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THE

CANADIAN NATURALIST.

SECOND SERIES.

ON THE EXTRACTION OF COPPER FROM ITS ORES IN THE HUMID WAY.

By Thomas MacFarlane.

Part II.—*Being a continuation from page* 231.

In adverting to the best method of putting this process in practise, it may be well first to take into consideration the best means of reducing the ore to powder. With such an ore as that of the Capel mine, it will probably be found, that, after it has passed through the operation of coarse spalling (by which it is reduced to pieces of about six inches in diameter), it cannot be further concentrated by fine spalling and picking, without the loss of much of the copper contained in the ore. (The waste from the fine spalling operation at Capel mine contained 3.4 per cent copper.) According to experience gained at the Acton mine, lime-rock after coarse spalling, can be reduced to pieces of 6½ inches in diameter (mixed with much smaller pieces and dust) for 10 cents per ton of 2000 lbs., by means of Blake's stone breaker, that machine reducing sixty tons of such rock in ten hours. The only crusher which can at all compare with Blake's is that patented by J. J. Storer and J. D. Whelpley of Boston, which breaks the rock so as to go through holes of from three-fourths to one inch square; but it must be broken to a size of from three to four inches in diameter before it is introduced into the crusher. It may therefore reasonably be compared with Blake's. According to the inventors, Whelpley and Storer's crusher will break up eight tons of ordinary quartz per hour. The cost of feeding and attending the mill, and removing the product, together with expenses of engine and fuel, would probably amount to $6.50 per day, or 8¼ cents per ton. The cost of Whelpley and Storer's machine is somewhat more than that of Blake's, and while nine horse-power only is required for the latter, fifteen is said to be necessary for the former. With these data it may therefore be safe to estimate that the preliminary crushing of the ore would cost 10 cts. per ton. The crushing by means of ordinary rollers is here left out of consideration, as the ore must be very much reduced in size (to two inches in diameter and less) before it is possible to treat it by means of rollers.

In reducing the ore to a finer powder than is possible by means of any crusher, the choice lies between millstones, stamps, and Whelpley and Storer's pulveriser. The operation of pulverising by means of the first named is too expensive; and wet stamps, although they do it cheaper, have this disadvantage that the drying of the fine powder and the subsequent crushing of such parts of it as might cake together would increase the cost materially. By far the best pulveriser is undoubtedly that of Whelpley and Storer, which with twelve horse-power reduces to a state of fine dust from 1500 to 2000 lbs. of ordinary quartz or other stone per hour. Assuming that this machine were driven by the same engine which works the crusher, the cost of pulverising could not exceed 20 cents per ton.

The pulverised ore, after having been mixed with the salt and iron oxide, is next calcined; and it would seem quite practicable to effect this calcination in a semi-reverberatory furnace, the hearth of which would consist of cast-iron plates heated by the flame from a furnace passing through flues beneath. The smoke, etc., from the fire would be kept altogether, distinct from the gases evolved by the ore and other ingredients during the calcination. Since diligent stirring is rather injurious than otherwise, it follows that no great amount of labor is necessary; and since the temperature is to be kept as low as possible, it is also evident that the expenditure of fuel will be inconsiderable. It is therefore probably a reasonable estimate that $1 per ton would cover the expense of calcination.

The gases evolved during this operation are sulphurous acid and chlorine in very nearly the proportions of their equivalents. Partly to create a draft though the furnace and partly in order to utilise these gases, it would be well to put into connection with the furnace a spray-wheel and chamber such as described by Whelpley and Storer as being attached to their pulveriser. In contact with the water, these gases would form dilute sulphuric and hydrochloric acids, the further treatment and separation of which would be matters of comparative ease.

The best method of treating the solution obtained by lixiviating the calcined product would probably be simply to acidify the solution slightly, and precipitate while warm with metallic iron. The resulting copper would, after washing, be almost chemically pure; and in all likelihood, by compressing it into cakes and fusing it in crucibles, a pure product might be obtained. The residual solution after the precipitation would, on evaporation, yield large quantities of sulphate of soda. The cost of the manipulation connected with the lixiviation, etc., would probably not be less than $1.50 per ton; and if we include the production of the sulphate of soda, it would probably be raised to $2.50 per ton.

