the fossil cephalopods of the lower rocks so generally occur, forbids in many instances the strict application of definite structural characters. This understood, our Canadian genera may be conveniently described in the following order: *Orthoceras* (including *Gonioceras*, &c., as explained below), *Cyrtoceras, Phragmoceras* (belonging to the first sub-family, but placed here, for convenience, as allied by form to cyrtoceras), *Lituites, Nautilus,* and *Goniatites.* Other genera, enumerated by palæontologists, and occurring with us, are distributed under one or more of these types.*

* Many of the genera hitherto established for the Tetrabranchiate Cephalopods can only be regarded as provisional. Characters until recently considered of generic value (and on which distinct genera have been founded by Pictet, D'Orbigny, Hall, and other palæontologists of authority), are now shewn to be more or less inconstant, and consequently of uncertain application. The siphuncle in its form and position, as regards at least the types with simple septa, appears more especially to be a character of this kind; but it may be questioned whether the mere shape of the shell, although a readily observable character in most instances, and hence a convenient one, is actually of any greater value. It would seem, for example, that relations quite as close must have obtained between an orthoceras with ordinary siphuncle and a slightly curved cyrtoceras—as between the former and an orthoceras (or endoceras) with a laterally-situated siphuncle of large size and more or less aberrant structure.

Orthoceras.—In this genus the shell is straight and conical, tapering more or less gradually from the body chamber to its other extremity. The septa are simply concave, or slightly sinuous, and at comparatively short distances apart. If we imagine the shell of a nautilus unrolled and straightened out, we have the typical orthoceras shell. The siphuncle is variable, both in shape and position. Three convenient, if not strictly natural, sub-genera, *Orthoceras proper*, *Ormoceras*, and *Endoceras*, may be founded on its characters. The genus ranges from the Lower Silurian into the Triassic formation. In many of its examples, the shell, if perfect, would shew a length of several feet.

The first sub-genus, *Orthoceras proper*, has a siphuncle in the form of a narrow tube, central or sub-central in position. *O. lammellosum* (fig. 127) and *O. bilineatum* (fig. 128), both from Lower Silurian Strata, are Canadian examples of common occurrence.

Fig. 127.

Fig. 128.

The second sub-genus, *Ormoceras*, comprises the various orthoceratites (as the species of the genus Orthoceras are collectively termed) with moniliform or "beaded" siphuncle, as shewn in *Ormoceras tenuifilum* (fig. 129) from the Trenton limestone and lower beds. This sub-genus includes the Huronia and Actinoceras of authors, and also the peculiar flattened species named *Gonioceras anceps* by Hall. This latter form is an Orthoceras with beaded siphuncle and slightly sinuous septa, and with a shell so compressed as to offer almost trenchant edges. Fig. 130 represents a fragmentary specimen. The species is very common in the Chazy and Black river limestones at the lower part of the Trenton group. In weathered specimens, both of this and other species of *Ormoceras*, the outer portion of the shell is often obliterated, when the beaded siphuncle with its attached septa, has a certain resemblance to

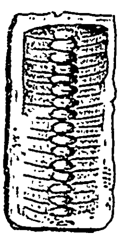


Fig. 129.
A worn fragment shewing siphuncle and septa.

Fig. 130.

the vertebral column of a fish. Weathered specimens of this kind are usually described by quarrymen and farmers as fish remains; but no vestiges of a true fish, or other vetebrated type, have as yet been discovered in our Silurian strata.

In the third sub-genus, for which, without regard to the supposition originally involved in the term, Prof. Hall's name of *Endoceras* may be retained, we may place the orthoceratites with very large and laterally-situated or more or less marginal siphuncle. *Endoceras proteiforme*, of Hall, (fig. 131), is a familiar Canadian example. The siphuncle, in this species, often contains a long cone of calcareous matter, made up of successive layers. This secretion probably served to counterbalance the increasing buoyancy of the shell, as the air-chambers during the growth of the latter became more and more numerous. The shells of smaller orthoceratites are also sometimes found, with other accidental bodies, in the interior of these large siphuncles. Examples of *Endoceras proteiforme*, five or six inches in diameter, and in fragments of over eighteen inches or two feet in length, have been obtained from the Trenton limestone of Nottawasaga township, near Collingwood, C. W.; also from Belleville; and from the Hudson River beds of the River Humber, near Toronto, as well as from other parts of the Province. One of the largest specimens, yet collected, was obtained by the writer from the shores of Georgian Bay, (Lake Huron,) and is now in the Museum of the Toronto University.

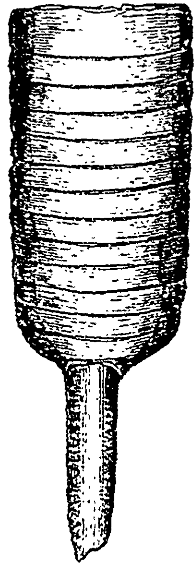


Fig. 131.

NOTE:—We have retained for the orthoceratites described above, the specific names by which they are familiarly known in Canada, after the determinations of Prof. Hall in his "Palæontology of New York." But *Orthoceras lamellosum* is probably identical with the European species, *O. regulare;* whilst *O. tenufilum* may perhaps be referred to *O. cochleatum* (Schlotheium); *O. bilineatum* to *O. calamiteum* (Munster); and *Endoceras proteiforme* to Schlotheim's *O. vaginatum*. *Gonioceras anceps*, on the other hand, is quite distinct from the *Orthoceras anceps* of De Koninck, and also from the earlier and doubtful *O. anceps* of Count Munster. An extended discussion of synonymes, or minute comparison of specific details, would be quite out of place, however, in an Essay of the present character.

Cyrtoceras:—This genus includes the *curved* orthoceratites with normal shell-aperture. The septa are simply concave, or slightly sinuated, and the siphuncle variable. Its forms, as at present known, may be arranged under two sub-genera, representing the first and third amongst the straight or true orthoceratites. The genus ranges from the lower Silurian into the Carboniferous formation.

The first sub-genus, *Cyrtoceras proper*, has a gradually tapering and more or less slightly curved shell, with small siphuncle: the latter occupying a central or sub-central position, or lying along the larger curve of the shell. Fig. 132 is a sketch of *C. annulatum* from the lower part of the Trenton group.

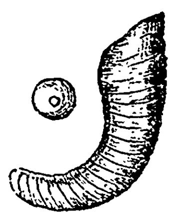


Fig. 132.

In the second sub-genus, characterised by a large siphuncle as in the endoceratites, we may place the *Piloceras* of Salter. This form presents short, thick, and slightly curved shells with large siphuncle. The latter often contains a cone of calcareous matter, as in *Endoceras proteiforme*. The type, as yet, is comparatively rare, but a species has been discovered in the Calciferous Sand Rock of the Mingan Islands, by Sir William Logan and Mr. Richardson. This is described by Mr. Billings in the *Canadian Naturalist*, Vol. V., p. 171. In making *Piloceras*, however, merely a sub-genus of *Cyrtoceras*, as explained above, we follow our own views.

Phragmoceras:—This genus, in form, is closely allied to *Cyrtoceras*, and is also confined to Palæozoic rocks. The shell is curved, and the septa simple or slightly sinuated; but the aperture of the shell is more or less strongly contracted. The siphuncle is variable, although in most species hitherto referred to Phragmoceras, it lies along the shorter curve of the shell. In the Bohemian *P. perversum* of Barrande, and in the *P. præmaturum* of Billings, it occupies, nevertheless, the convex side. Fig. 133 represents a fragment of the latter species (after Billings), from the Black River Limestone of La Cloche Island, Lake Huron.

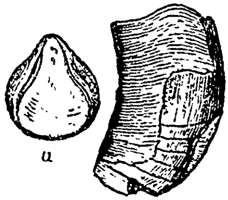


Fig. 133.
a. Represents the aperture.

Fig. 134.

To this genus, Hall's *Oncoceras constrictum* (fig. 134) should also be referred. This species is exceedingly common in the low part of the Trenton group; but when in imperfectly preserved specimens, it cannot be distinguished from a cyrtoceras. The siphuncle is near the outside or larger curve of the shell.

Lituites:—The shell in this genus, is involute or "rolled u (like that of the nautilus) for a certain distance, and is then projected in a straight line. The septa are simply concave, and the siphuncle of small size and mostly central. Species have not been found as yet above the Silurian rocks. In fragmentary specimens, however, it is often impossible to determine the genus—the straight part of the shell resembling that of an orthoceras with narrow siphuncle, and the involute portion being identical with the shell of a nautilus. Fig. 135 represents the *Lituites undatus* of Hall. Examples having a general resemblance to this, but (as first pointed out by the writer) with external siphuncle, occur in our Lower Silurian beds, at Lorette near Quebec, and elsewhere.

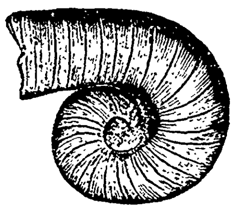


Fig. 135.

Nautilus.—This genus is one of peculiar palæontological interest, as the only living type of the great group of tetrabranchiate cephalopods, or those inhabiting a many-chambered shell. It passes (although with diminished, and, of course, with changing species) from the Silurian epoch into the existing age—its fossil representatives traversing the rocks of all intervening periods. The shell is involute, the septa simple and mostly central in position. Our Canadian examples are scarce, and have not yet been thoroughly determined.

Goniatites.—This genus first appears in Devonian strata, and becomes extinct in the Triassic deposits. It belongs, as already stated in our introductory remarks, to the family of the Ammonitidæ, and is essentially characterized by its angulated strata (see fig. 126, above). The shell is involute in form, like that of the nautilus, and the siphuncle external and of small size. Several species occur in the Devonian rocks of Western Canada, but the relations of these have not yet been fully worked out.

As already explained on a preceding page, the second or Dibranchiate Order of Cephalopods—comprising the Argonaut, the Octopus or "Poulpe" of the French, the Loligo, (more familiarly known as the Calamary or Squid), the Sepia or Cuttle-Fish, the extinct Belemnite, and other kindred genera—are without representatives in rocks of Canadian occurrence.

Articulated Animals.—The forms of the sub-kingdon *Articulata* (see vol. vi., p. 5,) are arranged in the following classes :—ANNELIDA, CIRRHOPODA, CRUSTACEA, ARACHNIDA, MYRIAPODA, and INSECTA; but of these, the annelids, cirrhopods, and crustaceans are alone represented by fossil examples in Canadian rocks.

ANNELIDA.—The annelids comprise various worm-like forms, and are usually grouped in three Orders :—*Abranchiata, Dorsibranchiata,* and *Cephalobranchiata.* The abranchiate annelids are without any visible or external branchiæ. They include the common earth-worms and other forms unrepresented in the fossil state. The dorsibranchiate annelids are marine worms with tufts of branchiæ in the form of delicate filaments at regular distances along the sides of the body. They offer a few fossil species, but have not been recognized in Canadian rocks. Finally, the cephalobranchiate annelids, also marine types, possess thread-like branchiæ around the mouth or head. Some of these forms secrete a calcareous tube or shell for the protection of the worm-like body. These constitute the genera *Serpula* and *Spirorbis*: the former having an irregular wavy tube, whilst in the latter the tube is spirally rolled up. These tubes are mostly attached to the backs of shells or other sub-marine bodies. A fine species of serpula, *D. splendens,* seven or eight inches in length, and a quarter of an inch across the opening, has been described by Mr. Billings from the Chazy limestone of the Lower Silurian Series (*Canadian Nat.*, vol. iv., page 470). Other genera of cephalobranchiate annelids form a protecting tube or sheath of fragments of shells or grains of sand (*Terrebella, Sabella*); but our rocks have not yet offered any examples of these.

CIRRHOPODA.—The cirrhopods form a small group of marine animals, sedentary in their adult condition, and more resembling mollusks at first sight than members of the articulated series. They secrete an external many-valved shell, and possess a number of delicate plume-like cirrhi, or so-called "arms," capable of protrusion beyond the shell, and of thus creating currents in the water, by which food is brought within the creature's reach. There are two more or less distinct types: *pedunculated* and *sessile* cirrhopods. In the former, to which the well-known barnacles belong, the animal is attached, head downwards, to ships' bottoms, pieces of floating timber, &c., by a kind of semi-corneous stem; whilst in the latter, typified by the *balanus* or "sea acorn," the shell is fixed directly by its base to rocks and other sub-marine bodies, or to such as lie between the tide-marks.* Fig. 136 represents a group of several *balani*, to shew the general form of the shell. Fragments of one or two species occur in our Post-Tertiary or comparatively modern deposits, at Beauport and elsewhere in Eastern Canada (see PART V.); but no cirrhopods are met with in our lower rocks. The *balanidæ*, indeed, appear to date only from the Tertiary age, although the *anatifidæ* or pedunculated forms exhibit representatives as low down as the Jurassic series, and perhaps in still older deposits.

Fig. 136.

CRUSTACEA.—This important class, abundant at the present time in genera and species, is sub-divided into a considerable number of Orders; but, of these, two only, embracing the *Cyproids* and the *Trilobites*, present examples of common occurrence in Canadian rocks. The higher and more typical forms of the crustaceans—the *Decapods*—comprising the various lobsters, crabs, and other allied species—offer no representatives below the Carboniferous formations.

* The balani, though usually fixed to stationary bodies, are sometimes, like their cousins the barnacles, fated to a more or less migratory life. We carried off surreptitiously from a public dinner table, a short time ago, the beak or projecting part of the head-covering of a large lobster, to the extremity of which a full grown balanus was attached. The specimen may be seen, by the curious in such matters, in the Museum of the Toronto University.

Cyproids, or *Bivalve Entomostracans*.—The crustaceans of this order are more or less minute forms, partly inhabitants of the sea, or of brine solutions, and partly of fresh water. The existing marine types belong mostly to the genus *Cythera* or *Cytherina*: the others to the genus *Cypris*. In each, the form is closely alike; and in fossil species the one is scarcely to be distinguished from the other, except by its associated fossils. In living forms, the minute animal is seen to possess a delicate bivalve shell, with curious tufted feet and antennæ, which it projects beyond the shell when swimming. These little crustaceans occur in rocks of all ages, and much resemble, in the fossil state, small scattered grains or seeds (fig. 137). The shell is frequently brown and lustrous, and usually oval or semi-circular in shape. Canadian genera (Organic Remains, Decade IV.,) have been referred to *Beyrichia*, *Leperdita*, &c., but their characters are quite microscopic and more or less indistinct.

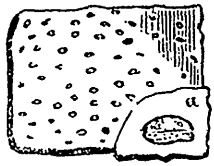


Fig. 137.
a. = Magnified Specimen.

Trilobites.—This order is entirely extinct. Its representatives—evidently marine types—are confined to the lower and middle portion of the Palæozoic series; or range, in other words, from the earliest fossiliferous rocks into the base of the great Carboniferous formation. Above the deposits of the latter geological horizon, not a trace of a trilobite has been discovered. The nearest existing type to this extinct group, appears to be the *Limulus*, or "King-crab"—a form which must be familiar to all who have visited the New England coast.

The shelly covering of the back, with a portion of that which protected the under side of the head, are the only parts of these crustaceans which have been preserved to us. The back (see fig. 138) consists of three principal parts: the *Buckler* or *Head-shield*, *H*; the *Body* or *Thorax*, *T*; and the *Pygidium* or *Caudal-shield*, *P*. The shell, moreover, in most instances, is strongly tri-lobed by two longitudinal furrows, as shewn in the figure. From this character the order derives its name.

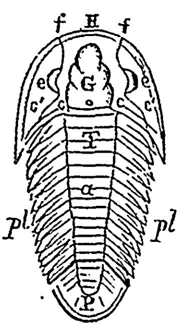


Fig. 138.

In the centre of the head-shield there is usually a distinctly raised portion (= G in fig. 138) called the *glabella*. It is bounded laterally bythe two longitudinal furrows mentioned above; and is either smooth, or variously lobed, furrowed, or granulated. In some genera it expands anteriorly, or towards the upper part; and in others it becomes contracted in this direction. The head-shield in most genera exhibits also on each side of the glabella a sutural line—called, technically, the *facial* suture—as shewn at *f f* in Fig. 138. The direction of the facial suture differs somewhat in different genera, as explained in our descriptions of these, below. In some few (as in Trinuclens) again, it is either absent, or concealed by being situated along the edge of the shield. The eyes (*e e*) when present, occur on each side of the head-shield, in the line of the facial suture, as shewn in the figure. They are compound, as in existing crustaceans, insects, &c.; and the component facets in certain genera (*Dalmannites, Phacops*) are thrown up in strong relief, forming the so-called *reticulated eye*. In other trilobites the reticulation is less distinct.* The sides of the head-shield or "cheeks," (*c c*), often separate along the facial suture, and are found detached. The shell is continued over the head-shield; and under the glabella, where the mouth was situated, a so-called *hypostoma* or *labrum* is occasionally found. This, which is also and more commonly met with in a detached state, is generally of an oval form; but in the genus *Asaphus* (see below) it is hollowed out into a fork, or is somewhat of a horseshoe shape. The hinder or lower extremities of the head-shield are rounded in some species, whilst in others they terminate in long or short horns.

The body or thorax of the trilobite is composed of a series of separate rings or segments, varying in number in different genera. Each segment is sub-divided into three parts by the two longitudinal furrows already alluded to. The middle part, or that between the furrows, is generally known as the *axis*, whilst the outside portions are called sides or *pleuræ*. These latter have their ends rounded in some species, and pointed, or even prolonged into spines, in others. In some, also, there is a raised band on each pleura, and, in others, a groove or furrow. Detached segments, or the three-curved impressions of these, shewing their trilobed character, are frequently seen in our Utica Slate and other fossiliferous rocks. The greater or less degree of mobility with which the thoracic segments were endowed,

* In the genus *Harpes*, according to Barrande, the eye is pseudo-compound, consisting of simple stomata in merely approximate union. See an article by the writer, on the classification-characters, &c., of the Trilobites, in this *Journal*, Vol. I, pp. 271-286.

permitted the trilobites to bring the under parts of the caudal and head-shields together, both for the protection of the soft or undefended parts of the body, and also, in all probability, to enable the creature to sink with greater rapidity into deeper water during moments of danger or alarm. Specimens in this "rolled up" condition are of very common occurrence (see fig. 143 *a*, and 144).

The shell covering of the *pygidium* or "tail" (*P* in fig. 138), consists of a single or entire piece: or rather, perhaps, of various consolidated segments. It is very generally met with detached from the other portions of the body. Its outline is either rounded, pointed, or digitated; and it sometimes terminates in a long spine, or exhibits several spinous processes. In some genera it is very small, whilst in others it equals the head-shield in size.

The more important genera and species of Trilobites, occurring in Canadian rocks, are enumerated below:

Trinucleus.—Head-shield surrounded by a perforated border; glabella, globose and strongly pronounced; eyes, wanting. Six body-rings. Caudal-shield of moderate size. *T. concentricus* (fig. 139), of the Trenton and Hudson River Groups, is our only species; but examples of this (in a more or less fragmentary state) are common. When perfect, the corners of the head-shield terminate in horns, and a spine projects backwards from the base of the glabella. Average length one to two inches.

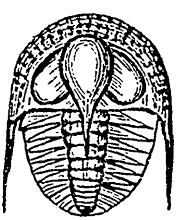
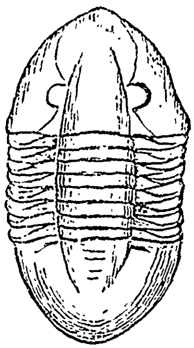


Fig. 139.

Asaphus.—Head, thorax, and pygidium, of about equal size. Glabella smooth or slightly furrowed, and not much raised. Eyes tolerably near together. Hypostoma forked. Body-rings, eight in number. Our two most common species comprise *A. platycephalus*, formerly called *Isoteles gigas* (fig. 140), with rounded head-angles and nearly smooth pygidium, chiefly from the Trenton Group; and *A. Canadensis* (Fig. 141), with head-angles terminating in points, and with furrowed pygidium, from the Utica Slate deposits. Fragments of this latter form, and sometimes entire specimens, occur in great abundance at Collingwood and at Whitby (see *Canadian Journal* Vol. III., p. 230). The forked hypostoma is shewn at *a* in the above figures. Another species, *A. megistos*, with smooth pygidium and horned head-shield, is also common in the Trenton Limestone of Cobourg, C.W. The genus *asaphus*, both on this Continent and in



a.

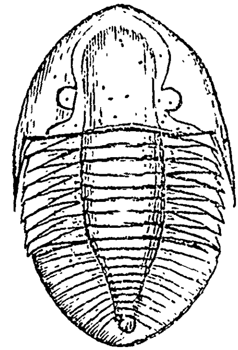


Fig. 140.

Fig. 141.

Europe, does not pass out of the Lower Silurian series. Examples vary in length from less than an inch to over eighteen or twenty inches.

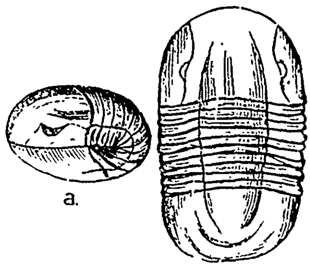
Ogygia:—This genus resembles *Asaphus* in its general aspect, number of body-rings, &c., but possesses an *oval* in place of a *forked* hypostoma. It is often impossible to decide, consequently, as to which genus fragmentary examples should be referred. Under *Ogygia*, the *Dikelocephalus* of Dale Owen, and the *Bathyurus* of Billings, should probably be placed. Several species of these, although in a more or less imperfect condition, have been found in the Quebec group (see PART V.) of Point Levi, and also, as regards *Bathyurus*, in the corresponding Calciferous Sand Rock of the Mingan Islands, as well as in the Chazy Limestone of Grenville, &c. The body-rings in the latter type are perhaps nine in number, but few specimens, in which they are complete, have as yet been met with. Fig. 142 represents a fragmentary example of *B. Angelini*, after a figure by Mr. Billings, from the Chazy limestone. A portion of the head-shield of *B. Saffordi*, copied also from Billings, is shewn at *a*. In *Dikelocephalus*, the pygidium has often a deeply serrated or spinose margin; but it may be

a.

Fig. 142.

questioned whether all the separated caudal-shields referred to that type, really belong to it.* The species are restricted, as far as present observation goes, to the lowest fossiliferous zone.

Illænus:—In this well-characterized genus, the shell-covering is more or less smooth and comparatively free from furrows. Head, thorax, and pygidium are in most specimens nearly equal in size. Glabella broad, but feebly raised or otherwise defined. Eyes far apart. Body-rings generally ten (rarely eight or nine) in number. Pygidium almost or quite smooth, with even, rounded outline. The genus belongs to both the Lower and Middle Silurian deposits, but is chiefly found in the middle and higher parts of the lower series. Fig. 143 represents one of our most common species, from the Trenton and Hudson River groups. It is usually referred to *Illænus crassicauda*. A "rolled-up" example is shewn at *a*.



a.

Fig. 143.

Phacops:—Glabella largely developed, expanded anteriorly, and often granulated but not lobed. Facial-suture cutting the sides of the head-shield. Eyes strongly reticulated. Head-angles and pleuræ with rounded ends. Body-rings eleven in number. Pygidium with rounded or entire outline. Range of genus, Lower Silurian to Devonian. *Phacops bufo* (fig. 144) from the Devonian beds of Western Canada, is one of our most characteristic and and best known species.

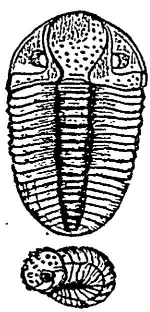


Fig. 144.

Dalmannites:—Like *Phacops*, but with lobed glabella, head-angles extended into horns, and pointed or spinose pleuræ. Pygidium also with more or less spinose margin, or otherwise terminating in a point or spine. Fig. 145 represents *Dalmannites limulurus* from the Niagara group. The caudal spine, in many specimens, is broken off.

* The caudal-shield referred to *Dikelocephalus magnificus* (*Can. Nat.*, Vol. V., p. 307) appears to have equal if not greater claims to be placed under *Ceraurus*.

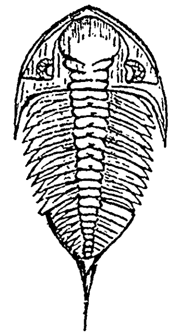


Fig. 145.

The reader will find descriptions of various fragmentary species in papers by Mr. Billings in the fourth and fifth volumes of the *Canadian Naturalist*. He is referred also to that publication for figures of less known or uncertain species of *Illænus* and other forms of this order.

Ceraurus.—This genus is the *Cheirurus* of European authors. It is more or less closely allied to Dalmannites, but the eyes exhibit only a delicate reticulation, and the pleuræ have a raised band on the surface, in place of a groove as in the latter type. The glabella is large, and furrowed at the sides. The facial suture cuts the side of the head-shield. The angles of the head terminate in points or horns. The pleuræ are also pointed; and the caudal shield has a spinose or serrated outline, or otherwise terminates in one or several horns. Body-rings eleven in number. The genus ranges from Lower Silurian into Devonian beds. A common species from the Trenton Group, *Ceraurus pleurexanthemuus*, is shewn in fig. 146. Impressions of the glabella, and of the two-horned pygidium, are especially abundant.