Although it is altogether impossible to give any reliable estimates with regard to be cost of a process which has not been tried on a large scale, yet it may be as well to attempt a calculation as to the cost and proceeds of this method of extraction, in order to ascertain as to whether it is economically feasible. The expenditure on the operation might be estimated as follows:

One ton of 7 per cent ore ($2.25 per unit on 6½ per cent).	$14 62
Crushing	0 10
Pulverising	0 20
Calcining	1 00
Lixiviating, &c	2 50
Refining the precipitated copper to ingot	2 00
Concentrating the sulphuric and muriatic acids	3 00
500 lbs. salt	2 00
130 lbs. iron	6 00
	$31.42

The following sums might be realized for the various products:

130 lbs. ingot copper (supposing 6 per cent only to be obtained from 7 per cent ore), at 22 cents	$26 40
979 lbs. dry sulphate of soda (supposing only one third of the sulphur to be recoverable in this form), at 1 cent per lb. (6s. sterling is its value in England)	9 79
660 lbs. sulphuric acid (supposing another third to be recoverable in this form), at 2 cent. per lb. (1 penny per lb. being its value in England)	13 20
1188 lbs. muriatic acid, at 2 cents	5 94
	$55 33

According to these figures, a profit of $23.91 might be made on every ton of the ore treated. There may of course be many errors in these estimates, but they would seem at least to justify a considerable expenditure in order to ascertain whether the process can be worked on the manufacturing scale with success and profit.

Acton Vale, C. E., 16th June 1865.

SYNOPSIS OF THE FISHES OF THE GULF OF ST. LAWRENCE AND BAY OF FUNDY.

By Prof. Theodore Gill, M.A.

The interest that has for some time been manifested in the fishes and fisheries of the Gulf of St. Lawrence and Bay of Fundy, and the absence of facilities for the ready identification of some of the species, appear to render desirable the publication, in a brief and connected form, of the views respecting the nomenclature and affinities of the species, resulting from our present knowledge of the class. This is the more desirable, as some of the observations hitherto made—on account of the difficulty experienced in identifying the species—have not that full value to which the conscientious care with which they have been made should entitle them. The present enumeration is based on the observations of Messrs Richardson, H. R. Storer, Dawson, Jones, Perley, Fortin, and Bell, verified in most cases by an examination of specimens either from the district referred to, or from closely contiguous portions of the same faunal region.

In the enumeration of the species, I have essentially followed the order adopted in the 'Catalogue of the Fishes of the Eastern Coast of North America,' modified however in some important respects by subsequent studies. Still further departures should be made,—but I defer such changes till the publication of a more extensive work on which I am now engaged. The analytical tables, artificial as such are, will, it is hoped, prove useful in assisting in the progressive identification of unknown forms, as well as in conveying information concerning the technical or natural characters of the groups, and in many cases their relations to each other. How difficult the compilation of such tables is can be readily appreciated by experienced ichthyologists who will examine any of those hitherto published. I may not therefore possibly hope that the present attempt should be exempt from many defects: only the more obvious superficial characters of families peculiar to the types here noticed, but not to all belonging to them, have in several cases been employed. In conclusion, it need only be stated that the nomenclature here adopted is in every case in most strict conformity with the rules proposed by the British Association, founded on the *teachings of the* great Swedish reformer, and subsequently endorsed by the American Association.* We may regret that rules so truly founded on good sense should have been so frequently infringed in previous enumerations of our fishes, and that the consequent innovations should have been admitted unchallenged by so many responsible naturalists. Many of these corrections, so long deferred, have only been very recently made, and such are adopted in the following enumeration. It is to be hoped, as it is believed, that the time has passed when obvious infractions of wholesome rules of nomenclature should not only be committed with impunity, but even sustained by others.

Those species which have not been found in the gulf or bay, but in closely contiguous waters, or at places beyond both extremities of the area indicated, are pointed out by an asterisk (*) placed before the name: when the name or specific rank is doubtful, an asterisk is generally placed after it.

Sub-classes of Fishes.

I. Branchiæ free at their distal margins.
 A. Optic nerves decussating. Arterial bulb normally with two opposite valves at its origin. (Skeleton more or less completely ossified.) TELEOSTEI.
 B. Optic nerves not decussating. Arterial bulb with several rows of valves. (Skeleton variable.) GANOIDEI.

II. Branchiæ attached. (Skeleton always cartilaginous.)
 A. Optic nerves not decussating. Arterial bulb with several rows of valves. Ventral fins always present, abdominal, provided in the males with peculiar sexual appendages. *Copula gaudent.* ELASMOBRANCHIA.
 B. Optic nerves decussating. Heart without muscular tunic, but with two opposite valves. Ventral fins entirely absent. (Body serpentiform, without pectorals or ventrals.) MARSIPOBRANCHIA.

* In order not to be misunderstood, I may state that, like most others, I have not hitherto followed § 2 of the British rules limiting priority to the twelfth edition of the *Systema Naturæ;* but at the same time I believe that if the tenth edition were substituted for the twelfth, adherence to that rule might not be unadvisable. No cause for the infraction of the rule occurs in the present article.

TELEOSTEI.

ORDERS AND SUB-ORDERS.

I. Branchial laminæ pectinated.
  1. Maxillaries normally developed and normally distinct from each other. — TELEOCEPHALI.
    A. Pubic bones generally connected with scapular arch. Ventral fins anterior (thoracic to jugular).
      B. Sides symmetrical.
        C. Dorsal rays anteriorly inarticulated, spinous; first ventral ray also spinous.
          α. Branchial apertures in advance of the pectoral fins. — ACANTHOPTERYGII.
          β. Branchial apertures behind or in the axils of the pectoral fins. — PEDICULATI.
        CC. Dorsal rays articulated as well as the first ventral ones. — JUGULARES.
      BB. Sides dissimilar, both eyes being situated on one side, which is darker than the eyeless one. — HETEROSOMATA.
    AA. Pubic bones free; ventral fins abdominal.
      B^1. Pharyngeal bones more or less plane. — ABDOMINALES.
      B^2. Pharyngeal bones falciform. — EVENTOGNATHI.
  2. Maxillaries generally obsolete or rudimentary. *Scapular arch not connected with skull.* Body serpentiform. — APODES.
  3. Supramaxillary bones rudimentary, enveloped in more or less extended barbels. — NEMATOGNATHI.
  4. Elements of lower jaw united and forming a single piece. — PLECTOGNATHI.
  SCLERODERMI.
II. Branchiæ tufted. (Body enclosed in a case formed by regular plates.) — LOPHOBRANCHII.

FAMILIES OF ACANTHOPTERYGII.

A. Breast with no suctorial disk.
  B. Cheeks not defended, no suborbital bone forming a stay. Posterior dorsal rays branched.
  The area in front of pectoral fins much abbreviated, very much higher than wide.
    1. Jaws normal, more or less protractile.
      α. Spinous dorsal normally longer than soft portion.

* Spinous dorsal not depressible in a furrow. Lower pharyngeal bones separated.	PERCIDÆ.
** Spinous dorsal depressible in a furrow. Lower pharyngeal bones separated. (*Lepominæ.*)	CENTRARCHIDÆ.
*** Spinous dorsal depressible in a furrow. Lower pharyngeal bones united.	LABRIDÆ.
β. Spinous dorsal shorter than second.	
* Skull with cavernous or excavated bones. Caudal with the lateral line continued between its median rays.	SCIÆNIDÆ.
** Skull smooth, not excavated.	POMATOMIDÆ.
2. Jaws normal, not protractile, the upper being covered by the skin at symphysis. Body elongated more or less fusiform. Last soft dorsal rays generally detached, and developed as spurious finlets.	SCOMBRIDÆ.
3. Jaws pointed, the upper united and prolonged into an ensiform weapon.	XIPHIIDÆ.
B². Cheeks partly protected. Area in front of pectoral fins well developed, oblong! Ventral fins considerably behind pectorals, with large spines.	GASTEROSTEIDÆ.
B³. Cheeks defended by one of the suborbital bones, which extends to the inner ridge of the preoperculum.	
D¹. First dorsal longer than the second.	SCORPAENIDÆ.
D². First dorsal shorter than the second.	
α. Ventral fins approximated, generally imperfect.	
1. Body not mailed.	COTTIDÆ.
2. Body completely encased by plates.	AGONIDÆ.
β. Ventral fins distant, separated by a wide flattened area.	TRIGLIDÆ.
B⁴. Cheeks unarmed, the suborbital osselets being little developed. Dorsal entirely composed of spines.	
α. Pyloric coeca obsolete.	
1. Teeth enlarged, adapted for crushing.	ANARRHICADIDÆ.
2. Teeth small and acute.	XIPHIDIONTIDÆ.
β. Pyloric coeca developed.	
1. Ventral fins developed. Head conic in front, compressed.	STICHAEIDÆ.
2. Ventral fins obsolete. Head oblong, pitted above oral; cleft subvertical.	CRYPTACANTHIDÆ.
AA. Breast with suctorial disk formed by the perfect union of the ventral fins.	CYCLOPTERIDÆ.

TELEOSTEI.

Order Teleocephali.

Sub-order Acanthopterygii.

PERCIDÆ Gill.

Percinæ (Bon.) Gill.

Anal fin with two spines. Vertebræ in increased numbers ($10+x \mid 14+y$).

Genus *Perca* Linn.