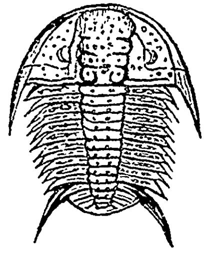


Fig. 146.

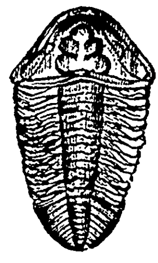


Fig. 147.

Calymene.—The glabella of this genus is prominently developed, lobed, and contracted anteriorly. The head-angles are rounded, and the facial suture cuts these. The body-rings are thirteen in number: pleuræ rounded. Pygidium with entire outline. Our most common species is the widely distributed *C. Blumenbachii* (fig. 147). This species ranges from the Trenton Group into the Middle Silurian deposits. It is very frequently found in a "rolled up" condition.

Homalonotus.—This genus has the same number of body-rings as *Calymene*, and the general shape, direction of the facial suture, &c., is also the same. The glabella, however, although contracted anteriorly, is without lobes, and the two longitudinally furrows, which impart a three-lobed character to the trilobites generally, are here but feebly developed. A common species of the Niagara Group, *H. delphinocephalus* is represented in Fig. 148.

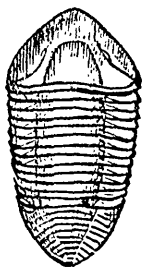


Fig. 148.

Triarthrus.—This genus is also somewhat allied to *Calymene*, but the body-rings are fourteen, or from fourteen to sixteen, in number, and the head-shield and pleuræ, in some species, terminate in points. The glabella is nearly straight at the sides, not much raised, and marked on each side by three short furrows. *T. Beckii*, (fig. 149) of our Utica Schist formation, is the best known species. Impressions of the glabella of this form occur abundantly in the shale beds near Collingwood, and also in the neighbourhood of Whitby, C. W. In *T. Beckii*, each segment of the thorax bears in the centre a short spine. In another species, made known by Mr. Billings under the name of *T. spinosus*, a long spine descends from the neck furrow of the glabella, and another from the eigĥth body-segment. A third species, *T. glaber* (Billings), is destitute of spines. The two latter forms occur in the Utica Slate of Lake St. John, north of Quebec.

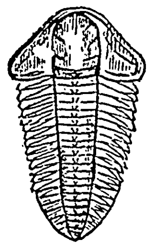


Fig. 149.

Conocephalites.—In this genus, the gabella, though convex, is very short, and the body-rings are fourteen or fifteen in number. Its species are characteristic of the lowest fossiliferous deposits, and are mostly of very small size. The head-shield of *C. Zenkeri*, after Billings, is figured in wood-cut 150 (*Can. Nat.*, vol. v., p. 205). It occurs in the Quebec Group of Point Levi.

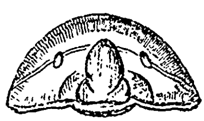


Fig. 150.

Paradoxides.—Head-shield terminating posteriorly in horns; glabella well developed; body-rings over fifteen in number; pleuræ pointed, the second or third pair often longer than the others; caudal-shield, very small. This genus is also characteristic of the lowest zones of fossiliferous strata. Some more or less obscure species, first found in Vermont, have lately been discovered in the Quebec Group of Anse au Loup, on the north shore of the Straits of Belle Isle.

Vertebrated Animals.—Remains of vertebrated forms are of rare occurrence in Canadian rocks. Our Silurian strata are entirely destitute of any signs of these remains, and traces only have as yet been discovered in our Devonian beds. These consist of fish scales and impressions (North Cayuga; St. Marys; Malden; Kettle Point; Bear Creek). In the higher Drift accumulations, the bones and teeth of the Mastodon and Mammoth, the latter an extinct species of elephant (*Elephas primigenius*), are occasionally found; and in these and more recent deposits, the remains of existing forms, such as those of the capelin (*Mallotus villosus*), the lump-sucker (*Cyclostomus lumpus*), the northern seal (*Phoca Grœnlandica*), the Canadian beaver, Wapiti, &c., have also been discovered. No marine forms, however, have been found in these deposits west of Kingston, as explained more fully, in our remarks on the Drift and succeeding period, in the next division of our subject.

NOTE ON GULDIN'S PROPERTIES.

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It is well known that Pappus, the Greek geometer who flourished toward the end of the fourth century of our era, is the author of the remarkable propositions which are generally called "Guldin's Properties of the Centre of Gravity." They occur, without demonstration, at the end of the preface to the seventh book of his *Collections*, and were first printed in the Latin translation by Commandine in 1588. Guldin, in his work published 1635–42, gave the statement of them in the same form with numerous applications, but still without demonstration; and having in this work attacked Cavalleri's method of indivisibles, Cavalleri in reply not only refuted Guldin's attack but employed his method to furnish the demonstration of these theorems, which Guldin had not been able to obtain. The "centre of gravity" referred to in these theorems is the geometrical centre of mean position, as the theorems do not depend on any mechanical principles but are purely geometrical in their nature, and are simple applications of the integral calculus. The usual statement of the first of these "Guldin's Properties" is as follows:

"If a plane area revolve about an axis in its own plane, the volume generated is equal to the product of the area and the length of the path of its centre of gravity."

This statement, however, ought to be limited to the cases where the area lies wholly on one side of the axis, as otherwise the product spoken of is equal not to the whole volume but to the difference of the volumes generated by the parts lying on opposite sides of the axis. This extension is sometimes useful, as, for instance, in the investigation of the metacentre of a floating body. Here, if the displacement be made round the axis passing through the centre of gravity of the plane of floatation, it follows at once that the wedges generated on opposite sides of this axis are equal, and the whole volume displaced therefore remains the same; or, conversely, if the displacement be made so that the volume displaced remains the same, and the wedges on either side of the line of displacement are therefore equal, it follows that this line passes through the centre of gravity of the plane of floatation. This also gives at once the solution of a problem set in the Senate House, 1848: "A plane moves so as always to enclose between itself and a given surface S, a constant volume. Prove that the envelope of the system of such planes is the same as the locus of the centres of gravity of the portions of the planes comprised within S."

If we suppose the axis of revolution in the statement to remove to an infinite distance, we have the case of a plane area moving parallel to itself, while its centre of gravity moves in a straight line perpendicular to the plane of the area, and Guldin's property holds not only with regard to the centre of gravity but also to *every* point of the area. A similar extension applies to the following:

"If a plane area move parallel to itself, its centre of gravity moving in a curve, the plane of which is perpendicular to that of the area, the volume generated is equal to the product of the area and the projection of the path of the centre of gravity on a plane which is at right angles both to the plane of the area and of the path, the projection being always in the same sense."

Another theorem suggested by the above is this:

"If the centre of gravity of a plane area move in a curve, the plane of which is perpendicular to that of the area, and the plane of the area is always inclined at the same angle to the path, the volume generated is equal to the product of the path and the projection of the area on a plane normal to the path at the point."

Another case to which the statement of Guldin's property applies is,—

"If a plane area move so that its centre of gravity describes a plane curve, to which the plane of the area is always normal, the volume generated is equal to the product of the area and the path."

The area in this case must be limited to lie wholly on one side of the evolute of the path at each point.

Another extension is the following:

"If a plane area revolve about an axis parallel to its plane, the volume generated is equal to the product of the path of its centre of gravity, and the projection of the area on a plane passing through the axis and the centre of gravity."

Here also the limitation exists, that the area must lie wholly on one side of the plane drawn through the axis at right angles to the plane of the area.

Similar extensions exist, *mutatis mutandis*, to the second of Guldin's properties. I am not aware that any of the preceding have been previously noticed.

TRANSLATIONS AND SELECTED ARTICLES.

ON THE ORIGIN OF HAIL.

An exceedingly elaborate and interesting article on this subject, from the pen of Frederick Mohr, has appeared in the September number of Poggendorff's Annalen, and as that periodical is not often to be met with in this country, an abstract of the treatise may not be without interest to the readers of the *Canadian Journal.*

The fall from the heavens of masses of ice, sometimes nearly a pound in weight, in hot climates and in the warmest seasons, naturally excited attention from a very early period, and manifold have been the endeavours to account for the phenomenon. The theories proposed however have all proved insufficient, being generally based on a fallacy, and at the present time physicists are generally content to rank the cause of hail as one of the things unknown. Whether Mohr's ingenious explanations may be admitted as satisfactory, is open to question. The writer cannot but believe that the whole theory, beautiful as it is many respects, and offering a satisfactory explanation of many collateral phenomena, is yet open to the same objection as the others, viz., that it is based on a fallacy.

The first theory proposed was that of Volta. He imagined that the sun's rays were entirely absorbed by the upper surface of a dense cloud, thereby causing a rapid evaporation, particularly if the upper stratum of air were dry; by the evaporation so much heat became absorbed or removed that the water contained in the cloud became ice. Here the heat of the sun is supposed to cause evaporation, and simultaneously to remove heat from the aqueous vapour in the cloud, which is obviously absurd. The increase in the size of the hail-stones, was explained by Volta on the supposition that the stones were projected upwards and downwards between two oppositely electrified masses of clouds, like the pith figures in a common electrical experiment, (the noise preceding a fall of hail has also been explained by the rubbing together of the hail-stones during this supposed attraction and repulsion,) but it is difficult to imagine how such heavy masses could be so kept in motion. Whether it be possible or not, if the first part of the explanation is wrong, the second falls to the ground.

In the theory of F. Vogel, it is assumed that the aqueous vapour which is supposed to exist in the clouds, in a vesicular form, can be cooled far below the freezing point without becoming ice, and that when particles of sleet (which are usually observed in the interior of hail-stones) fall from the higher regions of the atmosphere, the aqueous vapour is deposited on them and becomes ice. In this theory the increase of the hail-stone is accounted for, but not the original formation.

Leopold von Buch assumes that a mass of damp air being carried by the ascending current into the upper regions, deposits drops of water which in their descent through the lower and warmer strata evaporate, freeze, and cause a further deposition of water on their surface, which is continuously converted into ice. The same objections, but in a greater degree, apply to this theory as to that of Volta. Water falling from the upper regions, and passing into warmer and moister strata, cannot possibly evaporate so rapidly as to freeze.

"As long as it was believed that dew produced cold, the phenomenon remained inexplicable. Wells inverted the axiom and the problem was solved."—*Dove's Meteorology*.

Mohr does not attempt to account for the production of cold, but assumes it as existing, viz., in the upper regions of the atmosphere. Barral and Bixio found a gradual diminution of temperature up to 21,060 feet, at which elevation the thermometer indicated 39 below zero. (Very recently Glaisher has observed the same, but the change of temperature was not by any means uniform or in one direction.)

In a state of repose the lower strata of air will always be the warmer, heavier, and more saturated with moisture, while the higher strata will be the colder, lighter, and drier. A mixture of two strata may cause the temperature to sink below the dew point, thus causing a deposition of water, and herein, according to Mohr, lies the cause of a much more important disturbance.

(Mohr then proceeds to account for the formation of an enormous vacuum by the sudden conversion of vapour into water; but while it is quite true that a vacuum is produced by the condensation of steam, it seems somewhat doubtful whether the enormous vacuum required by the theory, can be produced by the condensation of the vapour of water contained in air, the volume of which does not depend on the amount of moisture; hence the translator prefers to give the German philosopher's explanation in his own words.)

"A volume of water when converted into vapour at a temperature of 100° C and 760 m m pressure, acquires a volume about 1700 times greater. At lower temperatures the increase is still greater, at 0° 182,323, and at 20° 58224. Aqueous vapour expands according to Mariotte's law under diminished pressure, but under increased pressure a portion of water is formed and the density remains the same. At a height where the stand of the barometer is only 380 m m, *i.e.*, about 18500 feet, aqueous vapour must have double the expansion above mentioned, viz., 3400 at 100°, at 0°

364646 and at 20° 116448. Hence during the condensation of the vapour, an enormous diminution of volume must take place. The vacuum so formed can only be filled from the sides and from above, the colder upper air rushing into the partial vacuum causing still further condensation of water and diminution of volume, and is thus in its turn the cause of the attraction of higher and colder masses of air. In proportion to the rapidity of the condensation of the vapour by the descending current, the superior vertical layers must rush in to fill up the void, and the surrounding horizontal layer will have less time to enter. The less dense masses of air in their descent alter their volume according to Mariotte's law, and this is a second cause of the disturbance of equilibrium, as every mass of air undergoes a great change of volume by a simple change of vertical position.

Hence the mass of air set in motion over the place of condensation, will be in the form of a funnel, and will be larger than the vacuum it is destined to fill in the lower strata. A certain amount of heat will be given out by the compression of the descending air and by the deposition of water, but this will be small in comparison with the cold of the upper strata, the hail will not be quite as cold as the air which forms it.

The formation of hail must commence with that of water, cold air is drawn in from above and the drops of water become frozen, if air from a great height be brought down into the partial vacuum, the masses of ice may be cooled many degrees below 0°, and hence in their descent will cause the general deposition and solidification of water on their surfaces. When an irruption of very cold air takes place, not only may single drops freeze into solid ice but many may join together and form larger masses. The vapour of water is cooled down to the freezing temperature by the descending current, while a solid body (the hail-stone) is present to induce a deposition on its surface. The same cause which produces the hail-stone, is active in forming those depositions of ice on the branches of trees, which are not unfrequently seen during the winter season. It is possible also that the noise which is occasionally heard preceding a hail-storm, may arise from the particles of ice being driven against each other by the rapidly descending masses of air.

Hail can only be formed when so considerable a diminution of volume takes place, that the heavier lateral masses of air have not time to enter, but the lighter vertical portions are alone or principally absorbed. Only in this case is the cold sufficient to form ice. In the hail-cloud we may assume a funnel-shaped vortex (strudel) of ice-cold air, with frozen and liquid water, which descends spirally towards the earth. If this be true, a hail-storm should only be of limited extent, which is well known to be the fact. When the condensation takes place over a large area, the latent heat of the condensing vapour is sufficient to prevent the formation of ice, and an ordinary rain storm results, hail is only formed when the colder air is rapidly drawn into a narrow space.

According to this theory a hail-storm cannot stand still, or continue over one spot for any length of time; it must stop when the lower strata are cooled. But as it progresses in any direction it meets with fresh materials for its reproduction. If we imagine a *hail-funnel* moving onward, its path will be in the shape of a long narrow cleft in the atmosphere, and it is easy to conceive how the force of the hail-storm may continue the same or may even increase, as was the case with the notorious hail-shower which passed through France and Holland in 1788.

Hail belongs essentially to temperate climates, it is not observed in the tropics or in high northern latitudes. In the latter the air is cold and dry, no considerable vacuum can be formed, and hence no sudden entry of cold air. The most severe hail-storms occur in Sicily, the south of France, and the coasts of the Mediterranean. (Very enormous single hail-stones have also been observed in the middle States of the Union.) In the tropics the lower strata of air are so hot that when a commingling of two masses takes place, the latent heat of the condensing vapour is so great as to prevent the formation of ice, and even to cause the descending rain to possess a remarkably high temperature.

Hail is observed more frequently after mid-day than before, oftener by day than by night, because the lower atmosphere is then warmer and moister.

According to this theory we should imagine that windy weather would be unfavourable to the formation of hail, and that any disturbance occurring on still sultry weather would tend to its formation. This is found to be the case.

Hail indicates a storm or tempest, (Gewitter,) but a storm need not be accompanied by hail, the latter is only a phase of the phenomenon, depending on peculiar circumstances. A storm may be formed in the immediate neighbourhood, or may approach from a distance; the latter kind is most violent, as the vacuum has been prolonged to the surface of the earth through the warmest and moistest strata, while in the former it has been only partially produced in the upper and drier regions.

When the atmosphere is strongly warmed and laden with moisture, after a continuance of sultry weather, the first indication of the formation of a storm appears as a veil (flor) overspreading a portion of the heavens, and in which, after a time, darker spots are formed assuming the appearance of clouds. Gradually the dark-grey or black colour of the cloud increases, shewing the great elevation at which the condensation is being effected. A flash of lightning passes through the darkening mass, and streaks of rain are almost immediately perceptible. Now the storm begins to move, and takes a certain direction quite independent of the wind. The rain as it falls to the ground, is accompanied by a strong current of descending air, which is clearly shown by the bending down of the flexible branches of poplars, by the flattened appearance of well foliaged fruit trees, and by the whirling rise of leaves and dust from the surface of the ground. A sultry calm precedes the storm, while immediately after its passage a similar stillness ordinarily prevails. The tempest cannot have been brought by the wind, but must have brought or produced it. The condensation of water, sufficiently rapid to produce a tempest, can only take place in still weather, during prevalence of wind only general showers can be formed. While the storm is gathering the motion is only in the clouds, it is brought into the lower regions by the descent of the rain. Most storms occur in the afternoon, when the sun is in the south or south-west, hence the shadow of the cloud falls north or north-east. The shadow thus formed has a cooling and hence condensing effect on that side, and therefore produces a tendency in the storm to move in that direction, when the rain falls this is enormously increased, and thus the path of the tempest is established without reference to the direction of the wind, if there be any. Various slight circumstances may affect the initial direction, and it is not uncommon to see storms crossing each other at right angles."

Mohr assumes that the electrical phenomena usually accompanying a storm, are caused by the friction of the particles of water against each other, such friction being produced by the rapidly entering masses of air. The motion visible in the clouds is not an effect of the electricity, but rather the cause. The rain is often seen to fall heavily after each flash of lightning, which is explained by supposing the rapid entrance of a cold mass of air, the deposition of water and friction of the particles, thus causing evolution of electricity, visible in the flash a considerable time before the consequent thunder is heard, and long before the rain can fall.

Electrical storms are well known to be more dangerous in winter and spring than in summer, which may be explained by the fact that the quantity of vapourised water is small on the whole in winter, and only considerable near the surface of the earth. Hence condensation and production of a vacuum can only take place here, and hence the ease with which the electricity may pass from the cloud to the earth.

The cooling effect of a storm is explained by the mingling of the colder upper air with the warmer on the surface. When this cooling is considerable, another storm may not be expected, inasmuch as a greater uniformity has been produced in the atmosphere. Another storm will only occur after a continuance of heat. If no cooling effect is observed, it is probable that another storm will occur shortly.

Mohr thus attempts to explain the fluctuations of the barometer by the condensation of water, and as this explanation seems open to question, the passage is given in his own words:—

"A balloon floating over my barometer presses on it as if it were filled with air of the same density as that which surrounds it. A drop of water floating over the barometer presses on it with the same force as an equally small volume of air. When water passes from the state of vapour to that of liquid, it loses almost entirely its action on the barometer. Hence every condensation must cause a lightening of the barometer, the mercury must fall, and not only in the immediate vicinity of the storm but also at a distance, inasmuch as masses of air are drawn away to fill up the vacuum formed at the spot where the storm is raging."

H. C.

ON THE COLOUR OF WATER.

BY W. BEETZ.*

It is only in recent times that explanations based upon actual experiments have been given of the colour of water in the sea, in lakes, and in rivers; it was previously thought sufficient to conceal the entire ignorance of a daily-observed phenomenon by hypothesis. Bunsen was the first to state, and establish experimentally, the simple proposition that "chemically pure water is not, as commonly assumed, colourless, but naturally possesses a blue colour." He observed this coloration on looking at a piece of white porcelain through a column of water two yards long. He explained the brown to black coloration of many waters, especially of North German inland lakes, as arising from an admixture of humus; the green colour of the Swiss lakes, and, still more so, the siliceous springs of Iceland, as arising from the colour of the yellowish base, and of the siliceous sinter surrounding the springs, and which is caused by traces of hydrated oxide of iron. Wittstein, by careful chemical investigations, has quite recently shown that the green colour also derives its origin from organic admixtures. According to him, the less organic substance a water contains, the less does its colour differ from blue. With the increase of organic substances, the blue gradually passes into green, and from this, as the blue is more and more displaced, into brown. Water is softer the nearer it is to brown, and harder the nearer it is to blue; this does not arise from a greater or less quantity of organic substance, but of alkali, on which, again, the proportion of dissolved organic substance depends. This alkali dissolves the organic substance in the form of humic acid If a water does not contain much humic acid, this is not caused by a want of humic acid in the ground, but by the fact that this ground did not give to the water an adequate quantity of alkaline solvent material.

From these results we may consider the question settled as to why, on chemical principles, some waters are blue, others green, and others brown. I may be permitted to make a few remarks on some physical phenomena which have been observed on coloured waters.

Formerly water was almost universally classed among those bodies which have a different colour in transmitted, to that which they have in

* From the *Phil. Mag.* for September, 1862.

reflected light. Newton says, "water reflects the violet, blue, and green rays, but readily transmits the red." Count Xavier de Maistre considers the colour of water to be blue in reflected, and yellowish orange in transmitted light. Arago, that it is blue in reflected, and green in transmitted light. The view that the blue of water only occurs in reflected light is common to all three statements.

In the experiments which Bunsen made to ascertain the colour of distilled water, transmitted light was alone concerned, and yet he found the colour blue. In order to look through still longer columns of water I used the following apparatus:—A box, the bottom and and sides of which are made of plates of gutta percha, is closed at both ends by parallel plates of very white thin glass. Directly inside these, two similar glass plates are fixed, which are covered with a silver reflecting surface, by Liebig's method. A narrow slit is scratched in the covering at *d* and *d'*. If a pencil of direct sunlight is projected upon slit *d*, this will be reflected several times backward and forward between the two mirrors; if the box is filled with a liquid, the light is compelled to traverse this liquid repeatedly, and it is easy to increase or diminish the length of the layer to be traversed, by altering the angle of incidence. This experiment may be made either objectively or subjectively. If the pencil is allowed to fall into the slit *d*, so that after a certain even number of reflexions it falls directly upon the slit *d'*, it can be caught upon a screen after its emergence. The number of reflexions may be altered by gradually rotating the box. But if the observer uses the illuminated slit *d* as a self-luminous object, and looks through *d'* into the box, he sees, close to one another, a series of narrow subjective pictures of the slit; they are gradually smaller and nearer each other, and correspond to the different numbers of reflexions. In making some experiments, I had, at first, so placed the mirrors that the uncovered glass surfaces were opposite each other. The light must then, at each reflexion, pass twice through the glass plates themselves. If the box contained no liquid, then the image appeared almost white after six to eight reflexions; but still, on comparing the subjective images with one another, it could be seen that each following one had a somewhat yellowish tint. I supposed that this coloration was to be ascribed to the tolerably thick layer of glass which the light had to traverse, and therefore turned the mirrors, which were once more polished on the silvered side. Yet even in this case each following image showed a yellower colour, though in a less degree. The colour must therefore be ascribed to the special colour of the silver, from which part of the light is reflected diffusely. Yet when the polish is good, it is so unimportant that it does not disturb further observation.

If the box is half filled with distilled water and the entire slit *d* illuminated, the lower part of the picture on the receiving plate is seen to be blue, while the upper part remains white. Looking through the slit *d'* at the upper part of the box, the entire range of more and more yellowish pictures is seen; looking through the lower part, each following picture appears of a darker blue, with a very feeble tinge of green. The phenomenon is just the same when water from the deep blue Achensee is poured into the vessel; if this is replaced by water from the Tegernsee, after a few reflexions the images appear of an intense yellowish green (not bluish green), although my box was only 10 inches long, If garden earth is drenched with water, which is allowed to drain off, and this is filtered and mixed, first in small and then in larger quantities, with distilled water, the colour of the images passes first into yellowish green and then steadily into a brown colour, just as was to be expected from Wittstein's experiments. The colours in question in these experiments are also those in transmitted light.

What, then, are the phenomena which have evoked the idea of the dual colour of water?

Newton based his view upon an experiment of Halley. As the latter, on a sunny day, had descended in a diving-bell to a great depth in the water, the upper surface of his hand, which was directly illuminated through the sea-water and through a window in the bell, appeared of a rose-red, but the water below him and the under surface of his hand, which was illuminated by the rays reflected from the lower water, was green. The experiment is manifestly erroneously interpreted. The rays which came from below are clearly not reflected by the water, but transmitted; they are reflected indeed from foreign substances in the water, especially from the sea-bottom. The further distant this is, that is, the deeper the sea at the given place, the deeper will be the colour of the water—deep green when the water has a green, deep blue when it is blue (in transmitted light.) The rays which fell from above into the bell must also show the color of water, but to a much smaller extent, because the layer of water which they traverse is, in any case, much less thick than that which the rays coming from below have traversed. Thus the upper rays brought comparatively more white light than the lower ones; and hence the upper surface of the hand had the complementary colour, that is, rose-red, for the same reason for which, in the blue grotto at Capri, the contrast colour, orange, occurs.