Teeth villiform. Dorsal fins distinct. D. xiii – xv. i – ii. 13 – 14. A. ii. 6 – 9.

Perca flavescens Mitch. Yellow perch; Perch. (Perley.)
Perca flavescens, Storer, Mem. Am. Ac. v, 52, pl. ii, fig. 1.

Labracinæ Gill.

Anal fin with three spines. Vertebræ generally in normal number (10 – 11 | 14 – 15).

The genera *Roccus* and *Morone* differ even more decidedly in anatomical than xternal characters.

Genus *Roccus* Gill ex Mitch.

Tongue with eeth at middle. Dorsal fins almost distinct. D. ix. i. 12 – 14. A. iii. 10 – 13.

Roccus lineatus Gill. Striped bass. (Perley.)
Labrax lineatus, (C.), Storer, Mem. Am. Ac. v, 54, pl. i, fig. 4.

Genus *Morone* Gill ex Mitch.

Tongue with no teeth in middle. Dorsal fins connected at base. D. ix. i. 12 – 14. A. iii. 7 – 11.

Morone Americana Gill. White perch. (Perley.)
Labrax rufus, Storer, Mem. Am. Ac. v, 57, pl. i, fig. 1.

CENTRARCHIDÆ Gill.

Lepominæ Gill.

Soft parts of dorsal and anal fins equal and opposite to each other.

Genus *Pomotis* (Raf.) Gill.

D. x 10–12. A. iii. 10–12. Pharyngeal bones closely contiguous. with paved teeth.

Pomotis aureus Gill ex Walb. Sun-fish. (Perley.)
Pomotis vulgaris, Storer, Mem. Am. Ac. v, 60, pl. iii, fig. 1.

LABRIDÆ (Cuv.) Blkr.

Labrinæ (Bon.) Gthr.

D. xiii – xiii + *x*. Teeth conical. Lateral line continuous, not abruptly decurved behind.

Genus *Tautoga* (Mitch.) Gthr.

Opercles naked. Teeth in two rows. D. xvii. – 10. A. iii 7 – 8.

Tautoga onitis Gthr. ex Linn. Black-fish. (Perley.)
Tautoga Americana, Storer, Mem. Am. Ac. v, 276, pl. xx, fig. 2.

Genus *Tautogolabrus* Gthr.

Opercles (including interopercle) scaly. Teeth in a band. D. xvii – xix. 9 – 11. A. iii, 8 – 9.

Tautogolabrus adspersus Gill ex Walb. Cunner. (Perley.)
Ctenolabrus coeruleus, Storer, Mem. Am. Ac. v, 274, pl. xx, fig. 1.

SCIAENIDÆ (Cuv.) Gthr.

Otolithinæ Gill.

Body fusiform. Lower jaw projecting. Vertebræ about 14 + 10.

Genus *Cynoscion* Gill.

Cynoscion regalis Gill ex Schn. Weak-fish.
Otolithus regalis, Storer, Mem. Am. Ac. v, 122, pl. ix, fig. 1.

POMATOMIDÆ Gill.

Pomatominæ Gill.

Teeth compressed. Anal fin moderate.

Genus *Pomatomus* Lac.

Pomatomus saltatrix Gill ex Linn. Blue-fish.
Temnodon saltator, Storer, Mem. Am. Ac.

SCOMBRIDÆ (Cuv.) Gill.

Scombrinæ (Bon.) Gill.

Dorsal fins distant. Tail with cutaneous keels.

Genus *Scomber* (L.) Cuv.

Body slender, with no enlarged scales in front. Finlets 5 – 6.

Scomber grex Mitch., 1814. Mackerel.
Scomber vernalis, Storer, Mem. Am. Ac. v, 132, pl. xi, fig. 2.

Orcyninæ Gill.

Dorsal fins generally approximated. Tail with cutaneous keels.

Genus *Orcynus* (Cuv.) Gill.

Lateral line simple. Vomer and palatines as well as jaws, with small teeth. D. xii – xv.

Orcynus secundo-dorsalis Gill ex Storer. Horse-mackerel; Albicore. (Perley.)

Thynnus secundo-dorsalis, Storer, Mem. Am. Ac. v, 143, pl. xii.

XIPHIIDÆ Bon.

XIPHIINÆ (Bon.) Gill.

Ventral fins obsolete.

Genus *Xiphias* (L.) Cuv.

Tail with a single cutaneous keel. Dorsal fin in young, entire behind; in adult, with the greater portion of the spinous part obsolete.

Xiphias gladius Linn.† Sword-fish. (Perley.)