Arago adduces no experiment in support of his view; he only proposes to make one, to which reference will afterwards be made. He introduces his view with the words "the reflected colour of water is blue, the transmitted, as some think, green;" and upon this supposition he bases the explanation of some phenomena. He shows, in particular, why the waves of the blue sea are green. He considers them as water prisms, on one surface of which the white daylight is reflected, sent through the following wave, and thereby made green. But it is easy to see that in the green waves, as well as in the large blue mass of water, it is only a question of transmitted light. On looking at the mirror-like surface of the Achensee in a perfect calm, the colour is seen to change from a deep blue in the middle to a bright green, and thence into a yellowish red. This water, which contains very small quantities of humus salts, colours the light greenish when it only passes through thin layers, and blue when it passes through thicker. This phenomenon has many analogies. Newton says, it must be noticed that in coloured liquids the the colour alters with the thickness. For instance, a red liquid in a conical glass held between the light and the eye appears pale yellow near the bottom, where it is thinnest; somewhat higher, where it is thicker, of a golden yellow; where it is still thicker, red; and where it is thickest, dark red. Hence it must be assumed that such a liquid absorbs the violet and indigo rays very readily, the blue rays with greater difficulty, the green ones with still greater difficulty, and the red ones least of all.

This is just the case with bluish-green sea-water. It absorbs the red rays very easily, the green ones with more difficulty, and the blue ones least of all. Hence when white daylight passes to the bottom through a thin layer of this water, and reflected from this returns to the air, it is feebly green. If on both courses it has traversed great distances, it is blue. It also appears green when it has passed through the moderately thin section of a wave (which it may indeed have reached by reflexion from another wave.)

I spoke just now of the reddish-yellow colour in the almost dry places which has been noticed by so many observers. This colour depends entirely on the nature of the ground. Most frequently it consists of whitish sand, or whitish pebbles. If these were absolutely white, if they reflected colours in a diffused manner to the same extent, the reddish colour would not occur. A new porous clay-cell of a Grove's battery may appear quite white, while, when it is moistened with water, it is of a rusty yellow or flesh-red colour. Hence its surface acquires the property of reflecting red light to a preponderating extent. If, now, the substances which constitute the sea-bottom have the same property, the bottom will appear red in those parts in which it is covered with quite thin layers of water. If the thickness of the layer of water increases, fewer red rays reach the bottom; the returning rays are again partially absorbed by the water, and thus the red colour is continually disappearing, although the forms of substances lying on the ground can always be distinctly perceived.

Moreover, this red colour is much increased by contrast. In the dry places of the Aar I have often observed that the bright red, which they show, diminishes considerably when they are viewed, not near the beautiful green of the deeper water, but through an isolated tube.

There might seem to be a fact in discordance with the statement, that sea-water in thin layers is green, and blue in thicker; a white object, for instance an oar, appears of a distinctly pure blue when immersed at even a very inconsiderable depth below the level of the Achensee, while it is of an intense green below the Tegern-or Königsee. The light which impinges upon the white surface of the oar, has had to traverse a much more considerable distance than that from the surface of the water; it comes from the side through a considerable mass of water, in which it has assumed the characteristic colour of the lake. But if the same white surface is brought near the bank and turned towards it, and is at the same depth as in the former case, it is seen in the Achensee to be of an almost unaltered white, while in the Tegernsee it is always somewhat greenish; for the colour of the blue water is only perceptible at great distances, that of the green at very small ones.

This surprising strong coloration in consequence of laterally incident light, led me to the proposal which Arago has made, to investigate the true colour of water in transmitted light.

A hollow prism made of glass plates is so brought under water that the horizontal light from the surface is totally reflected from the hypothenuse. Instead of this apparatus, Poggendorff proposed a glass mirror inclined at 45° to the horizon. I happened to have occasion to make a corresponding experiment; I wanted to fill a tinplate tube, which was closed at the ends with glass plates and had a hole in the side, by placing it in a very inclined position, quite under the sea level. When the upper glass plate had the right inclination, in the Tegernsee it reflected in sunny weather an emerald-green light more intense than I have obtained in any other way; in the Achensee, however, a blue light, as if it had passed through concentrated solution of sulphate of copper. Hence Arago's proposal is appropriate; and if he had had an opportunity of carrying it out, he would certainly have given up the notion that water shows different colours in reflected and in transmitted light.

The colour of water alters naturally, when solid particles are suspended in it. By mixing such bodies which, like the above-mentioned constituents of the ground, reflect red light in preference when they are moistened, it may yet appear red; by greater masses of whitish sand which have become heaped up in the lakes during a continuous storm, or which the rivers have worn down from their beds, the water appears clearer than otherwise. Simony observes that the Wolfang and Attersee appear in winter, when they are clearest, of a dark green, but in summer bluish-green or cerulean blue, and he considers this colour as occasioned more especially by the marl and grey sandstone predominant in the débris.

In the previous considerations, the influence of the colour of the sky and of the surrounding neighbourhood has been disregarded. Yet there are many who seek the cause of the colour of water in these circumstances. But these secondary influences must be taken into account along with the chief cause. When the surface of the lake is quite clear, it acts as a mirror. The special phenomena of colour are the more concealed, the more regular reflected light reaches the eye from the place in question; they appear purest where no or but little light is regularly reflected, for example, against a dark rocky background. But if the sea is in motion, the regular reflection always diminishes, and the aspect of the surface is changed by the occurrence of waves in a very complicated manner, depending on the formation of the bank, the direction and intensity of the wind, and similar circumstances, which the mariner can recognize, and even predict from that aspect.

I permit myself a remark as to the place in which the green colour of water arises. The Tegernsee receives its water by several supplies, among which the Weissach and the Rottach are the most considerable. After lengthened dry weather, the bed of the Weissach is quite empty; the pebbles which cover the bottom are quite dry, and almost white. After a time of such weather, I went up the course of the Weissach in order to observe the first water which moistened the ground. This water could have no other origin than the atmosphere. Yet the first quantity, which was sufficient to look through in bending over the bed, immediately appeared green. Hence the humic acid salts must have been already formed in the bed of the river, and are only dissolved by the water; it is not necessary to assume that the springs which fed the rivers must bring an alkaline solution which shall afterwards dissolve the humic acid.

Water, of atmospheric origin, in its purest condition of ice and snow is also blue. The glaciers of the Alps and of Iceland also show this colour when the adjacent waters, which in part arise from the glacier streams, are green. H. and A. von Schlagintweit estimate the colour of glacier-ice in the crevices as being equal to the mixed colour shown by a colour circle on which 74·9 parts of white, 24·3 of cobalt blue, and 0·8 part of green were painted. Osann saw that the light in a hole in the mountain snow about two feet deep was blue, and believed that this colour was due to the blue colour of the air, which has a deeper blue in the upper than in the under layers, and he therefore thinks that the blue colour of glacier-ice is heightened by that of the air in those higher regions. But the experiment on which he depends succeeds with freshly fallen snow on the plain as well as above the snow-line. The other colour depends on the colour of the small crystals of ice which the light repeatedly reflected backwards and forwards in such a small hole must traverse. Green ice can only be caused by the freezing of green lakes and rivers; the atmospheric fall, and the compression of the high snow can only give rise to the formation of blue ice.

Erlangen, December, 1861.

REVIEWS.

A Manual of Geology, treating of the Principles of the Science, with Special Reference to American Geological History. By James D. Dana, M.A., LL.D. Philadelphia: Theodore Bliss & Co. 1863.

The appearance of this much desired volume is gratifying, in more respects than one, to those interested in the progress of Natural Science. Not only does the work supply, and supply thoroughly, a long-felt want; but its publication may be looked upon, we hope, as strong presumptive evidence that the serious and protracted illness of Professor Dana, by which the issue of the work was for some time retarded, has now happily passed away. Until the appearance of this treatise, we had no work at all approaching to a complete or exhaustive character, on American geology. Popular compilations, and some of undoubted merit, like the Manual of Professor Hitchcock for example, have, it is true, appeared from time to time; but the illustrations and materials of these are largely drawn from European sources; and whilst certain departments of the subject may be fully elaborated, others are comparatively untouched, or, at least, are far from representing in a satisfactory manner the present aspect of the science In Professor Dana's Manual, these objections will be sought for in vain. The work is thoroughly American in its character, without being exclusively so; as ample reference is made to the geology and physical characteristics of the globe generally. Its pages are copiously illustrated with figures of American fossils, with maps of interesting geological regions, and with sections and views of rock structures as exhibited on this continent. As regards completeness, moreover, the work may be relied upon in all respects, as a faithful exponent of the present state of our knowledge on the subjects brought under review. In its first division, under the head of *Physiographic Geology*, we are presented with a general survey of the surface-features of the Earth, embracing the distribution of land and water, the physical characters of the great continents and oceanic basins, the more important atmospheric phenomena, and other kindred topics. The second part, entitled *Lithological Geology*, is devoted to a special consideration of the mineral constituents, varieties, structural details, &c., of rock masses, as illustrated more especially by American types. The third and principal subdivision of the volume, *Historical Geology*, contains a detailed exposition of the geological ages and epochs, from the far distant Azoic period to the present or historic time; and it exhibits in this connexion, many important generalizations respecting the life-forms, and the various climatic, geographical, and other features, of the eras thus discussed. To this succeeds a section on *Dynamical Geology*, or review of the various forces now in action in modifying the surface and general conditions of the globe.

Such is a brief synopsis of the contents of this important volume. On account of the peculiar nature of the work, its constant reference to back pages and sections, and the necessarily paragraphic form in which much of its information is laid before the reader, it is not easy to obtain an extract for quotation, more especially from the purely geological portions, in which its able character can be fairly shewn. The subjoined passages (selected partly on account of their general interest) may serve, however, to shew the uninitiated reader that a treatise on geology comprises something more than a mere dry description of barren rocks and stones:

Criteria of Rank among Animals.

(1.) Under any type, *water-species are inferior to land-species:* as the Seals to the terrestrial Carnivores; the water-articulates or Worms and Crustaceans to land-articulates or Spiders and Insects.

(2.) *Species of a tribe bearing some of the characteristics of an inferior tribe or class are inferior species, and conversely.*—Thus, Amphibians show their inferiority to True Reptiles in the young having gills like Fishes; the early Thecodont Reptiles, inferiority to the later in having biconcave vertebræ, like Fishes; the Marsupials and Edentates, inferiority to other Mammals in having the sacrum consisting of only two united vertebræ, as in most Reptiles. On the contrary, the Dinosaurs show their superiority to other Saurians in having the sacrum made of five (or six) vertebræ, as in the higher Mammals.

(3.) *As a species in development passes through successive stages of progress, relative grade in inferior species may often be determined by comparing their structures with these embryonic stages.*—As a many jointed larve without any distinction of thorax and abdomen is the young state of an Insect, therefore Myriapods or Centipedes, which have the same general form, are inferior to Insects. As a young living Gar has a vertebrated caudal lobe (making an accessory upper lobe to the tail), which it loses on becoming adult, therefore the older Ganoids with vertebrated tails (or heterocercal) are inferior to the latter in which the tails are not vertebrated (or are homocercal). As the young of a Frog (a tadpole) has the tail and form of a Salamandrian, therefore the Salamandrians are inferior to Frogs. As the number of segments in the young of Insects often exceeds much that of the adult, therefore species of adult animals in which there is an excessive number of segments (beyond the typical number) have in this a mark of inferiority; and thus the Phyllopods and Trilobites among Crustaceans bear marks of inferiority, the typical number of segments in the abdomen of a Crustacean being but seven, and in the whole body twenty-one,—each pair of members corresponding to *one*, commencing with the eyes as the anterior.

Professor Agassiz has brought out and illustrated in his writings each of the above Criteria.

(4.) *Species having the largest number of distinct segments in the posterior part of the body, or having the body posteriorly prolonged, are the inferior among those under any type.*—Shrimps and Lobsters are thus inferior to Crabs; Centipedes, to Insects; Salamandrians, or tailed Batrachians, to the Frogs or tailless Batrachians; Snakes, to Lizards; the Ganoids with vertebrated tails, to those with non-vertebrated. It does not follow on this principle that Frogs, although tailless, are superior to Lizards; for they are of different types of structure.

(5.) *Species having the anterior part of the body most compacted or condensed in arrangement, or having the largest part of the body contributing to the functions of the head-extremity, are the superior, other things being equal.*—Thus, Man stands at the head of all Vertebrates in having only the posterior limbs required for locomotion, the *anterior having higher uses;* and also in having the head most compacted in structure and brought into the least compass consistent with the amount of brain. In the same manner, the Carnivores among the large Mammals (Megasthenes) are superior to the Herbivores, the anterior limbs not having locomotion as their sole use, and the head being more compacted and condensed for the size of brain. The highest Crabs, the Triangular or Maioids, are superior in the same manner to the lower, and far more to the Lobster tribe and other Macrourans; descending in grade from the higher Crabs, the outer mouth-organs become more and more separated from the mouth, and finally, in many Macrourans, they have the form of feet, thus passing from the head-series to the foot-series. Insects are on this principle superior as a class to Crustaceans, although of so much less size.

Condensation anteriorly and abbreviation posteriorly is the law of all progress in embryonic development, and also of relative rank among species of related groups.

Relation of the History of Life to the Physical History of the Globe

1. *The plan of progress was determined with reference to the last age, with all its diversities of climate, continental surfaces and oceans, as its era of fullest exhibition.*

2. *The progress in climate and other conditions involved a concurrent progress from the inferior living species to the superior.*—The existence of a long marine era, through the Silurian and part of the Devonian ages, admitted only of the existence of marine life. Hence the dominant type of the Silurian was the Molluscan, which, with the Radiate, is eminently marine. In addition, there were marine Articulates and marine plants; and when the Vertebrates began it was with marine species, the Fishes. Thus the prevalence of waters involved inferiority of species. The increase of land, gradual purification of the atmosphere, and cooling of the globe, prepared the way for the higher species.

It is probable that the oceanic waters were also in an impure state compared with the present, from containing an excess of salts of lime; and this also involved the existing of inferior species,—such as Crinoids, Corals, and Mollusks, a very large proportion of whose weight is in calcareous material. The removal of this excess of lime from the waters produced limestone strata, purified the waters, and fitted the oceans for other species,

The great prevalence, in the Primordial, of Lingulæ (whose shells contain a large amount of phosphate of lime) is further evidence of the greater density of the waters, and seems to indicate the presence of an excess of phosphates.

3. *The progress in climate and in the condition of the atmosphere and waters involved a localization of tribes in time, or chronographically, just as they are now localized by climate over the earth's surface, or geographically.*—Tribes were made for a special climate or condition of the globe; and when this climate or condition had been passed in the earth's progress, the tribes no longer existed. The culmination of the Reptilian and Molluscan types in the Reptilian age, or of Trilobites and Brachiopods in Palæozoic time, are examples. The former when instituted had those special relations to climate that made the Reptilian age the era of their culmination; just as now palms and bananas reach their perfection only in the equatorial zone; figs in the tropical; myrtles and laurels, in the sub-tropical; evergreen trees, in the warm-temperate; ordinary deciduous trees, in the cold-temperate; and pines, in the sub-arctic. As there are now these zones on going from the equator to the poles. so there were successive eras passed over from the Silurian—the period of universal warm temperature—to the present age of a frigid arctic, and a mean temperature of 58° to 60° F. Climate may not have been the only cause; but it was one, and of great importance. The Crustacean type is one of those which have culminated in the age of Man; and this accords with the fact that its highest species—the Maioids, or Triangular Crabs—are now most numerous and of the highest rank in the colder temperate zone. It was made to reach its maximum in a cold climate, and therefore in the existing age.

No species survived through all time, and few through two successive periods; The oldest now existing began in the Middle Tertiary, and these were only Invertebrates. The oldest quadruped dates no farther back than the Post-tertiary.

But two genera range through the whole series of ages from the first or Potsdam epoch,—*Lingula* and *Discina*,—enough to manifest the oneness of system from the beginning. There was in general a changing of genera with the successive periods. Even *tribes* wholly disappeared from age to age, as the world outgrew them. Of Trilobites, 500 species once lived, of the Ammonite group, 900 species, all of which are extinct; the Nautilus tribe, 450; three or four species are all that exist. Of Ganoid fishes, 700 species have been discovered; the tribe is now nearly extinct. Thus, the old has passed away as the new has come in. Remains of nearly 40,000 animal species have been gathered from the rocks, all of which are extinct; and, considering how few of the whole number have become fossilized, this can hardly be one-tenth of the number that have existed and are gone. 2,500 extinct species of plants have been found,—

which cannot be over a twentieth of all that have covered the earth in its former ages.

4. *The extermination of species was in general due to catastrophes, while the extinction of tribes or higher groups may have been a consequence of secular changes in the condition of the climate, atmosphere, or waters.*—The extermination of species here alluded to, and some of the kinds of catastrophes which caused them, are briefly considered on p. 398.

5. With regard to *the Organization of Species*, Geology suggests no theory of natural forces. It is right for science to search out Nature's methods, and strive to employ her forces—organic or inorganic—in " . effort, vain though it prove, to derive thence new living species. The study of fossils has given no aid in this direction. It has brought to light no facts sustaining a theory that derives species from others, either by a system of evolution, or by a system of variations of living individuals, and bears strongly against both hypotheses. There are no lineal series through creation corresponding to such methods of development. Instead of gradations from Mollusks or Articulates to the lower Fishes, and so on upward, the Fish-type commences near its summit-level, or rather between the level of the typical fish and that of a higher class of Vertebrates. Were either of these plans the system in nature, examples of the blending of species would be common through all the classes, high and low; and North America would afford them as successive stages between the old Elephant or Mastodon and earlier species, and so throughout the various tribes of life, animal and vegetable. But, in fact, appearances suggesting the idea of such shadings among species are exceedingly rare,—wonderfully so, considering that Palæontology has only the imperfect stony secretions of animals to study out, which sometimes afford insufficient distinctions even when perfect and from living species. Under any scheme of development of species from species, the system of life, after ages of progress, would have become a blended mass,—the temple of nature fused over its surface and throughout its structure. The study of the past has opened to view no such result.

Geology appears to bring us directly before the Creator; and, while opening to us the methods through which the forces of nature have accomplished His purpose,—while proving that there has been a plan glorious in its scheme and perfect in system, progressing through unmeasured ages and looking ever towards man and a spiritual end,—it leads to no other solution of the great problem of creation, whether of kinds of matter or of species of life, than this:—DEUS FECIT.

In closing this brief notice of Professor Dana's excellent treatise, we may observe that the author appears to have carefully avoided, throughout, the adoption of any one-sided views. In all debatable cases, the opposite sides of the question are equally discussed: a method of treatment which adds much to the value of the work.

E. J. C.

Nelson's Atlas of the World: constructed from the most recent authorities; with divisions and measurements in English miles. By Thomas Nelson, Jun., and Thomas Davies, C. E.

Nelson's Wall Maps.

Nelson's Family Maps. London and Edinburgh: T. Nelson & Sons.

Under the direction of one of the most enterprising of British publishers, we have here produced an atlas and series of large and small maps, embracing some of the most useful improvements that practical sagacity and experience have recently contributed to the facilities of education. The points in which they differ from all previous maps are not more admirably adapted to remove the difficulties they cope with, than they are simple. Like so much else that is of the most practical utility, the wonder is that such adjuncts to our school maps were never thought of by Geographers till now.

The projection of the maps is a combination of the conical development, with that by which Flamstead successfully aimed at not only making equal spaces on the map represent equal portions of the earth's surface, but also at admitting of correct measurements being made parallel to and perpendicular to the equator. In the combined system here adopted, the parallels of latitude are represented by concentric segments of circles as in the conical development; while, as in that of Flamstead, the degrees of longtitude are accurately laid off on each parallel, and the meridians are drawn through these points, forming curved lines convex towards the centre meridian. By this arrangement, while it possesses all the accuracy of Flamstead's projection in the measurements of areas, and of distances parallel to, and perpendicular to the parallels of latitude, the diagonal measurements are more accurate.

The next practical difficulty dealt with is the process resulting from the application of astronomical mensuration to the science of Geography. The ordinary mode of stating the geographical position of Toronto is: latitude 43 degrees, 39 minutes, North; longitude 79 degrees, 21 minutes, West. But this scientific language requires for all ordinary uses, to be translated into the speech of common life. Comparatively few can form any distinct idea of the relative distances and positions of places on the earth's surface by their longitude and latitude. Impressed with this conviction, Mr. Thomas Nelson, one of the authors of the new atlas, conceived the happy idea of applying to geography a system of mensuration by English miles; and thus by the employment of the language of common life, making maps more readily intelligible, and more suited for general use. From this have resulted the following new and distinctive features:—1st. All the maps, with the exception of the hemispheres, are laid off in squares of a specific number of one thousand miles, and these are again subdivided into squares of one hundred miles each. For example, the map of Europe forms a square of four thousand English miles, subdivided into smaller measured squares; and the map of England embraces a square of four hundred miles. sub-divided into squares of one hundred miles. In ordinary atlases the scale varies so much, that the young student is in danger of adopting the impression that England is about the same size as Russia, or the United States. In the new atlas this is effectually obviated. Russia, and Norway and Sweden, as the largest countries of Europe, exceeding in area one thousand square miles, are laid off on maps of the definite number of measured squares. All the other countries of Europe, and also the Canadas, Cape Colony, New South Wales, &c., are mapped on the standard scale of one thousand miles square. Each map moreover, embraces all within the measured area, so that the student has always the relative size and distances brought vividly to his mind; and the comparative extent of separate countries cannot be over-looked.

By this simple process, the youngest child can ascertain at once how far Edinburgh is from London, or Toronto from Quebec. By the old process, the student would ascertain that Quebec is in latitude 46 degrees, 49 minutes, North; longitude 71 degrees, 16 minutes, West; by the New Atlas, in addition to this he ascertains at a glance that it is about 3,050 miles west of London; about 320 miles south of London; and 3,330 north of the equator. He can also ascertain with ease its approximate distance from any desired point. Thus by the maps, with the additional assistance of a copious index and table of distances, the student has at his command relative geographical positions in this form: Rome, for example, lies 540 miles east of London, and 663 miles south of it. Its direct distance is 889 miles.

The maps retain the ordinary degrees of latitude and longitude, so that whatever novel features they present are additions, not substitutes for the old system and terms of measurement. But on the hemispheres the lines of latitude are drawn at intervals of 1000 miles north and south of London, and the lines of longitude at the same intervals measured on the parallel of London. In addition to those, another class of circles drawn from London as a centre, show the distance by thousands of miles from that point; and on the other maps the lines of hundred or thousand square miles, are accompanied by the measured intervals of latitude and longitude.

We have thus specified some of the more obvious improvements introduced by Mr. Nelson into the system of Geographical instruction by maps. To indicate the difference of time at each point on the earth's surface, as determined by the number of degrees through which the sun travels westward every hour, the Mercator's projection is marked off in parallels of longitude at intervals of 15 degrees, each marked with the hour westward or eastward of London. On turning to an Atlas chiefly used in our Canadian Schools to ascertain how the same information was there conveyed, we were amused to find the clumsy and almost ludicrous device of a page covered with rows of clock-dials, with the hands of each pointing to a different time, and printed underneath each the name of some city: London, Rome, Washington, Toronto, Nankin, Jerusalem, &c. The contrast between the science of the one and the unpractical empiricism of the other, could scarcely be surpassed.

The Wall Maps are coloured so as to exhibit the details in bold contrast; and the execution of the whole is admirable. The great additional labour and cost involved in the construction and engraving of Maps in which ellipses have to be used instead of circles, have unquestionably tempted Geographers to adhere to the common projection, notwithstanding some notorious defects. The projection generally adopted is not, indeed, the true globular one, but a modification of that projection, in which economy of construction is secured at the expense of accuracy. In the new system of projection and the other novel features of the maps we now refer to, they appeal to all who are interested in education, by improvements suggested by sound practical common sense, and a successful application of intelligent experience to surmount difficulties felt by every young student in mastering that useful part of education, which is indicated in most higher school prospectuses, under the name of "The use of the Globes." At the end of such a course of training, it would be an instructive test to ascertain how many are able to translate the ordinary Geographical definitions of latitude and longitude, into a distinct idea of the relative distances and positions of any two places on the Earth's surface.

That we have not over-estimated the value of the Atlas and Maps, here referred to, is proved by the fact that they have been specially selected for commendation by Sir Roderick Murchison in his Address before the Royal Geographical Society, in which he remarked:—

"Nelson's Atlas is an excellent and carefully executed work, of that class which reflects so much credit on our Scottish Geographers, and is an evidence of the great and increasing interest taken by the public in Geography"; and he specially refers to the novel feature of the distances and measurements given in English miles. A no less high authority, the distinguished astronomer, Sir John Herschel, thus speaks of them: "I have seldom or never seen Maps more beautifully executed. The idea of dividing each map into squares of a hundred and a thousand miles, and of inserting circles indicating the distances from London, is a happy and useful one for popular Maps." In those for Canada we might perhaps desire an additional series of circles, showing the distances from Ottawa, or some other point on our Western Hemisphere; but we have said enough to indicate our sincere belief that Mr. Nelson has produced an Atlas and Maps with such strong claims for preference by teachers, that it will constitute an important element of educational progress when they supersede all others in our Common and Grammar Schools.

D. W.

Annals of the Astronomical Observatory of Harvard College. Vol. III. Account of the great Comet of 1858. By G. P. Bond, Director of the Observatory of Harvard College. Cambridge: Welch, Bigelow, and Company, Printers to the University, 1862.

Our readers need not be told that a comet is yet an unsolved problem of the Universe. It is true that there has been no doubt as to the nature of the orbits of these strange visitants since Newton, applying his wonderful analysis to that of 1680, compelled it to confess that it was describing a conic section round the sun, like the members of that family party which constitute the solar system, among whom it had intruded. In earlier days, they had been supposed to be only meteors existing in the earth's atmosphere, but Tycho Brahé put an end to this notion, by shewing that their orbits lay beyond the moon. Kepler, who wrote a treatise on them, remarkable, as all his works are, for poetic imaginings and ingenious conjecture, was apparently puzzled by the complication of the geometrical conditions of their motion, and was reduced in despair to propose straight lines as the best he could make of their paths. The true curve was, as we have said, demonstrated by Newton, and when, a few years later, Halley had found that the comet, which bears his name, was moving in an ellipse, and confidently predicted its return at a stated period, nothing was wanting to assign to the wanderers their character as material bodies subject to the power of gravitation like common things. Yet though they were thus seen to be under the influence of Father Sol, and to obey the same laws as his recognised children the planets, and though some of them even conform so far as to move about him in re-entering orbits, there are peculiarities which prove them to be foreign to this family, alike in their origin and persistence. For while all the members of the planetary system move around the sun nearly in the same plane, all in ellipses of small eccentricity or nearly circles, and all in the same direction, comets on the contrary violate all these laws; their orbits are of all sorts of eccentricity, most of them parabolas, some even hyperbolas; their planes are inclined at all angles to the ecliptic, and their motion is frequently retrograde instead of direct. Laplace has calculated the mean position of the orbital planes of a great number, and has found it to lie with reference to the ecliptic at the angle at which it ought to lie, if there be no determining cause to one position rather than another. An acute remark of Herschel's may here be noted in connection with the fact that the periodic comets have mostly their motion direct, and their planes not widely different from the ecliptic, a result which ought to be expected, for a comet in a parabolic orbit near the ecliptic, if its motion were *direct*, would be likely to be thrown by the disturbing action of the planets into an elliptic one, while if it were *retrograde*, the orbit would be converted into a hyperbola, and the comet would pass away from our system never to return to it. We may then consider a comet to be a body moving in the extra-planetary spaces in a straight line with uniform velocity, till its path approaches near enough to the sun to be sensibly affected by his attraction, and the comet then obeying the principle of universal gravitation is drawn into a conic, the nature of which depends on its initial velocity, in some cases merely passing once round the sun and again going off into space, in others moving round him in a periodic orbit which may or may not be permanent according as its motion takes it into the neighbourhood of other bodies which disturb it from this orbit, and perhaps (as we shall see presently) there may be a something in the commonly-called "free" space itself which has an effect. The number of comets whose observation has been recorded amounts to nearly a thousand, and in recent times the average is said to be about five a year, but this is only a small portion of the number even of those which come into our system, (for it is only of such that we have cognisance), not to speak of those outside of it. Many there must have been too faint to be visible at all; many of them not visible from our situation at the time of their approach to the sun. It must have been a startling apparition during the total eclipse of 62, A.D., when a huge swordlike comet was seen close to the sun, not seen before or after. Some few have been bright enough to be seen in broad daylight, but not many can bear the light even of the full moon, and, in more than one instance, after approaching the sun in considerable brilliancy and being lost for a time in his glare, the comet has never reappeared on the other side of him, though closely watched for. Very capricious too are even the periodic ones in their splendor; as that of 1759 which, from its decaying lustre and diminished tail at each successive appearance, deluded Laplace into a conjecture that it might be undergoing a process of condensation and solidification which would fit it to become an orderly member of the planetary group, a world in the act of manufacture under our eyes; and this would have been a triumph for the "nebular Hypothesis." Unfortunately, in 1835 it came round as bright as ever, spreading its tail with more than its pristine sweep, and the Nebular had one more disappointment to put up with.

The days are past when

> "Some pilgrim comet, on his way
> To visit distant shrines of light,"

could throw the nations into panic as a forerunner of plague, war, and pestilence, could drive emperors from their thrones and be anathematised by Popes, but not less at the present day is the excitement, though of a more pleasurable kind, caused by these strange visitors. "There is, beyond question," says Herschel, "some profound secret and mystery of nature concerned in the phenomenon of their tails." To fathom this mystery, to trace the history and hidden cause of the wonderful changes and disturbance that a comet undergoes, is now and has for years been earnestly attempted by astronomers, and no sooner does a comet swim within our ken, than it is watched by hundreds of eager telescopes which dog it with unrelaxing attention through every step of its visible course. Nor can a better proof of the keenness of this pursuit be given than is furnished by the magnificent volume whose title is cited at the head of these pages. We have here brought within one grasp the whole of the observations made upon the great comet of 1858, from the first glimpse caught of it by Donati at Florence, on June 2nd, when it showed itself as "a little nebulosity having a diameter of about three minutes, and with the illumination equally diffused throughout its surface," tracing night by night its gradual development and extinction, till it vanished from the gaze of Maclear at the Cape of Good Hope, on Feb. 26, 1859, when its diameter had become less than one minute. Many circumstances were combined to render the observing of this comet of peculiar value—its position relative to the earth got rid to a great extent of the effects of foreshortening, and an unusual continuance of fine weather on both sides of the Atlantic, and the absence of moonlight at the most critical periods, rendered available more opportunities than are commonly afforded. Professor Bond, of whose ability America may well be proud, and who has added lustre to the reputation which his lamented father had well earned for the observatory of Harvard, has admirably performed the duty he proposed to himself, by collecting all the scattered mass of information to be found in the reports of the numerous astronomers from all parts of the globe (no less than 84 different observers are quoted); it adds to the value of his work that he has quoted them each in their own language and words (though a lazy reader may wish he had translated here and there, especially as Danish and Swedish are not given every body to know), and still more that by classifying the phenomena he has enabled us to consider each separately, without extraneous distraction, and has further made the necessary calculations and reductions with his well-known skill and accuracy; it is only justice to Professor Bond to add that his own observations at Harvard form the most valuable portion of the whole series. Nor can we refrain from giving our humble approbation of the thorough manner in which the volume has been sent to press, of the fine typography and extremely beautiful engravings; and when we add that the whole expense has been defrayed by the private liberality of some leading citizens of Boston, our readers will join us in admiration of such noble liberality displayed during this dark epoch of their unhappy country.

A comet may be divided into four parts; First, the *nucleus*, a star-like point, sometimes a disc; Second, the *coma* or wig, a luminous haze surrounding the nucleus, and generally increasing in intensity towards the centre:—these two constituting the *head;* Third, the *tail,* directed from the sun and widening as it recedes, brightest at the edges, its outline lost in mist at the end: and to these three, we must now add the *veil*, first observed in the present comet, a dim band of light surrounding the head and tail, sharply distinct from them by the faintness of its illumination. These characteristics, however, do not mark every comet. Many of them have no trace of tail: one, at least, has been recorded whose head entirely disappeared, leaving a long tail as its only representative: others have had more than one tail,—that of 1744 had six, "spread out like the sticks of a fan,"—in several, an additional tail has been thrown out *towards* the sun,—in other cases the twin tails have been inclined at angles from 18° to 120°, and sometimes there have been streamers darted out like those of the Aurora: in the present comet, two such were seen; one of them starting from the head and touching the tail proper, running in a nearly straight line far beyond it, and the other shooting out from the tail itself about one third of its length from the head, and running off at a different angle from the former. Again with regard to the nucleus, it has been totally wanting sometimes, and both it and the planet-like disc shewn in other cases have resolved themselves under a high power of the telescope into nebulosity; on the other hand, the head has in two or three cases appeared to consist of a number of such stellar points; Halley's comet in 1835 was seen by Sir John Herschel at the Cape to have formed a new nucleus after its perihelion passage, and this nucleus had a diminutive coma and tail within and distinct from the original head, a miniature comet within a comet; the like phenomena having also being long ago recorded by Kepler. But the most wonderful vagary of this kind was that actually seen in Biela's comet, which beneath the observer's eyes, split itself into two distinct comets, each having its own appendages complete, and travelling side by side the rest of their course with a chain of light uniting them. After undergoing various alternations of relative brightness, the old one appeared at length to obliterate its companion, and threw out three tails as if in token of victory, but the distance between them was great enough to render it probable they would henceforward move as independent comets, and their return has been anxiously looked for, though as yet (we believe) without success.

It is, however, in the tail that the great mystery lies. We have mentioned that the tail (speaking loosely,) is always directed from the sun: that is, it follows the comet in its descent to the sun, and precedes it in its recess. Now if the tail be a material body, acted on only by the gravitating attraction of the sun, and the mutual attraction of its parts; that it should thus sweep round, unbroken (to use Herschel's phrase) like a rigid rod, and this as in one case more than a hundred millions of miles long through a semicircle in less than two days, is absolutely impossible, being in defiance of the principle of gravitation and the common laws of motion. Before, however, entering upon the discussion of any explanatory hypothesis, it will be well to examine somewhat minutely the actual phenomena manifested in the production of this strange appendage.

Generally a comet is first seen as a telescopic object in the shape o a round nebulous body of a pale color, sometimes of equable illumination throughout, in other cases having its intensity increasing towards the centre, but without appearance of tail. As it approaches the sun, it begins to brighten and swell out slightly towards him, while on the opposite side the tail begins to run out in a luminous band of the breadth of the head. As it comes nearer and nearer the sun, much commotion is seen to ensue in its head, indicated by rapid changes of brilliancy and alternations of apparent density; the tail now surrounding the head on the side towards the sun, and branching off in the opposite direction round the head into two streamers. These apparently are separated for some distance from the head, forming a bifurcation of the tail with a dark space interposed, but presently c lesce, widening out as they recede, diminishing in brightness towards their ends, and less illuminated towards the median line between them. These streamers, however, are not straight but curved, the foremost streamer being convex towards the direction to which the comet is moving, and the hinder one being still more curved in the same direction, the former being also much the brighter of the two, and its outline more sharply defined and for a longer distance, so that in this state they are not inaptly compared by several of the observers to a quill pen or a bird's wing. A better notion would be gained of this conformation by a glance at the beautiful figures in this volume than by any verbal description. The axis or median line of these streamers is at starting directed *from* the sun, but not exactly in the line joining the sun and comet, generally being deviated backwards from the direction of the comet's motion. In the comet of 1557, the deviation amounted to 20°, if the observation can be trusted. In this of 1858, the observations may be satisfied by a constant deviation of from 4° to 6°, the axis being supposed to be in the plane of the orbit, but Prof. Bond finds this latter supposition inconsistent with the observations, and we may add that this result of a *constant* deviation being throughout preserved, is *a priori* very unlikely. Some remarkable irregularities presented themselves, however, in this comet. Shortly after the first appearance of the tail, the curvature it assumed was in the direction *opposite* to that above stated and which it afterwards had, and at the same time the *following* branch was brighter than the preceding one; observations so abnormal that one would have been inclined to refer them to a delusion of the observers, had they not been strangely confirmed by a recurrence of the same phenomenon, not long before the disappearance of the tail as the comet was going away. There was also noticed for some time a change in the curvature of the outlines, both branches being bent inwards about the middle of their lengths, making the tail somewhat of a lozenge shape, or like a willow-leaf. In connection with this may be noted the irregular termination of the inner branch as it gradually faded into a shapeless mass of light. We will here quote the observations themselves.

Oct. 8, Powell at Madras.—"Outline of envelope ragged, the tail reaching a little beyond α Coronæ Borealis. On the lower side the light shades off almost imperceptibly; on the upper, though ragged, it terminates comparatively abruptly. The darkness down the envelope scarcely so clear as before. Nucleus about as bright as Mars or α Lyræ. The shape of the envelope bears a resemblance to a pen, being narrow at the head, and after a short space suddenly spreading on the lower side like the feather of a quill."

Oct. 8, Webb at Tretire, Eng.—"The general impression of this (the under) side of the tail was that of spreading out like a feather, as compared with the more definite aspect of the convex edge."

Oct. 10, Same observer.—"The curvature appeared regular as far as a line joining α Coronæ and ζ Herculis, or perhaps a little farther; thence a fainter ray of considerable breadth was deflected at a large angle, perhaps 60°, as far as the stars of *Quadrans Muralis*. This portion was very feeble, but certain, *and looked quite like a scattered and abandoned vapor*."

And special note may be taken of the following:

Oct. 8, Secchi at the Collegio Romano.—"Si conserva pure all' osservatorio un disegno della cometa come era visibile ad occhio nudo, ove si ebbe cura di far rilevare la forma curva dell' estremità della coda, e quella specie di materia sparsa che l' accompagnava, irregolarmente diffusa che si potrebbe credere affatto uscita dalla sfera d' attrazione della cometa e perduta. Questa materia era sempre visibile dalla parte della curvatura interiore della coda la quale riusciva perciò mal terminata, mentre la esteriore era benissimo decisa."

The two secondary tails or streamers in this comet have been already noticed; they were much fainter than the real tail, whereas in that of 1861 (1), the streamer was decidedly brightest. A curious bulging out of the head into a sort of large horn, was observed in the early stage of the comet on the side towards the sun, at an angle of some forty degrees or so; an appearance so singular that its reality might have been doubted had it not been confirmed by its recurrence towards the end of the comet's course, testified from an opposite part of the world.

Another peculiarity seen for the first time, we believe, in this comet was the so-called "columnar structure" of the tail, the broad end of it being cut up by parallel dark bands, the direction of which did not appear to be referrible to either the axis of the tail or the sun. The two branches of the tail, coalescing after running some length, left between them a less illuminated space, to which the name of the "dark zone" has been given, varying much at intervals in extent and never sharply outlined; but within this was noted a "dark canal," proceeding direct from the nucleus with its breadth continued uniform, and traceable for a good way even into the brighter part of the dark zone. It is described as being at its origin "almost black," and might tempt us to fancy it an actual shadow of the nucleus, if it were not that its position, deviating some degrees from the sun, forbad the supposition. Of the outer faint "veil," or nebulous envelope dimly surrounding the head and tail, and sharp in its outer edge, little is to be said except that it was not symmetrically placed with regard to the nucleus, and was so delicate an object that it escaped the attention of nearly all the observers.* But the most important result of all, and one for

* There do not appear to have been observed any of those pulsations or coruscations of an auroral character, which are recorded in other cases,—as for instance when Kepler tells us that the tail of the comet of 1607 would in the twinkling of an eye become very large, and in several other cases where the tail exhibited undulations as if it had been blown by the wind, and in more recent times, the great one of 1843 shot out in one evening a new tail inclined at 18° to the other and *twice as long*, never seen again. The only notice we remark is by Mr. Spalding at Selby, Eng., who says:—

"A sudden and momentary emanation from the nucleus was remarked. At first it was supposed to be due to atmospheric causes; but from its recurring in precisely the same form, the author felt convinced that it was really attributable to a change in the nucleus."

"Appearances of a similar nature continued to be observed during the visibility of the comet."

It is odd that no other observer saw them in this instance, but we think there can be no doubt of the reality of such momentary pulsations existing, and that Olbers is entirely astray when he assigns their origin to atmospheric causes.

which Prof. Bond may claim the lion's share of credit, relates to the knowledge he has been enabled to gain of the formation of the tail itself.

Sir William Herschel was the first to notice in the comet of 1811, that the tail seemed to be only a prolongation of part of the coma which was separated from the head by a dark interval, and was led to the inference that the tail was in effect a hollow envelope enclosing the head at its upper part, and having a space between it and the head occupied by some dark atmosphere or non-luminous gas, thus satisfactorily accounting for the brightness of the apparent edges and the obscurity of the central part or dark zone. In the comet of 1835, this inference was confirmed by the experience of Bessel and others, with the addition that this envelope was connected with the head by a conical jet of light, an *aigrette lumineuse* or luminous sector, which proceeded in a fan-like shape from the nucleus toward the sun and then bending back on both sides seemed to send a flow of luminous matter into the tail. This jet was by no means stable in form; sometimes single, sometimes split up into several; now thin, now broad, but always brighter at its start from the nucleus and gradually melting into the haze of the coma. Bessel added the curious fact that the axis of this aigrette was in a state of rapid and continuous oscillation about an axis perpendicular to the plane of the orbit, never deviating far from its mean position, nearly directed towards the sun. This has not been observed in recent cases; the comet of 1858 showed no symptoms of such a movement. So far then we should infer that the tail was formed by a stream of luminous matter projected in a conical jet from the nucleus towards the sun, and then meeting with some repulsive agency, was checked, and turning back flowed round the sides in a continuous stream with ever-widening section. Sir John Herschel very aptly compares it to the trail that follows the smoker against a brisk wind. But the admirable examination of our 1858 comet by Prof. Bond leads us to modify this conclusion. He has shown that the tail is not thus formed by a continuous jet, but is due to a series of envelopes which are successively thrown off, like skull-caps, from the head. No less than five of these were identified and consecutively watched, (in that of 1861, there were no less than eleven) and so well did Prof. Bond become acquainted with the habits of his patient, that he was able to predict the recurrence of the event.

"Oct. 8. The nucleus to-night is decidedly brighter than on the 6th, and is preparing to throw off a new envelope."

"Oct 9. A new envelope, E., has been thrown off, as predicted last evening."

The normal process seems to be a brightening of the nucleus, then an envelope in contact with it; the nucleus becomes fainter, and the envelope spreads, becomes "mottled" or "curdled" with intermittent jets and lumps of luminosity, its form a sharply curved outline towards the sun and running round more than a semi-circle into two cusps behind the nucleus. Gradually it rises and the dark space intervenes between it and the head, broken however sometimes by the jets; its light fades as it gets higher, till it begins to crumble away at its vertex, and gradually disappears down to its cusps which are the last to melt into the general haze. The interval between the disengagement of the successive envelopes varied from 4 to 8 days, and the velocity of each diminished as they expanded, so that they closed on each other in the higher regions, and the puzzling circumstance of a decided dark spot occurring in one of them, was of use not only in identifying that envelope, but in showing that there was no rotation round the axis in it. Curiously enough, the dark spot was repeated in the same relative position in the following envelope.* It is not

* We quote the following from Prof. Bond's summary of results.—

"At first they (the envelopes) presented a variety of aspects, but as they expanded they tended to conform with a normal type, the light becoming more evenly disposed and the outline more symmetrical. For a few days the surface was closed on the side opposite the sun, although here and there penetrated by streams rising into the tail, principally from the cusps on either side. As it expanded, the discharge became general, but was always most considerable from the outside, thus forming the asymptotic branches below the nucleus. The curve on the side towards the sun in a completely formed envelope was very nearly circular for 60° to 80° on either side of the axis. This was originally the brightest and best defined region, but it was also the first to fade away, the material being evidently transferred to the outlines below the parallel of the nucleus, which remained in the sight long after the upper portions had disappeared, and finally driven off into the tail. The process of dissipation furnishes a satisfactory explanation of the branches of the tail, which are simply the continuation of the older envelopes merged together and undistinguishable from each other excepting near the nucleus. In this view the dark hollow of the axis represents the region not fully supplied from the envelopes, while they retained their closed or partially closed surfaces. . . . . After reference to the dark arcs interposed between adjoining envelopes and the bright marginal rims of the latter, the subject of the dark and bright spots on their surface is taken up. Several results of considerable importance have been derived from the discussion. Among them are,—1st. A degree of permanence in the internal distribution of the substance of the envelopes retained for a long interval after their ejection from the nucleus. 2nd. That their diversified aspect, especially the isolation of bright masses, cannot be explained as a mere optical effect produced by the intersection or separation of streams of luminous matter passing out continually from the nucleus into the tail. 3rd. The nearly permanent direction maintained by the spots relatively to the axis of the tail proves that there was no sensible rotation of the envelopes, excepting in a sense always preserving an unaltered aspect towards the sun. 4th. That there was no sensible oscillatory improbable that the structure previously mentioned as described by Bessel may be only an imperfect observation of those detailed by Prof. Bond, as we notice that the descriptions and even the figures of many of the observers tally very closely with those of Bessel, while at the very same time Prof. Bond's figures so plainly shew the envelope-formation. Indeed so very unlike are the drawings of the comet, made by different observers to represent its condition at the same time, that it is hard, while looking at the Plate in which they are put side by side, to credit that they are intended to represent the same object. Of course the blame of this must be laid to atmospheric causes, and the inferiority of the telescopes to the great Equatorial at Harvard.

We may note that Prof. Bond has calculated the nature of the curve followed by the outline of the head and envelopes towards the sun, and finds it to be a catenary, and the enveloping surface would be thus generated by the revolution of a catenary (not necessarily of constant directrix) about its axis. Prof. Bond could not decide whether the sections perpendicular to the axis were circles, and observes that he finds no evidence to show that they are not. We should rather remark on the extreme *à priori* improbability that they should be so.

Before proceeding to the physical hypotheses which have been set forth, there are two points worth consideration. First, can a comet be said to be in any sense a solid or opaque body? Second, is its light self-derived, or merely reflected like that of the planets? With regard to the first of these, Newton remarks—(we quote the quaint language of his first translator): "Now if one reflects upon the orbit describ'd, and duly considers the appearance of this comet, he will be easily satisfied that the bodies of comets are solid, compact, fixt and durable, like the bodies of the planets. For if they were nothing else but the vapours or exhalations of the earth, of the sun, and other planets, [rather :—vapours or earthy exhalations of the sun and planets,] the comet in its passage by the neighbourhood of the sun, would have been immediately dissipated. For......the heat, which dry earth on the comet while in its perihelion, might have conceived from the rays of the sun, was about 2000 times greater than the heat

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motion of the nature of that seen in Halley's Comet, as described by Bessel, 5th. The repetition of spots and rays, and other similar peculiarities of structure in successive envelopes, in nearly the same direction, strongly indicates that the nucleus itself constantly maintained the same aspect towards the sun, without sensible rotation other than is implied in this condition, and without oscillation."

of red-hot iron.* But by so fierce a heat, vapours and exhalations, and every volatile matter must have been immediately consumed and dissipated."

At the present day we should draw a conclusion from the same fact directly opposite to Newton's. We can hardly conceive that a solid body would *not* be vaporised by so fierce a heat. The question of opacity would of course be settled at once by the occultation of a star behind the nucleus, and there seem to have been plenty of cases where this would have been seen if it had occurred, yet Bessel says that he cannot satisfy himself that any observed passage of a comet over a star has been really central. Whether, however, there be any solid nucleus or not, the tail and head must be of extreme tenuity, for stars have been repeatedly seen through all parts, in some cases with brilliancy unaltered, in others, diminished, (as was to be expected, partly from the perspective effect, partly from the absorption of light by the passage,) and in a few even increased. This last result is so odd that one would like to disbelieve it, but the evidence seems too strong, for Relhuber in a comet of 1846 says that a star of the 8th magnitude (just invisible to the naked eye) when it was centrally covered by the comet, became very considerably brighter and was judged to be equivalent to one of the 6th, in which case it could have been distinctly seen without a telescope.† An opaque body also, if not self-luminous

* This remarkable calculation—almost a divination for the time it was made—has been repeatedly but imperfectly quoted, and almost always misunderstood. Arago has been evidently misled, by one of these imperfect references, to make an objection to it which is altogether mistaken. The following is the original passage:—"Est enim calor solis ut radiorum densitas, hoc est, reciproce ut quadratum distantiæ locorum a sole. Ideoque cum distantia cometis a centro solis Decemb. 8, ubi in perihelio versabatur esset ad distantiam terræ a centro solis ut 6 ad 1000 circiter, calor solis apud cometam eo tempore erat ad calorem solis æstivi apud nos ut 1000000 ad 36, seu 28000 ad 1. Sed calor aquæ ebullientis est quasi triplo major quam calor quem terra arida concipit ad astivum solem, ut expertus sum, et calor ferri candentis (si recte conjector) quasi triplo vel quadruplo major quam calor aquæ ebullientis; ideoque calor, quem terra arida apud cometam in perihelio versantem ex radiis solaribus concipere posset quasi 2000 vicibus major quam calor ferri candentis."