Xiphias gladius, Storer, Mem. Am. Ac. v, 149, pl. xiii, fig. 2.

GASTEROSTEIDÆ Bon.

GASTEROSTEINÆ (Bon.) Brevoort.

Body more or less fusiform. Head conic or sub-conic.

Genus *Gasterosteus* (L.) Brev.

Body stout, fusiform. Free dorsal spines 2 – 3.

Gasterosteus biaculeatus (Shaw) Mit.* Stickleback. (Perley.)
The species of this genus require a thorough re-examination.

Genus *Pygosteus* Brevoort.

Body elongated, sub-fusiform. Free dorsal spines 6 – 10.

Pygosteus occidentalis Brev. ex Cv.*

Pygosteus Dekayi Brev. ex Ag.*

These species likewise require confirmation.

SCORPÆNIDÆ (Sw.) Gill.

SCORPÆNINÆ (Bon.) Gill.

D. xi – xv. Spinous and soft dorsals connected.

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† On the point of sending this for publication, I received from Mr. Jones of Halifax, a figure of two caudal vertebræ of this species obtained while dredging in the harbor of Halifax.

Genus *Sebastes* Cuv.

D. xiv + i. 13. – 15. A. iii. 6 – 8. Vertebræ in increased number. (c. 12 + 19).

Sebastes norvegicus Cuv.*

Sebastes norvegicus, Cuv. et Val., Nat. Hist. des Pois., iv, 327, pl. 87.

Sebastes viviparus Kroyer. Rose-fish; Red sea-perch; Snapper. (Perley.)

Sebastes norvegicus, Storer, Mem. Am. Ac. v, 86, pl. vii, fig. 1.

HEMIPTRIPTERINÆ Gill.

D. xv + χ. Spinous and soft dorsals separated.

HEMITRIPTERUS Cuv.

Hemitripterus Acadianus Storer ex Walb.

Hemitripterus Acadianus, Storer, Mem. Am. Ac. v, 83, pl. vii, fig. 4.

COTTIDÆ (Rich.) Gill.

COTTINÆ (Bon.) Gill.

Head large. First dorsal moderate, generally oblong, mostly behind head.

Genus *Cottus* Linn.

Branchial membrane partly free below. D. viii – x | 13 – 17. Teeth on vomer.

Cottus grœnlandicus Cuv. Sculpin; Bull-head. (Perley.)

Acanthocottus variabilis, Storer, Mem. Am. Ac. v, 74, pl. iv, fig. 1.

Pre-opercular spines 3; the upper not extending as far as the opercular.

Cottus Labradoricus Gthr. ex Grd.

Acanthocottus Labradoricus, Grd., Boston Journ. Nat. Hist.

Pre-opercular spines 4; the upper not extending as far as the opercular.

Cottus octodecim-spinosus Mitch. Sculpin; Bull-head. (Perley.)

Acanthocottus Virginianus, Storer, Mem. Am. Ac. v, 76, pl. iv, fig. 2.

Pre-opercular spines 3; the *upper extending beyond the opercular one.*

Genus *Gymnacanthus* Sw.

Branchial membrane free below around margin. Vomerine teeth, none. D. ix – x | 13 – 16.

Gymnacanthus patris Gill ex Storer.

Acanthocottus patris, Storer, Boston Journ. Nat. Hist. vi, 250, pl. 7, fig. 2.

AGONIDÆ (Sw.)

ANOPLAGONINÆ Gill.

Spinous dorsal fin obsolete.

Genus *Aspidophoroides* Lac.

Teeth on jaws only.

Aspidophoroides monopterygius Storer, 1839.

Aspidophorus monopterygius, Storer, Mem. Am. Ac. v, 80, pl. 8, fig. 1 (extremely bad).

TRIGLIDÆ (Bon.) BLKR.

DACTYLOPTERINÆ Gill.

Pectoral fins in adult excessively large, divided into an upper small and a lower larger part, and with no inferior thickened free rays.

Genus *Dactylopterus* Lac.

Dactylopterus volitans Lac.

Dactylopterus volitans, Storer, Mem. Am. Ac. v, pl. vi, fig. 5, 6.

XIPHIDIONTIDÆ† GILL.

Body compressed and ribbon-shaped. Dorsal fin nearly uniform, entirely composed of robust spines.

Genus *Murænoides* Lac.

Branchiostegal membrane free below. Anal fin with two simple spines.

Murænoides ingens Gill.*

Gunnellus ingens, Storer, Boston Journ. Nat. Hist. vii.

Murænoides mucronatus Gill.

Gunnellus mucronatus, Storer, Mem. Am. Ac. v, 260, pl. xvii, fig. 2.

ANARRHICADIDÆ GILL.

Genus *Anarrhicas* Linn.

Body robust. Caudal convex free from the dorsal and anal.

Anarrhicas vomerinus Ag.* Wolf-fish; Sea-wolf. (Perley.)

Anarrhicas vomerinus, Storer, Mem. Am. Ac. v, 265, pl. 18, fig. 1.

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† The much elongated, ribbon-shaped body, form of head, structure of dorsal and pectoral fins, &c., appear to indicate that the centronotoid blennioids represent a true family.

STICHÆIDÆ Gill.

Genus *Leptoblennius* Gill.

Body very slender, with no lateral line. Teeth only on jaws.

* *Leptoblennius serpentinus* Gill.

Blennius serpentinus, Storer, Mem. Am. Ac. v, 257, pl. 17, fig. 1 (poor).

Genus *Eumesogrammus* Gill.

Body moderately elongated, with the lateral line divided into a superior and larger median branches.

Eumesogrammus sub-bifurcatus Gill.

Pholis sub-bifurcatus, Storer, Mem. Am. Ac. v, 258.

CRYPTACANTHIDÆ Gill.

Genus *Cryptacanthodes* Storer.

Cryptacanthodes maculatus Storer.

Cryptacanthodes maculatus, Storer, Mem. Am. Ac. v, 82, pl. viii, f. 6.

Body and fins ruddy, with dark spots.

Cryptacanthodes inornatus Gill.† Ghost-fish.

Cryptacanthodes inornatus, Gill Proc. Ac. Nat. Sc. Phila., 1863, 332.

Body and fins whitish, immaculate.

CYCLOPTERIDÆ (Bon.)

CYCLOPTERINÆ (Bon.) Gill.

Body contracted. Dorsal fins, two, the first spinous.

Genus *Cyclopterus* Linn.

Plates in one dorsal, and on each side in two lateral and one abdominal rows. First dorsal very small.

Cyclopterus lumpus Linn.

Lumpus anglorum, Storer, Mem. Am. Ac. viii, 402, pl. 32, fig. 2.

LIPARIDINÆ Gill.

Body elongated. Dorsal single, entire.

Genus *Liparis* (Art.)

Teeth triscuspid. Ventral disk below posterior half of head.

Liparis ——.

Liparis vulgaris, Fortin in Rep. Com. Crown Lands, Canada, 1863, p. 161.

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† *C. inornatus* has been signalized from Halifax by Mr. Jones, since the transmission of this article for publication, under the name of *C. maculatus*, (this Journal, p. 129, April, 1865).

SUB-ORDER PEDICULATI.

I. Branchial apertures below, in or behind the inferior axillæ of the pectoral fins. Lower jaw projecting. LOPHIIDÆ.

II. Branchial apertures above in the axillæ of the pectoral fins. Mouth subterminal or inferior, the lower jaw being received within the upper. MALTHEIDÆ.

LOPHIIDÆ (Raf.) Gill.

Genus *Lophius* (Linn.) Cuv.

Lophius Americanus Val.

Lophius Americanus, Storer, Mem. Am. Ac. v, 266, pl. xviii, fig. 2.

MALTHEIDÆ (BLKR.) GILL.

MALTHEINÆ Gill.

Disk heart-shaped, produced at the snout; body robust.

Genus *Malthe* Cuv.

* *Malthe cubifrons* Rich.

Malthe cubifrons, Rich., Fauna Bor. Am., Fishes, 103 (pl. 96).

SUBORDER JUGULARES.

I. Branchial apertures very large, continuous, the membrane cleft far forwards. GADIDÆ.

GADIDÆ (Cuv.)

MERLUCIINÆ (Sw.) Gill.

Dorsal fins two; first well developed; second, as well as anal, emarginated behind middle.

Genus *Merlucius* Raf.

Merlucius bilinearis Gill ex Mitch. Silver-hake of Grand Haven; Whiting of St. Johns. (Perley.)

Merlucius albidus, Storer, Mem. Am. Ac. vi, 363, pl. 28, fig. 2.

GADINÆ (Bon) Gill.

Dorsal fins three; anal two.

Genus *Pollachius* (Nilss.)

Mouth moderate, lower jaw longer, with barbel obsolete or rudimentary.

Pollachius carbonarius Bon.* Pollock; Sea-salmon. (Perley.)

Merlangus purpureus, Storer, Mem. Am. Ac. vi, 358, pl. 28, fig. 3.

Genus *Gadus* (Linn.) Bon.