† Quoted in Hind's *Comets*. We add the following from the present volume, "When it [Arcturus] had entered well within the margin of the tail, a dark notch was formed, cutting out a portion of the tail round the star; and as the star got farther in, this became a dark aureola surrounding the star, and in diameter equal to about one tenth of the line of transit. This continued until the star reached the middle; at this part there is a broad dark line which extends from the nucleus to a distance considerably above the point where the star crossed. When Arcturus arrived here, this dark space was perfect up to the star, but on the other side the white light of the tail appeared to come quite up to the star; in short, as the bright part of the tail had been darkened in the vicinity of the star, the dark part was brightened, at least so much of it as was on the side farthest from the nucleus. I saw the notch again on the opposite side previous to emersion, and then lost it by clouds. The effects I have described are, doubtless, optical, and the notch and aureola evidently due to the bright light of this star; the effect on the dark central part is not so easy to explain."

or not surrounded by a luminous atmosphere, would present phases like the planets, and onthis point again the evidence is conflicting, but the advantage lies decidedly on the negative side.

Is the light of the comet its own? The very sudden changes of brilliancy would seem to answer this question in the affirmative, if it were not that they may be equally well supposed to arise from sudden changes of density in the substance of the comet which might change its capacity for reflection; and the same consideration negatives also the argument that may be drawn from the observed illumination at different distances not conforming to the arithmetical ratio it should follow, if due wholly to the sun. On the other hand, the light from the comets has been found in some cases to be polarised, proving that some portion at least of it has undergone reflection; but in other cases (notably in that of 1843) no trace of polarisation could be detected, and it is just to infer that these comets at least were in the condition of an incandescent gas. And again, as Bessel has remarked, if the substance of the comet be capable of reflecting light, it must also be capable of refracting it, and this would be evidenced by the change of position in a star seen through it. A very favorable opportunity of testing this enabled him to assert that there was no such refraction, or at least none large enough to be sensible to our most refined observations. And indeed such a refraction could hardly be expected to be sensible, when we consider how excessively refined the density of the cometic substance must be to occupy such immense spaces with so small a mass,—so small indeed that no disturbance has ever been detected as produced by them in the motions of the least of the planetary system, as in the case of Lexell's comet which paid a visit to Jupiter, and so far from deranging his satellites, was itself diverted from its proper orbit and sent off to wander anew in distant regions, never having been seen among us since. On the whole it seems probable that there is no solid substance in a comet, but that it is a mass of extremely rarified incandescent vapor, reflecting also the light of the sun, and thus shining both by its own and by borrowed light.

The older philosophers were content to say that the particles of a comet's tail ascended from the sun by virtue of their inherent levity, just as some bodies fell to the earth by virtue of their inherent gravity. Another hypothesis made the tail to be only the effect of light in passing through the nebulosity of the head, like the beam of sunlight admitted through a small hole into a darkened chamber, and viewed transversely. Kepler conceived that the substance of the comet was broken up by the impact of the solar rays, and that the light particles were carried away by the impulse, forming the tail, while the denser ones stayed behind and made the head; and this was an ingenious conjecture, the Solar rays being imagined as something shot out from the sun like arrows. Newton was the first to advance a better founded theory. He supposed the existence of an ether pervading space or an atmosphere of the sun, and that the parts of this in the vicinity of the comet, becoming rarified by the heat which it acquired from its approach to the sun, ascended amid the cooler and denser atmosphere, carrying off with it the luminous particles of the comet, just as we see in our atmosphere a current of heated air ascend, carrying up with it the smoke of a fire. This hypothesis goes a long way toward satisfactorily explaining the prominent phenomena concerned, such as the form of the tail, its curvature, the deviation of its axis, the brightness of the forward edge, but it fails to account for the more unusual ones, such as the secondary tails. And perhaps the strongest objection to it is that which lies on the surface, namely, the absence of proof that there exists such a *vera causa* as the assumed ether. It is true that observations on Encke's comet establish a gradual diminution of its periodic time, an effect which would be produced by the resistance of such an ether, (and indeed such an effect was predicted by Newton himself, whose sagacity nothing seems to have escaped, for the comet of 1680, a prediction not fulfilled however,) but it cannot be held established that this is the very cause which produces the said effect. For the calculation of the retardation in this single case would only enable us to ascertain the law of resistance of the ether assumed to exist, and it would be necessary to show that this law satisfies also the retardations in other observed cases, before we can assert the truth of our hypothesis, and no such other case has yet been found, which fact is itself almost conclusive against the hypothesis.

Bessel, reasoning from the appearances presented in his observation of Halley's comet, has developed another theory which is waiting the test of facts for acceptance or rejection. The conical jet, or *aigrette lumineuse*, had a rapid oscillatory movement from one side to the other of the sun's radius-vector. According to Bessel this can not be explained as an effect ot the attraction of the sun. For although the attraction might cause an oscillation (corresponding to the libration of the moon), the period of it would be very long, while the observed duration was very short. It is necessary therefore to infer that the sun exerts on the comet a force distinct from that of attraction, capable of producing this rotation: that is, a polar force which tends to direct one radius of the comet towards the sun, and the opposite radius in a contrary direction. Such a force as magnetism for instance. Granting the existence of this force, the explanation of the oscillatory movement is obvious. Our readers may like to see Bessel's own words:—"Le mouvement oscillatoire de l'aigrette antour du rayon vecteur ne peut pas s'expliquer par l'attraction du Soleil, il faut supposer que le Soleil exerce en outre sur la comète une force de rotation; de plus, il est nécessaire que le noyau de la comète participe à ce mouvement. . . . . . . Il est nécessaire d'admettre une force polaire que tende à diriger un des rayons de la comète vers le Soleil, et le rayon opposé dans le sens contraire; il n'y a aucune raison pour rejeter *a priori* une pareille force. Le magnetisme sur la Terre nous offre l'exemple d' une force analogue, quoiqu' il ne soit pas encore prouvé qu' elle se rapporte au Soleil [it has been since]; si cela était, on en pourra voir l'effet dans la prècession des équinoxes [?]. Une fois cette force admise, il est facile d' expliquer le mouvement oscillatoire de l'aigrette; la dureè des oscillations dépend de la grandeur de cette force, et leur amplitude d'une constante relative au mouvement initial des molécules."

Undoubtedly if the sun exerts any other force than that of attraction, it must be a force of the kind Bessel calls "polar," for the action summed throughout the whole system must be zero. The analogy drawn by him between this supposed force and the terrestrial magnetism seems quite imperfect, nor can we understand how Bessel could conceive that the polarity induced in the particles of the earth by magnetism would affect the position of the earth's axis, so as to make itself apparent in the precession of the equinoxes. Certainly we ought to be very sure of our facts before we have resort to this extreme hypothesis, and we have already mentioned that Prof. Bond not only did not discover any such oscillation in the '58 comet, but makes it tolerably evident that a less searching scrutiny might have led to an assertion of its existence. The only rotation which Prof. Bond detected—rather by way of inference than direct observation—was that of the nucleus, so as to present the same face always to the sun, as the moon does to the earth, which would seem to involve the conclusion that a rotation had been originally impressed upon or possessed by the comet exactly adapted to its orbital motion, which is so wildly improbable that we may be glad to escape from it at any price.

To explain the emission of the particles in a cone towards the sun and their turning back to form the tail, Bessel invents a *repulsive* force exerted by the sun on particles projected from the nucleus with velocities such that the component perpendicular to the radius-vector is the same for all. Such a repulsive force might be due (he says) to electricity, magnetism, or to a non-resistant ether pervading space, on which latter supposition the theory becomes very like Newton's. He is thus enabled to explain the form and curvature of the tail. For the manner in which he conceives the action of this force and its necessary contrary, we must leave him to speak for himself*, merely adding that for the case of two tails, he finds it necessary to admit that this repulsive force must have two different values for different portions of the luminous matter, and so for six tails we should have six such forces, and so on without limit. On the whole Bessel's theory has not received much confirmation from recent observations, and there still lies behind, both against it and Newton's, the overpowering difficulty of the rapid sweep of the tail round the sun, requiring, on any hypothesis of material emissions from the head, such enormous forces, and employing velocities almost inconceivably great. We believe all such hypotheses to be untenable; but is it possible to suggest any other? Let us imagine a mass of nebulous matter, left to the attraction only of its own particles; it will arrange itself into a sphere, the strata increasing in density towards the centre. Now let the sun attract it, and it will assume an ovoid shape, the longer axis pointing to the sun. Suppose it now in motion round the sun, and by a tidal action the fluid shape will change so as still to turn its longer axis towards him. Now add

* Je regarde le mouvement oscillatoire de l'aigrette lumineuse de la comète de Halley comme un effet de la même force qui lance dans des directions opposées les particules sorties du noyau parallèlement au rayon vecteur. Voici comment je suppose que cette force agisse. Toute action d'un corps sur un autre peut être divisée en deux parties, dont l'une s'exerce également sur toutes les particules de ce dernier, et dont l'autre se compose des différentes actions exercées sur diverses parties. Lorsque les corps sont très éloignés l'un de l'autre, et que leur action est trés faible, c' est la première partie qui devient d'abord sensible, à mesure que la distance diminue; la seconde ne peut avoir de valeur appréciable que plus tard. Ainsi, lorsqu' une comète se rapproche du Soleil après en avoir éte très éloignée, on s'aperçoit d'abord de l'action générale qu' il exerce sur toutes ses parties. Je suppose que cette action consiste en une volatilisation des particules qui en outre soient polarisées de telle sorte a être repoussées par le soleil. La seconde partie de l'action peut avoir pour effet la polarisation de la comète elle-même, et une émission particuliere de matière lumineuse dans la direction du Soleil. La partie de la surface d'ou sort l'aigrette lumineuse a une polarisation telle, qu' elle tend à etre attirée vers le Soleil; et par conséquent, les particules qui les composent ayant la même polarisation, tendent aussi à se rapprocher du Soleil. Mais ces particules se meuvent dans une espace rempli d'une matière polarisée en sens contraire, qui tend à se reproduire constamment, aussi les deux polarisations contraires se neutraliseront, et les particules qui composent l'aigrette prendront la propriété opposée à celle qu' elles avaient précédemment, d' autant plus qu' elles se sont plus éloignées du rayon de la comète.

the effect of heat as it nears the sun, vastly expanding its dimensions; there will be condensations and rarefactions in abundance, and the stratification will become complicated enough to meet most contingencies, but the median line will deviate from the radius vector in the backward direction. Now add a luminous action of some sort excited by the sun, (say "electricity," remembering certain resemblances in the comet's behaviour to that of the Aurora,) and instantaneously exerted in the directions of least resistance. Perhaps by this time we may have come to something not unlike Herschel's "negative shadow," impressed, however, not on the "luminiferous ether" but on the atmosphere of the comet itself, and if we take into account the possibility of the existence of several centres of condensation instead of only one, the subsidary phenomena may not be impossible to explain. It seems certain that the body of a comet is not confined merely to that part of it which is visible to us,—the discovery of the new "veil" may assure us of this,—and the diminution of volume of the head as it approaches, with the subsequent increase as it recedes from the sun suggests (as Newton remarked) an evaporation or transformation into non-illuminated gas of the nebulous substance, which is again condensed into the head.

What is the "final cause" of comets, or what useful end do they serve in the plan of creation? Not to mention the moral effects they have exerted in past ages on the ignorance of mankind, nor the forgotten theory of Whiston, that a comet was the instrument of God's wrath in the Noachian deluge, by so near an approach that the impulse of the resulting tide in the inner sphere of water was great enough to fracture the solid envelope of the earth, nor the strange conjecture of Buffon that the planets were bits of the sun chipped off by the dash of comets against him, nor that of Olbers that the asteroids were the fragments of a large planet broken up by collision with a comet, nor other groundless fancies of the same kind, we can assert that one good service has been rendered by them to philosophy, by enabling us to ascertain from their perturbations the masses of the planets, and perhaps also by showing that the nebulous matter of extra-planetary space is like common matter in its subjection to the law of gravitation. Newton, however, with a fertility of imagination which recalls to us Dr. Johnson's saying:—"I am persuaded that had Sir Isaac Newton applied to poetry, he would have made a very fine epic poem,"—has suggested that the light and heat of the sun may be renewed and sustained by the comets which, moving in ever-contracting orbits, would ultimately fall in and be absorbed by him, and this theory has been revived in our days with elaborate circumstance by Prof. W. Thompson. Not only the suu but other fixed stars may share this benefit, and thus might be accounted for the sudden and irregular apparition of brilliant stars in the heavens, not known before. Nay, even the planets may be benefited in this way, for, says Newton :—

"The tails therefore that rise in the perihelion positions of the comets will go along with their heads into far remote parts, and together with the heads will either return again from thence to us, after a long course of years; or rather, will be there rarefied, and by degrees quite vanish away. . . For all vapour in those free spaces is in a perpetual state of rarefaction and dilatation. . . And it is not unlikely, but that the vapour, thus perpetually rarefied and dilated, may be at last dissipated, and scattered through the whole heavens, and by little and little be attracted towards the planets by its gravity, and mixed with their atmosphere. For as the seas are absolutely necessary to the constitution of our earth, that from them, the Sun, by its heat, may exhale a sufficient quantity of vapours, which being gathered together into clouds, may drop down in rain for watering of the earth, and for the production and nourishment of vegetables; or being condensed with cold on the tops of mountains, (as some philosophers with reason judge) may run down in springs and rivers, so for the conservation of the seas and fluids of the planets, comets seem to be required, that from their exhalations and vapours condensed, the wastes of the planetary fluids spent upon vegetation and putrefaction. and converted into dry earth, may be continually supplied and made up. For all vegetables entirely derive their growths from fluids, and afterwards in great measure are turned into dry earth by putrefaction; and a sort of slime is always found to settle at the bottom of putrified fluids. And hence it is, that the bulk of the solid earth is continually increased, and the fluids, if they are not supplied from without, must be in a continual decrease, and quite fail at last I suspect moreover, that it is chiefly from comets that spirit comes, which is indeed the smallest, but most subtle and useful part of our air, and so much required to sustain the life of all things with us." And in another place, "The vapours which arise from the sun, the fixed stars, and the tails of the comets, may meet at last with, and fall into the atmospheres of the planets by their gravity; and there be condensed and turned into water and humid spirits, and from thence by a slow heat pass gradually into the form of salts, and sulphurs, and tincture, and mud, and clay, and sand, and stones, and coral, and other terrestial substances."

We must refer to Arago for a grave discussion of the following questions: *Do Comets sensibly influence the weather?* Epicures know the "vintage of the comet-year," and who has not read of the

> .... Comet, which with torrid heat,
> And vapour as the Libyan air adust,
> Began to parch that temperate clime.

Were the dry fogs of 1783 *and* 1831, *matter detatched from a comet's tail? Has the moon ever come into collision with a comet? Has she herself formerly been a comet?* and if so, what has she done with her wig? *What would become of us if the Earth were to be carried away as a satellite by a comet?* In which case Arago holds it not proven that the human race would necessarily perish from thermometric changes, and this is consolatory. *Has the axis of the Earth been shifted by the shock of a comet, and did not such a shock produce the depression of the large area in Central Asia?* Lastly, *what would be the effects of a collision between our Earth and a comet?* In answer, listen to Laplace!—If the earth dashed against it, so that the motion in space should be stopped, all things not adhering to the earth's surface, animals, water, &c., would fiy off it at a rate of 72000 miles an hour. Even if the shock did not wholly destroy the earth's velocity, still the axis of rotation would be altered, the seas would leave their beds and rush towards the new equator; in this universal deluge, animal and man would in great part perish, or would be destroyed by the violence of the blow; entire species annihilated; all the courses of human industry confounded, &c., &c. A horrible picture to contemplate! True,—we are comforted by the great virtue of the "if," and by the calculation that the odds are 281 millions to 1 against the happening of the event. So, when the legendary militia-man with shut eyes fired his musket against the barn-door, the chances were millions to one against his hitting any assigned point; nevertheless, *some* point was hit in spite of the enormous odds in its case; and when we know that Biela's Comet cut the Earth's path when she was only one month absent from that point, it must be confessed that the comet has come very close to us nothwithstanding our theory of probabilities.

We have seen that Newton regards with complacency the admixture of a comet's tall with our atmosphere. Herschel on the other hand thinks such a rencontre would be "not unattended with danger." Probably in such matters it will be well to follow the advice of the celebrated philosopher of Astracan—that "the best way to ascertain what the result of such an event can possibly be, will be to wait till the event actually happens."

We conclude with our most hearty thanks to Prof. Bond for his splendid work, and trust to see still more important services rendered by him in a similar examination of the great Comet of 1861.

J. B. C.

SCIENTIFIC AND LITERARY NOTES.

ETHNOLOGY AND ARCHÆOLOGY.

ARTIFICIAL OCCIPITAL FLATTENING OF ANCIENT CRANIA.

The following correspondence is inserted in the Journal at the request of Dr. Joseph Barnard Davis, M.R.C.S., Eng., F.S.A., who has responded to the invitation, contained in the third letter of the series, to reply to the previous letter and paper on the above subject: by enclosing to Dr. Wilson his letter, (No. 4.), with the following request: "I shall feel obliged by your placing it in the hands of the Editor of the *Canadian Journal*, to be printed with our letters to the *Athenæum*, which I also enclose, and any additional remarks you may be pleased to make."

No. 1. *To the Editor of the Athenæum.*

University College, Toronto, Aug. 14th, 1862.

In the last number of the *Natural History Review*, for July, Dr. Joseph Barnard Davis contributes a paper 'On Distortions in the Crania of the Ancient Britons,' the point of chief importance in which is to establish that the peculiar flatness in the occipital region of ancient British crania was produced by some artificial process analogous to that effected by the American Indian cradle-board in infancy. It happens, unfortunately, that, in the belief that Dr. Davis recognized my prior origination of this idea, I have spoken of him in a forthcoming work, 'Prehistoric Man,' as giving the weight of his concurrent testimony to my previously-published opinions. This is not the only case in which I experience the difficulties of a colonial author, with the Atlantic intervening between him and his publisher, and making that false when published which was true when penned. As the sheets of my work are through the press, and the question has some scientific bearings of general interest, perhaps you will favour me with a brief space in the columns of the *Athenæum* for necessary explanation.

In a paper 'On the Supposed Prevalence of One Cranial Type throughout the American Aborigines,' which was read for me by my late brother, Dr. George Wilson, before the Ethnological Section of the British Association, at Dublin, in 1857 and printed in the *Edinburgh Philosophical Journal* for the following

January, as well as in the *Canadian Journal* (Nov., 1857), I remarked, when referring to a striking example of the vertical occiput in an Indian skull found in Canada,—"I think it extremely probable that further investigation will tend to the conclusion that the vertical or flattened occiput, instead of being a typical characteristic, pertains entirely to the class of artificial modifications of the natural cranium familiar to the American ethnologist alike in the disclosures of ancient graves, and in the customs of widely separated living tribes. In this I am further confirmed by the remark of Dr. Morton, in reference to the Peruvian crania;" and, after quoting him in reference to the unsymmetrical conformation common to the Indian occiput, which, he says, "is sometimes, no doubt, increased by the manner in which the child is placed in the cradle," the paper thus proceeds: "To this Dr. Morton subsequently added, in describing an unsymmetrical Mexican skull, 'I had almost omitted the remark, that this irregularity of form is common in, *and peculiar to, American crania.*' The latter remark, however, is too wide a generalization. I have repeatedly noticed the like unsymmetrical characteristics in the brachycephalic crania of the Scotch barrows; and it has occurred to my mind, on more than one occasion, whether such may not furnish an indication of some partial compression, dependent, it may be, on the mode of nurture in infancy, having tended, in their case also, if not to produce, to exaggerate the short longitudinal diameter, which constitutes one of their most remarkable characteristics." Such was the hint I gave of an important feature affecting the question of primitive British archæology, the full working out of which I reserved for the revisal of my '*Prehistoric Annals of Scotland.*' I readily accept the consequences of my delay in publishing more extended views on the subject, and recognise Dr. Davis's claims to all that is novel in his paper; but as he omits all reference to my published views, while referring to various Continental authorities, and produces the idea as an original discovery, the following extract from one of his contributions to the '*Crania Britannica*' will best set forth my reasons, not only for claiming priority of publication, but for crediting Dr. Davis with the adoption of the idea as one first suggested in my paper on the American cranial type. In Decade III. of the '*Crania Britannica,*' when describing an ancient skull from Caedegai Barrow, Denbighshire (pl. 23, p. 3), he remarks:—"Our description of those from Juniper Green, Lesmurdie and Newbigging has made known an unusual and rather abrupt flattening in the occipital region, which we consider to have been the work of art at an early period of life. * * * Among the American races in general there is so marked a flatness in the occipital region, that Prof. Morton was induced to regard it as one of the few typical characteristics of the skull belonging to the American nations, and spreading from one end of the continent to the other. This position, which is, no doubt, founded on truth, must be allowed to be liable to numerous exceptions. * * * Prof. Daniel Wilson, of Toronto, in an able paper, has expressed a reasonable doubt whether this occipital flatness, or great vertical diameter, be properly a universal character of the American races, and has supported his argument by observations made upon crania disinterred in Canada. He has also given expression to a query, which the examination of skulls remarkable for vertical diameter and flatness of occiput naturally induces, whether the American races may not owe these cranial characters, in some measure at least, to artificial distortion? That nature accorded to many of them a brachycephalic skull, and also that this feature is so marked as to be regarded as a typical character among the majority of the races of the western continent, may be admitted. Still, art has been frequently, almost generally, called in to heighten this conformation in a smaller or greater degree; and it is by no means improbable that its influence may be perceived among the aboriginal crania of the British Isles, especially in this greater or less occipital flatness, which is frequently unsymmetrical." ('*Cran. Britann.*,' Decade III., Sept., 1858.)

The mention here made by Dr. Davis of my views on the American artificially-modified cranium is referred in his own foot-note to the *Canadian Journal* (Nov., 1857). The reader of the '*Crania Britannica*' might be apt to suppose that the concluding remarks about British aboriginal crania were entirely new; but any one who takes the trouble of turning to the original article quoted above will find that I had considered the question in its bearings on "the brachycephalic crania of the Scottish barrows" on the same page: hence my assumption that Dr. Davis gave the weight of his testimony to my previously-published views. A highly-interesting chapter, by Dr. Davis, in the First Decade of the '*Crania Britannica*' is devoted to discussing both natural and artificial distortions of the skull; and there, it may be presumed, such an idea would have found place had it been entertained by the writer at that earlier date. He now refers to the Juniper Green, Lesmurdie and Newbigging skulls as illustrating the artificially flattened occiput. But it is only in the description of the last of these, in the same Decade III., published in 1858, that a "slight distorting process" during life is hinted at. In the description accompanying the view of the Lesmurdie skull, in the earlier published Decade, "posthumous distortion" and, in that of Juniper Green "posthumous deformation," are alone referred to.

The Juniper Green skull, as will be seen from the description of it in the '*Crania Britannica*,' was recovered by myself in 1851, when I was collecting materials for a work on Scottish ethnology, supplementary to my '*Prehistoric Annals of Scotland*,' then just published; but which my departure for Canada put a stop to. The skull was carried home in my hand a distance of some miles, and its flattened vertical occiput specially attracted my attention, and formed a subject of conversation on the way with my friend, Mr. Robert Chambers. My opinions were based on the conclusion that its peculiar form could not be assigned to "posthumous deformation," as Dr. Davis suggests in his description, because the skull, when originally found, lay in a stone cist, well fitted and covered with a large stone slab, so that it could not have been subjected to the slightest posthumous compression. It also struck me, on first perusing the description of another skull from a barrow at Codford, in Wiltshire, in the same earlier Decade II., that Dr. Davis had overlooked the very element then recognized by me as a probable source of certain peculiar forms of British crania. The Codford barrow skull is no less strikingly marked in its vertical occiput, and in its short longitudinal, as compared with its vertical, diameter. This, accordingly, is just one of the cases to which I referred as probably "furnishing an indication of some partial compression, dependent, it may be, on the mode of nurture in infancy, having tended, if not to produce, to exaggerate the short longitudinal diameter, which constitutes one of its most remarkable characteristics." But what does Dr. Davis say of it? He treats it as an altogether natural, though exceptional, form, thus:—"The circumstances of such a decidedly brachycephalic cranium occurring amongst the ancient British series should arrest the attention. It shows the latitude of form or variety among any given set of features, but still far from allowing of the withdrawal of the skull from the race to which it belongs, and without by any means wholly overshadowing the ethnical characters appertaining to that race." These remarks occur in Decade II., on the page immediately preceding the description of the Juniper Green skull. When I first read them, with my opinions already formed as to the probable artificial origin of the vertical occiput, they attracted my attention as erroneous. I do not think any reader can have guessed from them that Dr. Davis had already adopted for himself the opinion "that the parieto-occipital flatness was produced by some artificial process."

It has afforded me peculiar pleasure, both before and since I left Scotland, to forward, by any means in my power, the valuable labours of Dr. Thurnam and Dr. Davis in the '*Crania Britannica*,' as a truly national work. I trust, therefore, I need not disclaim any unfriendly spirit in making this explanation, forced on me by being already committed to a statement now liable to misconstruction in sheets which, though unpublished, are already through the press. In a friendly review notice of Decade III., in the *Canadian Journal* for March, 1859, I have said, "In Dr. Davis's latter remark on aboriginal British crania, he adopts observations on the subject which occur in the article in this journal," &c. Possibly this escaped his notice.