Mouth large. Lateral line white. Anus under second dorsal fin. Size large.

Gadus morrhua Linn.

Gadus arenosus (Mitch.)† Cod or Cod-fish.

Morrhua Americana, Storer, Mem. Am. Ac. vi, 343, pl. 27, fig. 4.

Genus *Microgadus* (Gill).

Mouth large. Anus under first dorsal fin. Size small.‡

Microgadus tomcodus (Walb.) Tomcod; Frost-fish. (Perley.)

Morrhua pruinosa, Storer, Mem. Am. Ac. vi, 357, pl. 27, fig. 5.

Genus *Melanogrammus* Gill.

Mouth rather small. Lateral line black.

Melanogrammus æglifinus Gill ex Linn. Haddock. (Perley.)

Morrhua æglifinus, Storer, Mem. Am. Ac. vi, 355, pl. 28, fig. 1.

PHYCINÆ (Sw.) Gill.

Dorsals two; anal one; Ventrals with styliform bases, generally forked.

Genus *Phycis* (Raf.)

Caudal convex behind.

Phycis chuss Gill ex Walb. Ling; American-hake. (Perley.)

Phycis filamentosus, Storer, Mem. Am. Ac. vi, 367, pl. 29, fig. 4.

Scales in about 110 transverse rows. Mouth blotched with dark purple inside.

Phycis tenuis Gill.

Phycis Americanus, Storer, Mem. Am. Ac. vi, 365, pl. 29, fig. 3.

Scales in 135—140 transverse rows. Mouth minutely punctulated with black within.

Genus *Urophycis* Gill.

Caudal emarginated behind.

Urophycis regius Gill.

Gadus (Phycis) punctatus, Rich. F. B. A. III, Fish p. 253, (woodcut).

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† Probably not distinct from *G. morrhua*.

‡ Gadus and Microgadus are trenchantly distinguished by important anatomical characters, for a knowledge of which reference is made to the Proc. Ac. Nat. Sc. Phila. 1865, p. 69.

LOTINÆ Gill.

Dorsals two; posterior as well as anal entire.

Genus *Lota* Cuv.

Anterior dorsal much behind scapular region. Teeth not enlarged.

Lota lacustris Gill ex Walb. Fresh-water cusk. (Perley.)

CILIATINÆ Gill.

Dorsals two; anterior fringed, with a longer ray in front.

Genus *Rhinonemus* Gill.

Head depressed behind, snout with cirrus.

Rhinonemus caudacuta Gill ex Storer. (Bell.)

Motella caudacuta, Storer, Mem. Am. Ac. vi, p. 361, pl. 29, fig. 1.

Genus *Ciliata* Coch.

Head and body compressed, *silvery*.

* *Ciliata argentata* Gill ex Reinh.

BROSMINÆ Sw.

Dorsal single.

Genus *Brosmius* Cuv.

Brosmius Americanus Gill.

Brosmius flavescens, Storer, Mem. Am. Ac.

Lower jaw shorter, with an undivided barbel.

Brosmius flavescens Les.*

Lower jaw longer, with a forked barbel.

SUB-ORDER HETEROSOMATA.

PLEURONECTIDÆ.

PLEURONECTINÆ, Gill.

Mouth small, the supramaxillary ending before or under front of eye.

Genus *Pseudopleuronectes* Blkr.

Body with imbricated ctenoid scales. Teeth fixed, incisorial. Lateral line not arched in front.

Pseudopleuronectes Americanus Gill ex Walb. Common flounder. (Perley.)

Platessa plana, Storer, Mem. Am. Ac. viii, 389, pl. 30, fig. 2.
Platessa pusilla, Dek. (young).†

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† *Platessa pusilla* DeKay = *Pseudopl. Americanus*, young.

Genus *Limanda* Gottsche.

Body with rough imbricated scales. Teeth fixed, incisorial. Lateral line arched in front.

Limanda rostrata Gill. Fluke or common dab. (Perley.)

Platessa rostrata, Storer, Boston Jour. Nat. Hist., vi, pl. 8, fig. 2

HIPPOGLOSSINÆ Gill.

Mouth large. Ventrals lateral.

Genus *Hippoglossoides* Gottsche.

Body thick. Scales ctenoid; caudal entire.

* *Hippoglossoides platessoides* Gill ex Fab.

Hippoglossoides platessoides, Gill, Proc. Ac. Nat. Soc. 1864.

Genus *Pomatopsetta* Gill.

Body thin. Scales mostly cycloid, caudal entire.

Pomatopsetta dentata Gill.

Platessa dentata, Storer, Mem. Am. Ac. viii, 391, pl. 30, fig. 3.