Placed as I am at some disadvantage, in relation to literary privileges, from my residence so far from the centres of Science and Literature, I shall esteem myself highly favoured by your courtesy if you can afford space for this communication in the *Athenæum*.

DANIEL WILSON.

No. 2. *To the Editor of the Athenæum.*

Shelton, Staffs., Sept. 22, 1862.

I beg that I may be allowed the favour of a few words of explanation in reference to the letter of Prof. Daniel Wilson in your last publication, which seems to invite my reply.

In the first place, I wish to say explicitly that I regret not having referred in my "Note" in the *Natural History Review* to Dr. Wilson's remarks in the *Canadian Journal* of November, 1857, which contain his surmises of what I take to be the *rationale* of the matter. This is a sin of omission, for which I must apologise. It would have been easy to have referred to Dr. Wilson's "idea," and it would, at the same time, have afforded me a confirmatory authority for the view I have taken—a view which, to say the least, craniologists seem not to be prepared to admit. This omission was an oversight, resulting from lapse of memory alor

The quotation given by Dr. Wilson from my description of the Caedegai skull in the '*Crania Britannica*,' to show that I was *cognizant* of his previous "hint," must surely *prove more than this*. For although it was only a "hint" or "idea," as Dr. Wilson justly describes it, yet the quotation itself shows that I *recognized* him as the enunciator of it. It may be that the reference of the idea to him was not so explicit as it might have been; but it was just the kind of general reference that most writers would have made in the case of a surmise. If, in truth, it were in Dr. Wilson's mind more than an idea, and he was convinced ever since the discovery of the Juniper Green skull in 1851 that the appearance in question was artificial, I had no means of being aware of this, and no knowledge of it whatever, as he had not anywhere published such a "settled conviction." Dr. Wilson is correct in his supposition that his "friendly review notice of Decade III. of the '*Crania Britannica*'" in the *Canadian Journal* of March, 1859, *had escaped my notice*. I was not aware of its existence; and if it contain a further extension of Dr. Wilson's idea, that I am at present wholly ignorant of. Possibly, when Dr. Wilson knows this, it may go far to excuse the omission he complains of. Allowing the greatest weight and importance to Dr. Wilson's previous hints, I believe the theory of the artificial flattening of the occiput is not received, which it certainly might have been, if we were to suppose the date of 1851 as the period of Dr Wilson's conviction, and that of 1857 as the distinct enunciation of this theory. The fact that it was announced as an idea only, accounts for the small attention it has received, not merely from myself, but from others also. Having experienced much of Dr. Wilson's friendly aid and encouragement in the '*Crania Britannica*,'—in truth, it was he who suggested the title of the book itself,—I hope I shall not be misunderstood when I say, that nothing could be farther from my intention than to do him an injustice.

Secondly, as to my own claims in referring these occipital flattenings to what I believe, with Dr. Wilson, is their true cause. On learning Dr. Wilson's "idea" in 1857 or 1858, I was not at all satisfied. Within a year, I had an opportunity of examining about fifty ancient British skulls in the Bateman Museum for other purposes. I took this occasion to inquire into a peculiarity I had observed before—viz., a flat surface, extending over the posterior parts of the parietals and the upper portion of the occipital—the "parieto-occipital flatness" so often alluded to in the '*Crania Britannica*.' I made notes of all the skulls in which this flatness prevailed, and observed that it occurred in *children* as well as adults, and that sometimes it was accompanied with a *posthumous* flattening, with which, however, it did not coincide, but was distinct. Thus it was by taking the parieto-occipital flatness as the basis of my operations—a view wholly new to Dr. Wilson, I believe—that I was led to deduce what I consider to be the true *rationale* of all these deformations. The next step was the receiving a North American Indian skull, with unsymmetrical parieto-occipital flattening, and the inference that the deformation was, in both cases, owing to the same cause—*i. e*, nursing on the cradle-board. Then came the difficulty of comprising the parieto-occipital and the ordinarily flattened occiput of Dr, Wilson in the same category, which seems to me to be explained by the shelf on the cradle-board being placed at different angles by different mothers.

I fear the history of such a discovery can be of little interest; but it seems necessary to give it, in order to show that, although I have not the slightest wish to deprive Dr. Wilson of the origin of the "idea," this idea proved of small moment in deducing the view I now entertain. Still, Dr. Wilson is justly entitled to the priority of its enunciation, and also to the credit of having led my mind to investigate the subject, if really and truly his "hint" was present to my mind in the inquiry—a point upon which I am so uncertain as not to be able to give any direct testimony. All I can say is, that I do not know whether I availed myself of this "hint" or not. It seems most probable that I did not, as my investigation commenced from a different point—viz., parieto-occipital flatness. But, whether or not, it seems to me of small import, as I have not the least desire to deny to Dr. Wilson the credit of the priority of the "idea."

Whether the remark in Dr. Gosse's 'Essai sur les Déformations Artificielles du Crâne," 1855, p. 74, which I have quoted in the "Note," be an indication that the idea had previously occurred to some one else or not, I cannot tell, as he gives no further explanation. Again, in the late Mr. Bateman's 'Ten Years' Diggings,' under the date of discovery, 1851, the year in which Dr. Wilson's attention appears first to have been called to the subject, an ancient British skull is described in these words: "The occiput flattened as if by artificial means during life" (181 T. p. 273). When the observation was made there is now no means of knowing; but it is so pointed as to lead to the query, whether the idea of the true explanation may not have occurred to others as well as to Dr. Wilson even quite as early as to himself?

Whether Dr. Wilson may still be able to quote me, as he says he has intended to do, as confirming the view he announced, must rest with his own judgment. I do not see any impediment to his doing so If he shall please to add, that my investigations had a different point of departure, and yet arrived at the same conclusion, I believe he may make me of use in contributing to the establishment of his views.

I trust that there is nothing in the tone or terms of this communication which can be otherwise than agreeable to Dr. Wilson. If there be, let me say beforehand, to prevent a misunderstanding I should deplore, that it was not intended, and that I gladly retract it.

J BARNARD DAVIS.

No. 3. *To the Editor of the Athenæum.*

"University College, Toronto, Dec. 2, 1862.

"In the *Athenæum* of Sept. 20th, a letter of mine appeared, in which I laid claim to priority of publication on the subject of artificially-flattened occipital forms in British skulls, and complained of the publication by Dr. J. Barnard Davis of a paper on this subject in the *Natural History Review*, in which he claimed the origination of the idea, without noticing my previously-published views, which references in the '*Crania Britannica*' showed to have been previously known to him. I wrote at the same time a lengthened paper for the *Canadian Journal* entitled 'Ethnical Forms and Undesigned Artificial Distortions of the Human Cranium,' with a view to the more complete elucidation of my views: and as this was written under the belief that those already published by me had been deliberately ignored, it is characterized by a controversial tone which I should not otherwise have assumed. Immediately on reading Dr. Davis's courteous reply in the *Athenæum* of Sept. 27th, in which he states that the omission of any reference to my prior publication 'was an oversight resulting from lapse of memory alone,' I wrote to him expressing my regret at the occurrence of such a correspondence, owing to our severance by the Atlantic preventing my receiving his explanation till months after the appearance of his paper. As I now find that Dr. Davis is much more sensitive on the personal aspects of the correspondence than on the question of priority of origination of the opinions there discussed, I shall feel gratified by your affording me an opportunity for expressing with equal publicity my undiminished esteem for him, and my regret that any controversial element should have mingled with our interchange of opinions. I willingly reciprocate the friendly feeling he expresses, and gladly retract whatever in the tone or terms of my former letter can be otherwise than agreeable to him. Such mutual good feeling need not interfere with the utmost freedom in the expression of diversity of opinions; and as to my communication to the *Canadian Journal* (Sept. 1862), I have pleasure in being able to place its columns at his disposal, and invite his reply to what I have published there, where it will be seen by all the readers of my paper.

"I am, &c.,

DANIEL WILSON.

"P.S. I forward this letter by the hands of Dr. J. Barnard Davis."

No. 4. *To the Editor of the Canadian Journal.*

Shelton, Staffordshire, Dec. 20, 1862.

SIR,—The following correspondence has a very intimate connection with the memoir entitled "Ethnical Forms and Undesigned Artificial Distortions of the Human Cranium," by Prof. Daniel Wilson, LL.D., which appeared in your excellent *Journal*, No. XLI., September, 1862, p. 399, and I shall esteem it an act of politeness if you will allow it to appear in the pages of *The Canadian Journal.*

Dr. D. Wilson has very handsomely invited me to reply to his long article, in which he thought proper to comment so freely upon my views, &c., *before seeing what I had to say to his communication in The Athenæum of September* 20; but I feel that in any attempt to reply, however intended, there could scarcely be avoided some appearance of that personal reflection which I sincerely deprecate and lament, or what might be assumed to be such an appearance. I shall therefore confine myself to two or three remarks, principally referring to facts, which, with the concurrence of Dr. Wilson, through whom this communication is transmitted, may be more correctly stated in your pages.

1. Dr. Wilson very properly, at pages 412 and 413, of his memoir, corrects the error into which I had fallen in referring the flattening of the occipital region, in the Juniper Green Cranium, to *posthumous* influences. Being interred in a *cist*, and not exposed to posthumous pressure, such could not be the cause. But he overlooks my own correction of this error, made long before, in different pages of the "Crania Britannica"—Description of Newbigging Skull, pl. 21,

p. (4); Description of the Caedegai Skull, pl. 23, p. (3); Description of Green Lowe Skull, pl. 41, p. (2), &c.

2. I find the readers of Dr. Wilson's memoir regard it as a laudation of my coadjutor, Dr. Thurnam, no doubt for very just and valid reasons, whilst it is, at the same time, a condemnation of myself. I conclude such was not the object of the writer, but it has insensibly resulted from his different treatment of two persons. In some cases, he appears even to have complimented the one at the expense of the other. There is, however, one passage at page 430, in which, by some singular confusion or misleading feeling, he has attributed to that other a sentence in the "Crania Britannica" with which Dr. Wilson is deeply offended, and yet the sentence itself is quite clear in referring its authorship to Dr. Thurnam. Whilst I am disposed to bear my own heavy sins, for which I am happy to say the just and natural apology I have made has produced me full forgiveness, it seems hard to make me the scape goat for the offences of my neighbours, even although they are much purer and better than myself. The sentence is this, referring to the skulls described in Dr. D. Wilson's learned and pleasing volume, "The Archæology and Prehistoric Annals of Scotland," I said: "Further inquiry has produced a serious question of the authenticity of some of the series. The skulls of the supposed Druids of Iona and the Hebrides, *Dr. Thurnam has ascertained* are doubtless those of Christian monks of the eighth or ninth century."—Cran. Brit., p. 21, note. I know not that I ever saw the skulls in question, and I am utterly incapable of giving any opinion upon them. Therefore, however apologetic towards my reputed offence the succeeding comment of Dr. Wilson may be, I must deserve to be wholly exonerated from the supposed delinquency in this case. Dr. Wilson writes: "In the brevity of his note Dr. Davis has probably compressed his remarks into a form implying somewhat more than they were intended to convey; but from the remaining portion of the above comment, no reader unfamiliar with the original text could fail to understand that I had produced certain spurious skulls as Druids of Iona."—(Ethnical Forms, p. 431). Of whatever else I may have been guilty, *I* must assuredly be acquitted of making such an unjust insinuation. It was not mine, that is plain to any reader, and I firmly believe its real author had not the most remote idea that any one could deduce from it an insinuation so unfounded. The heat of argument has sadly misled Dr. Wilson in this portion of his memoir.

3. At page 433, Dr. Wilson quotes from the "Crania Britannica,"—Description of Green Gate Hill Skull, pl. 3 and 4, p. (3): "These differences will go far to render questionable the opinion which has been assumed, that by ascending to the earliest pre-historic times we shall find the crania endowed with uniformity, or, as it were, stereotyped." To which he adds: "An idea not to be met with, so far as I am aware, elsewhere." I can assure Dr. Wilson that the idea is not mine, but that of an able advocate of pre-historic races. In Dr. W. R. Wilde's "Ethnology of the Ancient Irish," he says: "Although we find every variety of head among the modern mixed races of civilized countries, when we come to examine primitive or savage tribes we find the character of their crania and general physical condition more and more *stereotyped* as we recede from civilization."—P. 11.

4. The tone and temper of Dr. Wilson's memoir, where it comments so severely upon myself and the views I have been led to take upon the subject of a precedent and pre-historic race before the Ancient Britons, and who were distinguished by dolicho-cephalism, or kumbe-cephalism, seems to me to be singularly misplaced, if I may be excused the expression, on this ground, viz., that in the consideration of this pre-celtic hypothesis in the "Crania Britannica," I have always treated the opinions of its supporters with the utmost respect and deference, and even opposed them with reluctance. In the Description of the Long Lowe Skull, pl. 33, where the subject is discussed at most length, this passage occurs: "The pre-celtic hypothesis is received by investigators deserving so much respect and confidence, that we feel both bound and anxious to do ample justice to every fact of the case, and to exercise the utmost candour in the estimation of the hypothesis itself."—P. (4). This passage was written in all sincerity, and I am not aware of any page in the work in which I have deviated from the spirit which it expresses.

5. I confess to one delinquency with which I am charged, to this extent, that I may have manifested some change in my views upon some points in the course of the seven years during which the "Crania Britannica" has been in progress, and thus given opportunity to Dr. Wilson to point out some trifling inconsistencies. My opinions were not "crystallized" when my labours commenced, and, I am ready to acknowledge, even now, that they are not in that completed and fixed state, that the rays of light which Dr. Wilson and other inquirers may yet cause to shine into my mind must necessarily be wholly inoperative upon them.

Finally, I cannot help regretting that any act of carelessness on my part should have occasioned any uneasiness to my friend Dr. D. Wilson, to whom I owe so many favours and acts of kindness. I can assure him that it is a source of congratulation to European craniologists that the learned and acute author of "The Archæology and Prehistoric Annals of Scotland," and of the recent and elaborate volumes on the curious subject of "Prehistoric Man," should have directed his attention to the subject of cranial forms among the American races, and the strange difformities to which they have been exposed. In this branch of inquiry he has already shown, what I have long anticipated, that great differences of skull-forms have existed among these numerous and diversified nations,—doubtless coincident with their other diversities.

I am, &c., J. Barnard Davis.

No. 5. *To the Editor of the Canadian Journal.*

University College, Toronto, Jan. 19, 1863.

Sir,—Having invited Dr. Davis to avail himself of the pages of this journal for any counter-statement he desired to make to my paper on "Artificial Distortions of the Human Cranium," I enclose herewith his reply. In this, as it appears to me, he fails to discriminate between expressions of dissent from his opinions, and an attack on himself; the latter of which I altogether disclaim. After having been familiar for years with the utmost freedom of critical assault on my own published opinions, I find it difficult to appreciate his extreme sensitiveness on this point; or to understand why the most friendly relations either with him or Dr. Thurnam should prevent my controverting their opinions as freely as they know I have allowed them to challenge mine. They are both well aware that their adverse comments on my views as set forth in the "Prehistoric Annals of Scotland"—to which I recently replied in this journal,—made no change either in my correspondence with them, or in my exertions on behalf of their joint work.

Dr. Davis forgets the object of my letter to the *Athenæum*, and the article of same date in this Journal, when he speaks of my overlooking his corrections of his earlier error in relation to *posthumous* influences. I referred to a specific date in 1857, when I published certain opinions, and showed by reference to the *Crania Britannica*, that previous to their publication the views he held were incorrect. It was no part of my object to review his subsequent opinions. He says himself, in letter 2, he cannot tell whether he availed himself of my hint, or not, in these subsequent views. On this point I express no opinion; but I have failed to perceive any essential distinction between what he calls "a different point, viz., parieto-occipital flatness," and what I had long before referred to as "the vertical or flattened occiput."

The reader who turns to the *Crania Britannica*, p. 21, or to the passage quoted from it in this Journal (ante, vol. vii., p. 430), will probably be inclined to think with me, that a passage written by Dr. Davis, in which he states in his own words certain opinions, which he ascribes to Dr. Thurnam, is his, and not Dr. Thurnam's. My answer, however, to the opinions therein expressed is the same, whoever may be responsible for them.

As Dr. Davis writes now at my invitation, I shall leave his remarks to the impartial consideration of your readers, without comment; and only add in explanation of the course I pursued, that my letter to the *Athenæum*, was necessarily limited to the claim of priority of publication of the views in question. My article in the *Canadian Journal* for September, written simultaneously with it, set forth in detail what these views are. When Dr. Davis complains that the latter was written *before seeing what he had to say to my communication*, he forgets that his article,—in which he communicated to the scientific world, in *July* 1862, as an original discovery, what he now admits to have been suggested by me, in this *Journal*, so early as Nov., 1857,—not only was already in circulation among the readers of the *Natural History Review*, to whom I have no such access as I have accorded to him in these pages; but it remains there uncorrected to the present day.

I am, &c.,

DANIEL WILSON.

NATURAL HISTORY.

To the Editor of the Canadian Journal.

Peterboro, C. W., January 14th, 1863.

DEAR SIR,—Some four or five years ago I had the pleasure to offer to the Institute a tolerably good specimen of that most interesting *Rodent*, the *Castor Fiber:* and with the skin I forwarded a certificate to the effect that the animal was shot by a lad with whom I am acquainted, on the margin of a stream running between the village of Lakefield, in the Township of Douro, and the Town of Peterboro, at a spot situated but six miles from the latter place.

It may not be uninteresting to those Members of the Institute who make the *Fauna* of Canada their study, to learn that another individual of the same species was trapped, a few weeks since, in the Township of Monaghan, in a creek *within three miles of this town*. The Beaver weighed, when killed, forty-six pounds, and measured four feet eight inches in length.

It is well known to Naturalists that the nail of the second toe of each hind foot of the Beaver is invariably split; it is, in fact, a *double* nail. *Cui Bono?* I should esteem it a favour if any of your correspondents will adduce a reason for this peculiarity; for that some sufficient reason *can* be assigned I entertain not the shadow of a doubt.

Beavers are more abundant than usual in our County this season, and I have recently seen some very fine cuttings in the neighbourhood of Stony Lake; one, of poplar, eighteen inches in diameter. It is said that a single Beaver will "fall" a tree of that size in the space of half-an-hour.

I am, dear Sir, yours faithfully,

VINCENT CLEMENTI.

GEOLOGY AND MINERALOGY.

ORIGIN OF LAKE BASINS.

In an interesting paper on the lakes of Switzerland, etc., published in a recent number of the *Journal of the Geological Society*, Professor Ramsay maintains the glacial origin of the basins of these lakes, and he attributes a similar origin or mode of formation to the great lake basins of this continent. In this view, Prof. Ramsay states that he is supported by the opinion of Sir William Logan, who points out that our northern lakes are in true rock-basins, in areas occupied by comparatively soft deposits surrounded by harder rocks; the arrangement of the strata proving, moreover, that these lakes do not lie in areas of special subsidence. After a detailed review of the leading characteristics of the Alpine lakes, Prof. Ramsay condenses the evidence in support of his conclusions into the following summary. He remarks:

1st. That each of the great lakes lies in an area once covered by a vast glacier. There is, therefore, a connexion between them which can scarcely be accidental.

2nd. I think the theory of an area of *special subsidence* for each lake untenable, seeing no more proof for it in the case of the larger lakes than for the hundreds of tarns in perfect rock-basins common to all glacier-countries, present or past, and the connexion of which with diminished or vanished glaciers I proved originally in "The Old Glaciers of North Wales." In the Alps there is a gradation in size between the small mountain-tarns and the larger lakes.

3rd. None of them lie in lines of *gaping fracture*. If old fractures ran in the lines of the lakes or of other valleys, and gave a tendency to lines of drainage, they are nevertheless, in the deep-seated strata, exposed to us as close fractures now, and the valleys are valleys of erosion and true denudation.

4th. They are none of them in simple synclinal basins, formed by the mere disturbance of the strata after the close of the Miocene epoch; nor,

5th. Do they lie in hollows of common watery erosion; for running water and the still water of deep lakes can neither of them excavate profound basin-shaped-hollows. So deeply did Playfair, the exponent of the Huttonian theory, feel this truth, that he was fain to liken the Lake of Geneva to the petty pools on the New Red Marl of Cheshire, and to suppose that the hollow of the lake had been formed by the dissolution and escape of salts contained in the strata below.

6th. But one other agency remains—that of ice, which, from the vast size of the glaciers, we are certain must have exercised a powerful erosive agency. It required a solid body, grinding steadily and powerfully in direct and heavy contact with and across the rocks, to scoop out deep hollows, the situations of which might either be determined by unequal hardness of the rocks, by extra weight of ice in special places, or by accidental circumstances, the clue to which is lost, from our inability perfectly to reconstruct the original forms of the glaciers.

7th. It thus follows that, valleys having existed giving a direction to the flow of the glaciers ere they protruded on the low country between the Alps and the Jura, these valleys and parts of the plain, by the weight and grinding power of ice in motion, were modified in form, part of that modification consisting in the excavation of the lake-basins under review.

In connexion with this point, it is worthy of remark that glaciers, many of them very large in the modern sense of the term, on the south side of the Vallais (excepting those of Mont Blanc), and the large glaciers on the south side of the Oberland, all drain into the Lake of Geneva; those on the north of the last-named snow-field, also large glaciers, are drained through the Lakes of Brienz and Thun. These, among the largest existing glaciers of the Alps, are only the shrunken tributaries of the greater glaciers that in old times filled and scooped out the basins of the lakes. The rest of the lakes, as already stated, are in equally close connexion with the old snow-drainage of glacier-regions on the grandest scale,—all of them, excepting those of Neuchâtel, Bienne, and Morat, lying in the direct course of glaciers filling valleys that extend right into the heart of the mountains.

8th. Most of the lakes are broad or deep according to the size of the glaciers that flowed through the valleys in which they lie, this general result being modified according to the nature of the rock and the form of the ground over which the glacier passed. Thus, the long and broad Lake of Geneva, scooped in the Miocene lowlands, is 984 feet deep, and over its area once spread the broad glacier of the Rhone. Its great breadth and its depth evince the size of the glacier that overflowed its hollow. The Lake of Constance, lying in the same strata, and equally large, is 935 feet deep, and was overspread by the equally magnificent glacier of the Upper Rhine. The Lakes of Maggiore and Como, deepest of all, lie in the narrow valleys of the harder Secondary rocks of the older Alps; and the bottom of the first is 1992 feet, and the latter 1043 feet below the sea level. Both of these lie within the bounds of that prodigious system of glaciers that descended from the east side of the Pennine Alps and the great ranges north and south of the Val Tellina, and shed their moraines in the plains of Piedmont and Lombardy. The depths of the lakes correspond to the vast size and vertical pressure of the glaciers. The circumstance that these lakes are deeper than the level of the sea does not affect the question, for we know nothing about the absolute height of the land during the Glacial period.

The Lakes of Thun and Brienz form part of one great hollow, more than 2000 feet deep in its eastern part, or nearly 300 feet below the level of the sea. They lie in the course of the ancient glacier of the Aar, the top of which, as *roches moutonnées* and striations show, rose to the very crests of the mountains between Meyringen and the Grimsel.

The Lake of the Four Cantons is imperfectly estimated at only 884 feet in depth; but here we must also take into account the great height and steep inclines of the mountains at its sides. The Lake of Zug, 1311 feet deep, lies in the course of the same great glacier, the gathering-grounds of which were the slopes that bound the tributaries of the Upper Reuss and the immense amphitheatre of the Urseren Thal, bounded by the Kroutlet, the Sustenhorn, the Galenstock, the St. Gothard, and the southern flanks of the Scheerhorn.

The lesser depths (660 feet) of the Lake of Zurich were hollowed by the smaller but still large glacier that descended the valley of the Linth.

Passing then to an examination of the lakes of the Northern Hemisphere generally, Professor Ramsay concludes as follows:

Furthermore, considering the vast areas over which the phenomena described are common in North America and Europe, I believe that this theory of the origin of lake-rock-basins is an important point, in addition to previous knowledge, towards the solution of the glacial theory; for I do not see that these hollows can in any way be accounted for by the hypothesis that they were scooped by floating ice.* An iceberg that could float over the margin of a deep hollow would not touch the deeper recesses of the bottom. I am therefore constrained to return, at least in part, to the theory many years ago strongly advocated by Agassiz, that, in the period of extremest cold of the Glacial epoch, great part of North America, the north of the Continent of Europe, great part of Britain, Ireland, and the Western Isles, were covered by sheets of true glacier-ice in motion, which moulded the whole surface of the country, and in favorable places scooped out depressions that subsequently became lakes.

This was effected by the great original glaciers (probably connected with the origin of the *unstratified* boulder-clay) referred to in my memoir on the glaciers of North Wales, but the magnitude of which I did not then sufficiently estimate.

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* I do not in any way wish to deny that much of the glaciation of the lower countries that came within the limits of the Drift was effected by floating ice on a large scale, which must have both polished and striated the rocks along which it ground. I have, with other authors, described this in various memoirs. But the two sets of phenomena are distinct.

The cold, however, continued during the depression of North Wales and other districts beneath the sea, when they received the *stratified* erratic drift; and glaciers not only did not cease at this time of depression, but were again enlarged during the emergence of North Wales and other countries, so as to plough the drift out of many valleys. These enlarged glaciers, however, bore no comparison in size to the great original sheets of ice that converted the north of Europe and America into a country like North Greenland. The newer development of glaciers was strictly local. Amelioration of climate had already far advanced, and probably the gigantic glaciers of Old Switzerland were shrinking into the mountain-valleys.

Finally, if this be true, I find it difficult to believe that the change of climate that put an end to this could be brought about by mere changes of physical geography. The change is too large and too universal, having extended alike over the lowlands of the Northern and the Southern Hemispheres. The shrunken or vanished ice of mountain-ranges is indeed equally characteristic of the Himalaya, the Lebanon, the Alps, the Scandinavian chain, the great chains of North and South America, and of other minor ranges and clusters of mountains like those of Britain and Ireland, the Black Forest, and the Vosges.

MINERALOGICAL NOTICES.

Meteoric Stone of Chassigny.—This celebrated meteorite, first examined by Vanquelin in 1816, a few months after its fall, has been recently analysed by Damour, and shewn to exhibit the formula of a ferruginous chrysolite, viz.:—$2RO, SiO^2$—in which $RO = \frac{1}{4} FeO + \frac{3}{4} MgO$ (*Comptes Rendus*, LV., No. 15). The stone, with a sp. gr. 3·57, has a pale greenish-yellow colour, and is quite free from metallic iron. Partsch, in his well-known catalogue of the Meteorites in the Royal Collection at Vienna, describes it as one of remarkable peculiarity. Although small grains of chrysolite (or olivine) have been observed in various meteorites, this is the only known example of a meteoric stone composed essentially of that mineral.

Forcherite.—Under this name, Prof. Auhkom, in 1860, described a hydrated siliceous substance, of a yellow colour, from Reittelfield in Upper Styria. A more recent examination by R. L. Maly (*Journ. fur prak. Chemie*, Sept. 1862), has shewn the substance in question to be an opal, accidentally coloured by variable proportions of sulphide of arsenic (orpiment?) The term *Forcherite* as applied to this variety of the opal, will not obtain admission, it is to be hoped, into the already overcrowded lists of mineralogical synonymes.

Composition of Staurolite and Tourmaline.—During the course of last year, Rammelsburg made known the presence of protoxide of iron (a fact already pointed out, however, by the writer of these notes, in 1848). Mitscherlitch has subsequently ascertained that all the iron is in that condition (*Journ. f. prak. Chem.*, *Bd.* 86). He has also re-examined various tourmalines and found that no sesquioxide of iron is properly present in these, but only FeO. A satisfactory formula for either staurolite or tourmaline, nevertheless, is still to be deduced.

E. J. C.

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST,—OCTOBER, 1862.

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

	Barom. at temp. of 32°.				Temp. of the Air.				Excess of mean above Normal.	Tens. of Vapour.				Humidity of Air.				Direction of Wind.			Resultant Direction.	Velocity of Wind.					Rain in Inches.	Snow in Inches.
	6 A.M.	2 P.M.	10 P.M.	MEAN.	6 A.M.	2 P.M.	10 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.	Result.	ME'N		
1	29.758	29.748	29.737	29.7472	44.6°	52.2°	54.7°	50.27°	— 0.15°	.264	.358	.403	.338	.90	.92	.94	.92	N E	E	E	N 60° E	10.5	6.4	6.2	5.59	5.83	0.085	...
2	.682	.614	.701	.6667	53.6	61.8	59.4	58.47	+ 8.53	.406	.504	.498	.473	.99	.91	.98	.96	N b E	S b W	Calm.	S 53 E	0.5	0.4	0.0	0.28	0.65	0.087	...
3	.735	.652	.572	.6453	58.7	61.9	60.9	60.80	+11.27	.480	.542	.528	.521	.97	.98	.99	.97	S E b E	E b N	E b S	N 78 E	1.0	6.4	2.0	3.48	3.53	0.565	...
4	.414	.337	.680	.4992	60.5	72.0	52.9	61.03	+12.00	.521	.500	.235	.400	.99	.63	.58	.72	E b S	W	N W b W	N 86 W	1.5	27.0	27.0	15.05	17.21	0.072	...
5	.918	.950	—	—	42.5	58.3	—	--	—	.218	.333	—	—	.80	.68	—	—	N W b W	N N W	Calm.	N 28 W	1.8	7.0	0.0	3.70	3.88	...	...
6	.797	.572	.363	.5555	43.5	58.3	60.5	54.63	+ 6.42	.231	.390	.442	.370	.82	.80	.84	.85	Calm.	S	S W b W	S 23 W	0.0	3.2	4.2	4.11	4.76	0.185	...
7	.414	.390	.368	.3917	62.3	73.5	67.0	67.55	+19.70	.536	.671	.566	.593	.95	.81	.85	.88	S W b S	S W b S	S W	S 41 W	10.5	11.2	5.5	6.31	6.32	Inp.	...
8	.416	.373	.331	.3937	65.9	76.0	68.4	69.38	+21.93	.488	.605	.618	.554	.76	.67	89	.77	S W b S	S W	S W	S 52 W	6.2	15.2	13.2	8.27	10.89	0.175	...
9	.605	.735	.816	.7363	55.8	57.2	52.9	54.95	+ 7.88	.377	.337	.338	.339	.85	.71	.84	.78	N W b N	N N W	N b E	N 7 W	0.5	2.8	4.0	3.08	3.29	0.030	...
10	.779	.569	.568	.6338	50.4	51.8	45.0	48.42	+ 1.75	.288	.290	.258	.292	.78	.75	.96	.86	N N E	N N E	N	N 1 E	5.5	10.8	9.0	8.95	9.73	0.270	...
11	.699	.740	.776	.7502	44.3	53.6	42.5	46.15	— 0.10	.239	.297	.190	.242	.82	.72	.70	.76	N N W	N b W	N N W	N 20 W	6.8	2.5	4.0	5.49	5.58	0.050	...
12	.810	.741	—	—	36.3	52.6	—	—	—	.176	.259	—	—	.82	.65	—	—	N	E b S	E b S	N 73 E	4.5	4.5	4.0	3.00	3.81	...	...
13	.619	.561	.533	.5758	42.5	57.6	50.0	50.10	+ 4.53	.244	.353	.324	.310	.89	.74	.89	.85	N b E	S E b S	Calm.	N 79 E	5.0	2.2	0.0	0.43	1.30	...	...
14	.601	.633	.796	.6910	41.4	55.8	42.1	46.02	+ 0.75	.250	.322	.223	.259	.95	.72	.83	.83	N W	N W b N	N N W	N 25 W	1.0	13.8	4.5	8.01	8 34	...	...
15	.902	.861	.724	.8213	36.0	41.0	39.9	38.92	— 5.93	172	.193	.211	.191	.81	.75	.86	.81	N E	N E	N b E	N 63 E	4.0	2.5	2.4	2.66	3.43	...	...
16	.577	.448	.428	.4817	45.0	48.2	47.9	47.03	+ 2.50	.278	.307	.311	.299	.94	.91	.93	.90	S E b E	S W	W S W	S 44 W	5.0	3.0	1.0	2.50	3.92	0.053	...
17	.537	.667	.818	.7038	41.4	53.3	41.7	44.98	+ 0.75	.232	.240	.210	.219	.89	.58	.79	.74	W b N	W N W	N W b N	N 65 W	6.0	11.8	2.0	4.70	4.78	...	...
18	.922	.799	.651	.7882	34.5	57.2	49.7	47.70	+ 3.67	.181	.303	.298	.265	.90	.64	.84	.79	Calm.	S b W	Calm.	S 25 W	0.0	9.6	0.0	5.08	5.35	...	...
19	.481	.490	—	—	49.3	52.2	—	—	—	323	.203	—	—	.91	.50	—	—	W S W	W N W	N W	N 61 W	8.8	17.0	15.5	13.03	13.76	0.026	...
20	.758	.675	.454	.6150	30.2	45.0	49.0	42.78	— 0.78	.149	.221	.256	.213	.89	.74	.74	.76	N W b N	S S W	S	S 21 W	1.0	7.5	10.5	8.79	9.09	...	...
21	.194	.101	.047	.1168	51.8	50.4	46.4	48.77	+ 5.52	.290	.340	.298	.302	.75	.93	.94	.87	S S W	S W	S b W	S 56 W	13.0	5.5	1.0	6.61	7 40	0.635	...
22	.125	.295	.551	.3430	42.1	46.8	40.7	42 77	— 0.20	.204	.180	.231	.206	.76	.55	.91	.76	W b S	W N W	W N W	N 67 W	13.8	25.8	10.5	16.22	16.57	Inp.	...
23	.773	.910	.866	.8585	35.2	43.2	36.3	38.23	— 4.52	.190	.198	.193	.192	.93	.70	.90	.83	N b W	W N W	Calm.	S 83 W	0.5	14.5	0.0	2.32	4.80	0.040	...
24	.736	.555	.703	.6628	45.0	52.6	46.4	47.45	+ 4.95	.230	.310	.249	.253	.77	.78	.79	.77	S	S W b S	N W b W	S 79 W	10.0	13.8	16.8	3.25	11.67	0.100	...
25	.884	.973	30 039	.9735	37.0	38.5	32.0	35.37	— 6.92	.183	.173	.166	.175	.84	.74	.91	.85	W N W	N	N	N 11 W	6.5	7.4	6.2	5.61	6.50	..	Inp.
26	.918	.775	—	—	30 9	31.3	—	—	—	.164	.160	—	—	.95	.99	—	—	N E b N	N b E	N b E	N 14 E	8.8	6.6	4.0	5.11	5.57	...	0.5
27	.528	.486	29.586	.5102	27.0	42.1	32.7	34.77	— 7.02	.136	.179	.172	.167	.93	.66	.92	.83	N W b N	W N W	Calm.	N 47 W	1.0	12.0	0.0	3.69	3.82	...	...
28	.655	.640	.654	.6478	32.7	45.4	41.4	40.43	— 1.05	.172	.234	.232	.216	.92	.77	.83	.86	Calm.	S E b E	W b S	S 14 E	0.0	0.5	1 0	3.01	3.29	0.315	...
29	.571	.654	.818	.7022	43.5	47.0	36.7	42.13	+ 0.87	.268	.223	.188	.223	.95	.68	.86	.83	S W b S	W	W b N	N 85 W	1.8	12.2	4.0	7.20	7.33	Inp.	...
30	.813	.557	.577	.6472	35 6	52.2	45.4	44.75	+ 3.80	.193	.275	.234	.235	.93	.70	.77	.79	N W	S	S W	S 24 W	0.5	4 4	1.0	2.09	3.70	Inp.	...
31	.607	.451	.518	.5188	41.7	57.6	51.8	51 17	+10.42	.228	.332	.249	.269	.86	.69	.64	.71	Calm.	S W b S	S W b W	S 42 W	0.0	13.5	5.8	6.19	6.42	...	...
M	29.6334	29.5924	29.6206	29.6188	44.53	53.79	47.94	48.70	+ 3.66	.275	.329	.302	.300	.88	.75	.85	.82	....	....	....	....	4.39	9.06	5.33	......	6.53	2.684	0.5

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR OCTOBER, 1862.

Highest Barometer........................ 30.039 at 10 p. m. on 25th } Monthly range =
Lowest Barometer .... 29.047 at 10 p. m. on 21st } 0.992 inches.

Self-registering Thermom.:
- Maximum Temperature .... 76°6 on p.m. of 8th } Monthly range=
- Minimum Temperature .... 26°2 on a.m. of 27th } 50°4
- Mean maximum Temperature .... 51°80 } Mean daily range=
- Mean minimum Temperature .... 41°43 } 13°36
- Greatest daily range .... 23°2 from a. m. to p.m. of 18th.
- Least daily range................ 2°8 from a. m. to p. m. of 26th.

Warmest day......... 8th... Mean temperature......... 69°38 } Difference = 34°61.
Coldest day .... 27th... Mean temperature ...... 34°77 }
Maximum { Solar.......................................98°0 on p.m. of 7th } Monthly range =
Radiation. { Terrestrial.................................19°6 on a.m. of 27th } 78°4
Aurora observed on 6 nights, viz.,—4th, 11th, 12th, 13th, 22nd, and 29th.
Possible to see Aurora on 12 nights; impossible on 19 nights.
Snowing on 2 days, depth 0.5 inches; duration of fall, 4.0 hours.
Raining on 19 days,—depth 2.684 inches; duration of fall 71.7 hours.
Mean of cloudiness = 0.72. Above average 0.10.
Most cloudy hour observed, 4 p. m., mean = 0.77; least cloudy hour observed, mid.; mean, = 0.66.

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

North.	South.	East.	West.
1786.81	1310.52	519.17	2622.61

Resultant direction N. 78° W.; Resultant velocity 2.89 miles per hour.
Mean velocity ....6.53 miles per hour.
Maximum velocity ....38.2 miles, from 11 a.m. to noon on 22nd.
Most windy day ......4th ....Mean velocity, 17.21 miles per hour. } Difference=
Least windy day......2nd ....Mean velocity, 0.65 ditto. } 16.56 miles.
Most windy hour ...1 p.m. to 2 p.m. ....Mean velocity, 9.55 ditto. } Difference=
Least windy hour...5 a.m. to 6 a.m. ....Mean velocity 3.95 ditto. } 5.60 miles.

1st. Foggy 10 p.m. and midnight.—2nd. Dense fog 6 and 8 a.m. and 10 p.m. and midnight.—3rd. Dense wetting fog all day.—4th. Ground fog 6 a.m.; distant thunder 9 a.m.; wind high and squally.—7th. Sheet lightning in N. E. at 6 p.m.; sultry day.—8th. Sheet lightning in W. at 7 30 p.m.; very sultry day.—9th. Imperfect rainbow at 6.20 a.m.—11th. Rainbow 3.30 to 4.10 p.m.—12th. Thin ice at 6 a.m.—14th. Dense fog 6 to 7 a.m.—17th. Thin ice at 6 a.m.—18th. Thin ice at 6 a.m.—19th. Shower of hail and rain 6 30 to 9 a.m.—21st. Severe thunderstorm 8 to 9 p.m.; loud thunder, vivid lightning, heavy rain, and very large hailstones.—25th. Particles of snow 9 30 a m. to 3.30 p.m., *(first of the season.)*—26th. Light snow 6 to 11.30 a.m.—28th. Lunar halo during the evening.

Heavy Dew recorded on 2 mornings during this month.—Indian Summer, 29th Oct.

to 2nd Nov. Inclusive.—Rapid descent of temperature: from 4th p.m. = 73°8, to 5th a.m. = 40°4; range in 16 hours = 33°4.—The month of October, 1862, was comparatively mild, wet, windy, and cloudy.

COMPARATIVE TABLE FOR OCTOBER.

YEAR.	TEMPERATURE.					RAIN.		SNOW.		WIND.		
	Mean.	Excess above aver'ge (45 5)	Max. ob- served.	Min. ob- served.	Range.	No. of days.	Inches	No. of days.	Inches	Resultant. Direction.	Resultant. V'y.	Mean Force or Velocity.
1840	44.4	— 1.1	68.5	23.9	44.6	13	1.860	3	...	...	...	....
1841	41.6	— 3.9	58.3	20.3	38.0	6	1.360	2	...	...	...	0.41 lbs.
1842	45.1	— 0.4	68.5	30.0	38.5	8	5.175	0	...	...	...	0.35
1843	41.8	— 3.7	65.7	24.5	41.2	12	3.790	4	2.5	...	...	0.54
1844	43.3	— 2 2	69.6	17.8	51.8	7	Imp.	4	12.0	...	...	0.43
1845	46.4	+ 0.9	62.7	20.0	42.7	11	1.760	1	Inp.	...	...	0.20
1846	44.6	— 0.9	69.7	20.7	49.0	14	4.180	2	Inp.	...	...	0.44
1847	44.0	— 1.5	65.0	20.3	44.7	13	4.390	2	Inp.	...	...	0.19
1848	46.3	+ 0.8	62.2	26.4	35.8	11	1 550	0	0.0	N 54° W	1.24	4.60mls.
1849	45.3	— 0.2	59.2	25.5	33.7	13	5.965	1	Inp.	N 12° W	1.27	4.76
1850	45.4	— 0.1	66.6	24.8	41.8	10	2.085	0	0.0	N 66° W	1.10	5.30
1851	47.4	+ 1.9	66.1	25.0	41.1	10	1.680	2	0.3	S 72° W	1.06	4.39
1852	48.0	+ 2.5	70.7	29.8	40.9	12	5.280	0	0.0	N 5° E	1.19	4.47
1853	44.4	— 1.1	64.7	25.5	39.2	10	0.875	2	Inp.	S 88° W	1.74	4.77
1854	49.5	+ 4 0	74.2	29.8	44.4	15	1.495	3	Inp.	N 45° W	1.52	4.57
1855	45.4	— 0.1	64.3	28.0	36.3	14	2.485	5	0.8	N 82° W	4.91	9.88
1856	45.3	— 0.2	70.1	23.3	46.8	10	0.875	2	0.1	N 76° W	2.15	6.07
1857	45.4	— 0.1	63.5	27.7	35.8	10	1.040	2	0.2	N 19° W	2.93	6.24
1858	48.8	+ 3.3	76.3	34.2	42 1	17	1 797	1	Inp.	N 34° W	0.36	5.96
1859	43.0	— 2 5	68.4	22.3	46.1	11	0.940	4	Inp.	N 68° W	5.04	8.12
1860	47.3	+ 1.8	63.7	28.4	35.3	15	1.618	1	Inp.	N 9° W	2.00	6.93
1861	48.7	+ 3.2	64.5	30.2	34.3	15	1.993	1	Inp.	N 61° W	1.06	5.96
1862	48.7	+ 3.2	76.0	27.0	49.0	19	2.684	2	0.5	N 78° W	2.89	6.53
Results to 1861.	45.52	...	66.48	25.38	41.10	11.7	2.485	19	0.84	N 56° W	1.67	5.86
Exc. for 1863.	+ 3.18	...	+ 9.52	+1.62	+ 7.90	+ 7.3	+ 0.199	+ 0.1	— 0.34	....	......	+ 0.67

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST,—NOVEMBER, 1862.

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

Day.	Barom. at temp. of 32°. 6 A.M.	2 P.M.	10 P.M.	Mean.	Temp. of the Air. 6 A.M.	2 P.M.	10 P.M.	ME'N	Excess of mean above Normal.	Tens. of Vapour. 6 A.M.	2 P.M.	10 P.M.	M'N	Humidity of Air. 6 A.M.	2 P.M.	10 P.M.	M'N	Direction of Wind. 6 A.M.	2 P.M.	10 P.M.	Resul't. Direction.	Velocity of Wind. 6 A.M.	2 P.M.	10 P.M.	Re-sul't.	ME'N	Rain in inches.	Snow in inches.
1	29.601	29.514	29.496	29.5358	45.0	58.0	46.1	50.35	+ 9.88	.249	.305	.254	.265	.83	.62	.81	.72	Calm.	S S E	S b W	S 34 W	0.0	7.5	1.8	2.23	2.83	...	...
2	.466	.366	—	—	50.8	52.6	—	—	—	.303	.283	—	—	.81	.73	—	—	N W b N	N N W	N W b N	N 45 W	3.8	3.0	13.0	10.40	12.26	0.680	...
3	.366	.310	.792	.5782	39.6	43.5	32.7	37.65	− 2.35	.184	.186	.135	.160	.75	.66	.73	.70	W b N	N W b W	N	N 52 W	13.0	22.5	0.5	10.41	11.55	Inp.	...
4	.885	.832	.680	.7955	28.7	39.6	30.6	36.50	− 3.27	.123	.194	.219	.179	.77	.79	.90	.81	N E b N	E b S	Calm.	S 63 E	3.0	8.2	0.0	2.90	3.59	...	...
5	.546	.424	.636	.5197	34.5	49.3	34.5	38.37	− 1.12	.173	.242	.144	.185	.86	.68	.72	.78	E b N	N W b W	N N W	N 33 W	0.5	10.0	11.8	8.84	8.99	0.050	...
6	.713	.634	.695	.6867	26.2	33.1	28.4	28.62	−10.55	.110	.093	.112	.105	.77	.49	.72	.68	N b W	N W	N E	N 25 E	3.6	7.0	7.5	5.31	6.22	...	...
7	.778	.777	.789	.7753	23.0	30.6	27.7	27.33	−11.67	.106	.100	.113	.102	.86	.58	.74	.69	N E b N	N E b N	N b E	N 28 E	8.0	8.2	6.2	7.88	8.13	..	0.2
8	.712	.716	.758	.7357	23.7	28.0	28.4	26.65	−12.03	.118	.124	.142	.128	.93	.81	.90	.89	N N E	N b E	N N W	N 10 E	6.0	7.5	5.8	5.46	5.90	...	0.5
9	.782	.706	—	—	28.4	41.7	—	—	—	.135	.210	—	—	.86	.79	—	—	N W	N W b W	W	N 66 W	10.4	16.2	5.0	6.40	6.72	...	...
10	.789	.792	.792	.7935	34.9	45.4	34.5	37.95	− 0.15	.161	.162	.163	.166	.79	.52	.82	.73	W S W	W b N	N N E	N 53 W	3.2	8.0	2.0	2.89	4.35	...	...
11	.685	.456	.361	.4937	36.7	48.6	49.3	44.80	+ 7.02	.188	.221	.293	.236	.86	.64	.83	.79	E S E	S b W	S W b S	S 51 W	2.8	7.2	13.5	5.42	8.55	0.045	...
12	.629	.709	.648	.6780	40.7	41.0	37.4	39.33	+ 1.83	.213	.157	.196	.182	.84	.61	.87	.76	W N W	N W b N	Calm.	N 69 W	11.8	2.2	0.0	5.25	5.53	...	...
13	.755	.822	.834	.8030	37.4	42.8	40.3	39.38	+ 2.20	.179	.177	.193	.185	.80	.64	.77	.76	W b S	S W b W	S W	S 55 W	3.0	10.0	8.0	5.60	5.83	...	..
14	.741	.809	30.158	.9333	38.5	42.8	27.7	35.60	− 1.30	.182	.177	.121	.157	.73	.61	.80	.75	S W	W N W	N	N 41 W	2.0	14.4	10.4	9.53	11.97	Inp.	Inp.
15	30.391	30.426	30.412	30.4273	17.2	27.0	24.8	22.80	−13.70	.087	.107	.105	.099	.91	.73	.79	.81	N	E S E	N E	N 50 E	5.2	7.5	5.8	7.31	7.75	...	...
16	30.345	30.191	—	—	24.4	35.3	—	—	—	.117	.164	—	—	.89	.80	—	—	N E b E	E	S S E	S 65 E	10.5	7.4	6.5	5.45	6.27	0.225	...
17	29.896	29.880	30.062	29.9553	39.9	49.3	41.4	43.13	+ 7.33	.233	.303	.187	.236	.95	.86	.72	.84	S E b S	N W b N	N	N 17 W	0.2	10.0	4.2	3.71	4.49	Inp.	...
18	30.061	.930	29.741	.8950	37.4	41.7	39.9	39.57	+ 4.08	.179	.218	.224	.210	.80	.82	.91	.86	N E	E	N E b E	N 78 E	0.8	4.8	2.2	2.85	3.37	0.260	Inp.
19	29.546	.421	.367	.4393	41.7	43.9	42.1	42.58	+ 7.50	.255	.263	.267	.262	.96	.92	1.00	.96	N N E	N	N	N 10 E	5.6	5.6	9.0	5.75	5.82	0.660	...
20	.215	.317	.468	.3497	38.5	36.0	32.9	34.87	+ 0.10	.208	.172	.135	.173	.89	.81	.83	.85	N b E	N	N	N 7 W	7.8	12.2	7.2	7.93	8.07	0.235	Inp.
21	.531	.495	.494	.5075	28.8	32.4	27.0	29.68	− 4.70	.144	.169	.121	.145	.90	.91	.82	.87	N N W	Calm.	Calm.	N 56 W	4.5	0.0	0.0	1.42	1.97	...	...
22	.446	.446	.591	.5047	30.6	34.5	29.8	31.45	− 2.63	.152	.148	.147	.146	.89	.75	.88	.88	W	N N W	N W	N 30 W	0.4	15.2	10.4	10.54	10.82	...	0.2
23	.723	.739	—	—	23.7	26.6	—	—	—	.112	.098	—	—	.87	.68	—	—	N W b N	W N W	W S W	N 80 W	7.1	13.5	9.5	10.92	12.11	...	0.1
24	.652	.645	.525	.5915	31.3	40.7	35.2	35.73	+ 2.47	.152	.180	.164	.165	.86	.70	.80	.79	W S W	S S W	S W	S 33 W	6.8	15.5	3.0	8.22	8.48	...	...
25	.468	.458	.475	.4720	39.2	43.2	36.3	39.40	+ 3.43	.216	.227	.185	.199	.90	.81	.86	.82	S	S W b S	Calm.	S 53 W	3.4	8.8	0.0	3.21	3.92	Inp.	...
26	.446	.452	.491	.4692	33.4	37.0	33.8	34.57	+ 2.00	.148	.159	.158	.154	.78	.72	.81	.77	W N W	N W b W	W b N	N 62 W	3.5	16.2	4.5	6.54	6.80	...	...
27	.453	.342	.272	.3480	33.1	33.1	29.8	31.82	− 0.37	.145	.145	.154	.147	.76	.76	.93	.81	W N W	W S W	S S W	S 34 W	6.8	6.5	1.8	5.32	6.41	...	3.0
28	.134	.139	.278	.1907	30.2	34.5	27.7	30.50	− 1.38	.149	.157	.121	.142	.89	.78	.80	.83	S W	S W b W	W S W	S 67 W	5.0	7.0	4.4	4.25	4.52	...	0.2
29	.352	.350	.477	.3970	26.2	33.8	31.3	30.85	− 0.65	.124	.173	.160	.154	.87	.89	.90	.89	N b E	S b W	S b W	S 43 W	5.0	0.5	0.4	0.74	1.81	...	0.6
30	.546	.496	—	—	32.0	33.4	—	—	—	.158	.163	—	—	.87	.85	—	—	W b S	W b S	N E	N 36 E	3.0	2.5	5.0	1.37	2.90	...	0.5
...	....	....	....	....	.....	.....	.....	.....	....	.....	.....	.....	.....	.....	.....	.....	.....	....	....	....	....	.....	.....	.....	.....	.....	.....	.....
M	29.6316	29.6118	29.6529	29.6364	33.46	39.59	34.34	35.58	− 0.57	.167	.182	.169	.171	.85	.73	.83	.80	....	....	....	....	4.89	8.84	5.31	......	6.60	2.205	5.3

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR NOVEMBER, 1862.

Highest Barometer . . . . 30.469 at 10 a. m. on 15th. } Monthly range=
Lowest Barometer . . . . 29.132 at 8 a. m. on 28th. } 1.337 inches.

Self-registering Ther.
- Maximum temperature . . . 58°0 on p.m. of 1st } Monthly range=
- Minimum temperature . . . . 16°2 on a.m. of 15th } 41°8
- Mean maximum temperature . . 40°59 } Mean daily range=10°09
- Mean minimum temperature . . 30°50 }
- Greatest daily range . . . . . . 19°2 from a. m. to p. m. of 11th.
- Least daily range . . . . 2°2 from a. m. to p. m. of 27th.

Warmest day . . . 1st ..Mean Temperature . . .=50°35 } Difference=27°55.
Coldest day . . . . 15th ...Mean Temperature . . .=22°80 }

Maximum { Solar . . . . 72°0 on p.m of 1st } Monthly range=
Radiation { Terrestrial . . . . 7°0 on a. m. of 15th } 65°.0

Aurora observed on 0 nights; possible to see Aurora on 8 nights; impossible on 22 nights.
Snowing on 11 days; depth 5.3 inches; duration of fall 51.0 hours.
Raining on 11 days; depth, 2.205 inches; duration of fall, 51.5 hours.
Mean of cloudiness=0.79; above the average, 0.05. Most cloudy hour observed, 2 p.m.; mean=0.82; least cloudy hour observed, 10 p.m.; mean=0.74.

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

North.	South.	East.	West.
2319.40	818.21	698.80	2252.95

Resultant direction, N. 46° W.; Resultant Velocity, 3.00 miles per hour.
Mean velocity 6.60 miles per hour.
Maximum velocity 26.6 miles, from 0 to 1 a.m. on 3rd.
Most windy day 2nd—Mean velocity 12.26 miles per hour. } Difference 10.45.
Least windy day 29th—Mean velocity 1.81 miles per hour. }
Most windy hour, 1 to 2 p.m.—Mean velocity, 9.36 miles per hour. } Difference
Least windy hour, 7 to 8 a.m.—Mean velocity, 4.50 miles per hour. } 4.86 miles.

1st. Dense fog 8 to 10 p.m.; lunar corona 9.30 to 11 p.m.—2nd. Solar halo during forenoon; thunderstorm 6 to 9 p.m.—4th. Perfect lunar halo 10 p.m and midnight.—5th. Lunar halo at 10 p.m.—6th. Lunar halo from 7.30 to 10.30 p.m.—7th. Solar halo during forenoon; lunar halo 7 to 8 p.m.—10th. Lunar corona at 6 a.m. —11th. Ground fog during the forenoon.—12th. Lunar halo 11 p.m. to midnight. —17th. Dense fog 6 to 8 a.m.

GREAT BAROMETRIC MOVEMENT.

November { 11th, 10 p.m. = 29.361 } Ascending range in 85 hours = 1.108 inches.
November { 15th, 10 a.m. = 30.469 }
November { 20th, 6 a.m. = 29.215—Descending range in 116 hours = 1.254 inches.

Movement in 200 hours.......................................= 2.362 inches.

The month of November 1862 was comparatively cold, dry, calm and cloudy.

COMPARATIVE TABLE FOR NOVEMBER.

YEAR.	TEMPERATURE. Mean.	Excess above Average, (36°7).	Maximum observed.	Minimum observed.	Range.	RAIN. No. of days.	Inches.	SNOW. No. of days.	Inches.	WIND. Resultant. Direction.	Velocity.	Mean Velocity
1840	35.9°	— 0.8	54.4°	20.5°	33.9°	5	1.220	8	...	...	...	...
1841	35.0	— 1.7	63.2	7.6	55.6	8	2.450	5	...	...	...	0.91lbs
1842	33.3	— 3.4	50.6	7.6	43.0	9	5.310	10	...	...	...	1.22 "
1843	33.5	— 3.2	51.2	14.4	36.8	10	4.765	7	1.2	...	...	0.59 "
1844	34.9	— 1.8	49.8	12.0	37.8	8	Imp.	4	8.0	...	...	0.48 "
1845	36.8	+ 0.1	58.8	7.6	51.2	7	1.105	4	5.0	...	...	0.53 "
1846	41.3	+ 4.6	55.5	18.2	37.3	12	5.805	2	0.4	...	...	0.64 "
1847	38.6	+ 1.9	58.2	7.8	50.4	14	3.155	3	Inp.	...	...	0.36 "
1848	34.5	— 2.2	49.3	16.5	32.8	9	3.020	3	1.4	N 81 W	1.81	4.81ms.
1849	42.6	+ 5.9	56.7	28.4	28.3	10	2.815	2	1.0	N 39 W	1.55	4.78 "
1850	38.8	+ 2.1	62.3	18.1	44.2	7	2.935	1	Inp.	N 42 W	1.43	5.27 "
1851	32.9	— 3.8	50.1	16.5	33.6	5	3.885	6	6.7	N 50 W	1.25	4.70 "
1852	36.0	— 0.7	50.4	18.7	31.7	7	1.775	3	2.0	N 59 W	1.53	6.50 "
1853	38.7	+ 2.0	54.1	14.4	39.7	15	2.425	6	2.7	N 9 W	0.55	5.52 "
1854	36.8	+ 0.1	54.9	15.1	39.8	13	1.115	4	1.3	.W	3.44	7.54 "
1855	38.6	+ 1.9	54.1	18.7	35.4	8	4.590	6	3.0	N 66 W	3.18	10.81 "
1856	37.4	+ 0.7	56.4	22.8	33.6	10	1.375	9	9.5	S 85 W	2.95	8.75 "
1857	33.5	— 3.2	57.8	—2.3	60.1	14	3.235	9	6.9	S 61 W	5.45	9.25 "
1858	34.2	— 2.5	52.0	20.5	31.5	12	3.879	13	4.0	N 25 W	3.14	8.87 "
1859	38.9	+ 2.2	61.0	24.1	36.9	12	5.793	9	0.6	N 81 W	3.39	9.65 "
1860	37.9	+ 1.2	62.7	14.0	48.7	12	2.569	8	1.9	S 89 W	4.95	11.02 "
1861	37.1	+ 0.4	51.5	25.1	26.4	14	4.294	8	3.2	N 46 W	1.94	7.44 "
1862	35.6	— 1.1	58.0	17.2	40.8	11	2.205	11	5.3	N 46 W	3.00	6.60 "
Results to 1861.	36.69	...	55.23	15.74	39.49	10.0	3.140	5.9	3.10	N 76 W	2.29	7.49
Exc. for 1862.	—1.11	...	+ 2.77	+ 1.46	+ 1.31	+ 1.0	— 0.935	+ 5.1	+ 2.20	...	...	—0.89

MONTHLY METEOROLOGICAL REGISTER, ST. MARTIN, ISLE JESUS, CANADA EAST—AUGUST, 1862.

(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° 6 A.M.	2 P.M.	10 P.M.	Temp. of the Air.—F. 6 A.M.	2 P.M.	10 P.M.	Tension of Vapour. 6 A.M.	2 P.M.	10 P.M.	Humidity of Air. 6 A.M.	2 P.M.	10 P.M.	Direction of Wind. 6 A.M.	2 P.M.	10 P.M.	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.
1	29.914	29.894	29.831	60.1	85.1	72.0	.456	.775	.601	.88	.65	.78	N E b E	N E b E	s b E	60.00	2.0	...	...	Hazy.	Cum. Str. 2.	C. Cirr. Str. 2.
2	794	753	832	60.1	89.9	68.5	456	894	642	88	64	92	W s W	s W	s b W	22.80	2.5	...	...	Fog.	C. C. Str. 6.	Clear.
3	853	818	814	65.1	92.0	73.3	583	768	617	94	51	77	s b E	s s W	s s W	2.80	2.5	...	...	Do.	Cu. Str. 4.	Str. 2.
4	797	748	832	68.1	93.6	76.5	543	755	765	79	48	84	s b W	s b E	s W	64.20	1.0	...	...	Cirr. 2.	Clear.	Hazy. AurBor.
5	680	615	721	70.1	89.0	70.1	592	802	537	83	57	77	s b W	s s W	N N E	142.70	2.0	...	...	Cirr. Str. 2.	C. C. Str 4.	Clear.
6	863	859	796	61.1	79.2	64.3	396	658	563	79	67	94	N N E	N N E	N N E	56.50	1.5	...	...	Clear.	Cirr. 2.	Cu. Str. 4.
7	30.005	886	830	57.6	89.1	69.6	378	992	572	81	64	72	E b N	s s E	s s E	51.00	2.0	...	...	Do.	C. C. Str. 4.	Rain.
8	29.641	646	831	61.1	79.8	72.1	480	850	631	91	85	81	s W	s s W	s W	166.80	2.0	0.503	...	Cu. Str. 10.	C. Cum. 4.	Clear. AurBor.
9	627	514	469	63.7	89.9	73.0	409	942	624	70	68	79	W b N	s s W	W s W	99.70	1.0	...	...	Clear.	Cu. Str. 2.	Do.
10	382	735	779	68.9	85.6	69.3	510	643	485	75	48	72	s s E	s W	W	96.30	1.0	...	...	Cirr. Str. 10.	Clear.	Do.
11	745	796	621	62.4	88.4	72.1	376	778	496	69	59	64	s W	s W	s W	90.20	1.5	...	...	Clear.	Do.	Cu. Str. 8.
12	585	714	866	68.3	81.6	57.0	457	738	357	69	69	78	s W	W	W b s	280.80	1.0	...	...	Clear. [Dis. Th.	C. Cum. 4.	Clear.
13	933	885	921	51.4	78.3	60.2	252	588	374	68	62	73	W	s W	s W	1.00	1.0	...	...	Do.	Clear.	Str. 4. AurBor.
14	730	667	646	56.4	75.7	64.2	336	484	497	75	56	88	s W	s W	s W	137.50	2.0	...	...	C. C. Str. 10.	Cu. Str. 10.	Rain.
15	666	645	706	48.1	73.2	59.0	285	624	439	85	70	88	s W	W b N	W	295.60	2.5	0.161	...	Cirr. Str. 10.	Do. 4.	Cirr. Str. 10
16	899	875	957	49.2	71.1	54.2	272	509	308	78	68	74	W	W	W	139.90	1.0	...	...	Clear.	C. C. Str. 4.	Clear.
17	30.101	30.094	30.036	43.1	74.2	61.6	209	376	406	75	47	74	W s W	W s W	s W	56.40	1.5	...	...	Light Frost.	Clear.	Do.
18	29.900	29.857	29.751	51.4	79.2	63.0	270	612	278	72	62	83	s W	s W	s W	39.60	1.5	Inap.	...	C. C. Str. 4.	C. C. Str. 8	CuStr4. AurB.
19	797	30.000	830	61.8	78.2	64.0	390	626	464	74	65	77	s W	s W	s W	63.20	1.0	...	...	Clear.	Clear.	Clear. AurBor.
20	841	29.853	928	60.4	82.2	65.1	426	610	483	82	56	78	s W	s W	N b E	84.20	1.5	...	...	Do.	C. C. Str. 8.	Cu. Str. 10.
21	962	860	928	51.4	71.6	64.1	296	365	464	79	47	77	N E b E	N E b E	s b W	126.70	2.0	0.160	...	C. C. Str. 10.	Cu. Str. 4.	Clear SolHalo
22	656	541	588	60.1	69.2	70.1	487	635	537	94	90	77	N E b E	N E b E	s b W	149.10	3.0	0.601	...	Rain.	Rain.	Do. CometVis
23	566	30.100	922	64.2	74.6	53.3	464	577	251	77	64	68	W	s W	W b N	252.24	2.0	Inap.	...	Cum. Str. 4.	Cum. Str. 10.	Clear.
24	30.140	110	30.077	43.8	74.1	54.2	209	396	314	75	48	86	W b N	s W	s W	82.40	1.5	...	...	Frost.	Clear.	Do.
25	29.918	29.780	29.722	47.2	77.2	70.1	273	689	516	85	69	70	s W	s W	s W	134.60	1.0	...	...	Do.	Do.	Cu. Str. 10.
26	691	644	710	67.9	77.2	67.8	516	689	556	77	69	84	s b W	s b W	s W	61.20	1.5	Inap.	...	C. C. Str. 10.	Rain.	C. C. Str. 4.
27	760	730	731	52.1	76.2	54.2	334	577	308	86	64	74	N E b E	N E b E	s b E	72.50	1.5	...	...	Cu. Str. 4.	Clear.	Clear.
28	604	513	446	60.2	72.1	62.2	456	631	449	88	81	85	s E	s b E	s b E	10.00	1.0	Inap.	...	C. C. Str. 10.	Cirr. Str. 10.	Cu. Str. 4.
29	625	698	750	51.1	60.3	53.0	296	255	321	79	49	80	W b N	W b N	W b N	310.40	1.0	...	...	Clear.	Do. 4.	Do. 4. AurBor
30	30.039	30.010	971	40.1	70.0	56.2	182	516	363	73	70	81	W b N	s W	s W	140.40	1.5	...	...	Frost.	Clear.	Clear.
31	29.887	29.806	654	52.0	80.6	62.2	315	711	429	83	68	77	s W	s W	s W	155.00	1.5	...	...	Clear.	Do.	Do.

MONTHLY METEOROLOGICAL REGISTER, ST. MARTIN, ISLE JESUS, CANADA EAST—SEPTEMBER, 1862.

(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° 6 A.M.	Barom. 2 P.M.	Barom. 10 P.M.	Temp. of the Air.—F. 6 A.M.	Temp. 2 P.M.	Temp. 10 P.M.	Tension of Vapour. 6 A.M.	Tension 2 P.M.	Tension 10 P.M.	Humidity of Air. 6 A.M.	Humidity 2 P.M.	Humidity 10 P.M.	Direction of Wind. 6 A.M.	Wind 2 P.M.	Wind 10 P.M.	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.	Weather 2 P.M.	Weather 10 P.M.
1	29.346	29.204	29.214	60.1	64.2	63.2	.487	.529	.513	.94	.89	.94	S W	S W	S W	201.90	3.0	0.976	...	Rain.	Rain. Dis.th.	Rain.
2	347	564	797	49.1	55.2	45.2	.297	.263	.206	.85	.64	.69	S W	W	W b N	325.58	1.5	...	...	Cu. Str. 8.	Cirr. Str. 4.	Clear. AurBor.
3	892	895	30.022	40.1	66.1	54.0	.203	.438	.385	.82	.68	.80	W b N	W b N	W	63.20	1.5	...	...	Frost.	Clear.	Do. [at 2 a.m.
4	902	820	29.830	50.0	83.4	70.4	.290	.597	.580	.82	.53	.80	S W	S	S W	109.40	1.0	...	...	C. C. Str. 9.	Cu. Str. 8.	Do.
5	821	772	840	70.2	77.2	70.1	.592	.841	.621	.83	.91	.85	S W	S W	W	116.60	2.0	In'p.	...	C. Cum 4.	Rain.	Do.
6	811	798	890	57.1	57.7	54.0	.436	.459	.396	.94	.97	.96	N E b E	N E b E	S E b E	237.20	3.0	1.261	.	Rain.	Do.	Rain.
7	727	656	710	47.4	66.2	61.1	.311	.509	.449	.93	.81	.85	N E b E	N E b E	S b E	92.20	2.0	0.130	...	Cu. Str. 10.	C. C. Str. 10.	Cu. Str. 9.
8	649	534	611	69.2	81.0	63.2	.671	.751	.478	.95	.72	.83	S E	S W	W	202.90	2.5	0.587	...	Rain.	Cu. Str. 4.	Clear.
9	937	999	30.037	58.1	72.4	56.0	.400	.631	.363	.84	.81	.81	W	W	S W	203.10	1.0	...	...	Clear.	Clear.	Do. Aur. Bor
10	30.047	30.019	023	50.2	79.7	68.2	.290	.606	.577	.82	.60	.85	S W	S W	S W	18.60	1 0	...	...	Do.	Do,	Do.
11	29.984	29.904	29.868	50.1	84.7	67.2	.309	.577	.496	.85	.49	.77	S W	S W	S b W	7.50	1.5	...	...	Do.	Do.	Do.
12	747	720	816	65.1	74.1	62.1	.549	.436	.491	.80	.53	.88	S b W	S b W	N N E	136.50	1.5	0.110	...	C.Cirr.Str.4.	Rain.	Cum. Str. 8.
13	904	30.014	30.134	60.4	68.4	50.0	.396	.356	.283	.76	.53	.78	N E b E	N E b E	N E b E	249.40	1.0	...	...	Clear.	Clear.	Clear.
14	30.241	150	050	45.2	69 1	54.2	.251	.543	335	.84	.79	.80	N E b E	S E	S E	68.50	1.0	...	...	Cirr. Str.10.	Str. 2.	Do.
15	29.938	29.954	29.963	54.1	64.0	53.0	.335	.497	.321	.80	.83	.80	S W	S W	S W	0.80	2.0	0.304	...	C. C. Str. 4.	Rain.	Do.
16	30.050	30.000	30.004	45.0	66.1	53.0	.251	.400	.328	.84	.61	.83	S W	S W	S W	6.80	1.5	...	...	Clear.	Clear.	Do.
17	29.951	29.964	29.976	42.0	68.4	56.3	.244	.443	.391	.91	.65	.87	S W	S W	N E b E	102.80	1.5	...	...	Fog.	Do.	Do.
18	704	575	700	56.7	71.3	69.1	.398	.537	.371	.90	.71	.82	S W	S W	S W	139.20	1.0	...	...	Cu. Str. 4.	Cu. Str. 10.	Do.
19	736	785	937	64.0	70.9	59.2	.490	.571	.410	.81	.84	.82	S W	S W	S W	66.10	1.5	In'p.	...	C. C. Str. 8.	C. Cum. 4.	Do. Ft.AuBor.
20	970	940	816	39.1	79.4	63.0	.195	.886	.491	82	.87	.88	S W	S W	S W	19.90	1.5	...	...	Clear.	Clear.	Do.
21	913	30.027	30.106	48.1	72.0	50.2	.285	.495	.290	.85	.64	.82	S W	S W	S W	24.10	1.0	..	...	Do.	Do.	Do.
22	30.047	29.910	29.926	42.1	78.2	62.1	.222	.671	.466	.83	.71	.85	S b E	S W	S W	11.10	2.0	...	...	Do.	Do.	Do.
23	29.870	675	580	44.4	86.2	68.4	.202	.557	543	.74	.54	.79	S S W	S b W	S W	36.90	1.5	...	...	Do.	Do.	Do.
24	612	739	839	54.2	65.6	45.0	.341	.542	.258	83	.87	.88	W	W	W	116.20	2.5	0.161	...	Rain.	Cu. Str. 4.	Do. Ft.AuBor.
25	430	789	832	44.2	67.9	56.0	.224	.431	.391	.79	.66	.87	W	S W	S W	30.30	1.0	...	...	C. C. Str. 10.	Clear.	Do. do.
26	819	797	863	45.1	73.0	60.1	.223	.476	.439	.76	.59	.88	S	S W	S W	103.40	1.5	...	...	Clear.	Do.	Do. do.
27	855	847	864	57.0	83.4	64.0	.413	.597	.497	.90	.53	.83	S W	S W	S W	148.19	1.0	...	...	Do.	Do.	Do. Aur. Bor.
28	805	712	741	54.1	73.6	64.2	.362	.619	.497	.87	.64	.83	S W	S W	S W	10.70	1 5	...	...	Cu. Str. 10.	Cirr. Str.10	Do. Ft.AuBor.
29	704	654	842	56.0	66.6	54.1	.398	.463	.362	.90	.71	.87	S W	N E b E	N E b E	39.30	1.5	...	...	Do. 4.	C. C. Str.10.	Cu. Str. 8.
30	972	978	30.071	39.1	44.2	34.0	.231	.157	.162	.91	.55	.87	N E b E	N E b E	S b E	105.90	2.5	...	...	Cirr. Cum.4.	Do. 4.	Clear.
...	......	......	......	......	......	......	......	......	......	...	...	...	......	......	......	....	...	......	...	....	....	....

REMARKS ON THE ST. MARTIN, ISLE JESUS, METEOROLOGICAL REGISTER FOR AUGUST, 1862.

Barometer	Highest, the 24th day	30.140
	Lowest, the 28th day	29.446
	Monthly Mean	29.792
	Monthly Range	0.694
Thermometer	Highest, the 4th day	93°.6
	Lowest, the 24th day	34°.0
	Monthly Mean	65°.61
	Monthly Range	59°.6

Greatest intensity of the Sun's Rays .... 105°.3
Lowest Point of Terrestrial Radiation .... 31°.2
Mean of Humidity .... .727
Amount of evaporation 2.97
Rain fell on 9 days, amounting to 1.425 inches; it was raining 15 hours and 40 minutes.
Most prevalent wind, the S. W.
Least prevalent wind, the N. b E.
Most windy day, the 29th; mean miles per hour, 12.92.
Least windy day, the 13th; mean miles per hour, 0.04.
Aurora Borealis visible on 6 nights.
Comet Visible.
The Electrical state of the Atmosphere has indicated moderate intensity.
Temperature of Thermometer in ground, 65°.0.
Solar Halo on the 21st day.
Frost on 4 mornings.

REMARKS ON THE ST. MARTIN, ISLE JESUS, METEOROLOGICAL REGISTER FOR SEPTEMBER, 1862.

Barometer	Highest, the 14th day	30.241
	Lowest, the 1st day	29 204
	Monthly Mean	29.833
	Monthly Range	1.037
Thermometer	Highest, the 14th day	84°9
	Lowest, the 3rd day	32°2
	Monthly Mean	58°48
	Monthly Range	52°7

Greatest intensity of the Sun's rays .... 98°0
Lowest point of Terrestrial Radiation .... 30°1
Mean of Humidity .... .791
Amount of evaporation 1.86
Rain fell on 9 days, amounting to 3.532 inches; it was raining 64 hours.
Most prevalent wind, S.W.
Least prevalent wind, S.
Most windy day, the 2nd day; mean miles per hour, 13.59.
Least windy day, the 15th day; Inapp.
Aurora Borealis visible on 9 nights.
Temperature of the ground at 18 inches, 63°.2.
The Electrical state of the Atmosphere has indicated feeble intensity.

*** In consequence of the removal of the Observatory from St. Martin's to Montreal, the report for September will close the series of observations taken there. Full reports of the observations taken at the *Montreal Observatory* will be furnished, as soon as it is placed in working order.