Genus *Hippoglossus* Cuv.

Body robust, with minute smooth scales, caudal fin emarginated.

Hippoglossus Americanus Gill. Halibut. (Perley.)

Hippoglossus vulgaris, Storer, Mem. Am. Ac. viii, pl.

SUB-ORDER ABDOMINALES.

FAMILIES.

I. Head plane above and behind. Pectorals inserted rather high on the sides.

α. Body elongated, with the back and abdomen parallel. Lateral line distinct, very low. SCOMBERESOCIDÆ.

β. Body oblong, subfusiform or oval, with no lateral line. Head flat above, with large scales. POECILIIDÆ.

II. Head more or less convex transversely above. Pectorals inserted very low on sides.

α. Dorsal fin more or less in advance of anal.

* Adipose dorsal finlet present behind. A lateral line. SALMONIDÆ.

* * Adipose dorsal finlet none. No lateral line. CLUPEIDÆ.

β. Dorsal and anal fins opposite, far behind.

* Head with oblong conical depressed snout. ESOCIDÆ.

* * Head rounded in front, with oblique tympanic and opercular apparatus, and an enormous mouth. STOMIATIDÆ.

SCOMBERESOCIDÆ Bon.

SCOMBERESOCINÆ Gill.

Body compressed; jaws both produced, slender; dorsal and anal posterior rays developed as separate finlets.

Genus *Scomberesox* Lac.

Scomberesox scutellatus Les.

Scomberesox scutellatus, Storer, Mem. Am. Ac. vi, 315, pl. 24, fig. 4.

BELONINÆ Bon.

Body little compressed; jaws both produced, strong and with well-developed teeth; dorsal and anal simple behind.

Genus *Belone* Cuv.

Belone longirostris Gill ex Mitch.

Belone truncata, Storer, Mem. Am. Ac. vi, 314, pl. 24, fig. 3.

POECILIIDÆ Bon.

HYDRARGYRINÆ Gill.

Teeth acute. Dorsal and anal, generally subequal and opposite.

Genus *Hydrargyra* Lac.

Branchiostegal rays six.

Hydrargyra majalis Val. ex Walb. Mammy-chub. (Perley.)

Hydrargyra flavula, Storer, Mem. Am. Ac. v, pl. 23, fig. 5 (male, with 12 – 15 vertical bands), and 6 (female with 2 – 3 longitudinal lines).

Genus *Fundulus* Lac.

Branchiostegal rays five.

Fundulus pisculentus Val. Big killy-fish; Minnow. (Fortin.)

Fundulus pisculentus, Storer, Mem. Am. Ac. v, 294, pl. 23, fig. 3 (male, with vertical light bands), and fig. 4 (female, uniform).

SALMONIDÆ Cuv.

SALMONINÆ Bon.

Teeth acute. Stomach not cœcal; pyloric cœca numerous.

Genus *Salmo* (Linn.)

Body spotted in adults. Mouth large, with well-developed teeth.

Salmo salar Linn.

Salmo salar, Storer, Mem. Am. Ac. vi, 320, pl. 25, fig. 2.

Salmo sebago Grd. Togue. (Perley.)

Salmo sebago, Grd., Proc. Acad. Nat. Sc., Phila., 1853.

Salmo fontinalis Mitchell. Brook Trout. (Perley.)

Salmo fontinalis, Storer, Mem. Am. Ac. vi, 322, pl. 25, fig. 3.

Genus *Coregonus* (Art.) Ag.

Body never spotted. Mouth small, toothless, with the lower jaw shorter.

Coregonus ——. Gizzard-fish. (Perley.)

Coregonus albus, Perley, Report on Sea and River Fishes of New Brunswick, p. 204.

ARGENTININÆ (Bon.) Gill.

Teeth acute. Stomach cœcal, and at the pyloric extremity provided with few cœca.

Genus *Osmerus* (Art.)

Sexes scarcely distinguishable externally. Scales in both regularly imbricated. Pectorals and ventrals moderate (P. 10–12).

Osmerus mordax Gill ex Mitch. Smelt. (Perley.)

Osmerus viridescens, Storer, Mem. Am. Ac. vi.

Genus *Mallotus* Cuv.

Sexes very dissimilar: scales of the male villose or pointed in a lateral band; pectorals and ventrals very large and overlapping one another; scales of the female as in *Osmerus*. (P. 18 – 20.)

Mallotus villosus Cuv. Capelin. (Perley.)

Salmo (Mallotus) villosus, Rich. F. B. A., iii, Fishes, p. 187.

CLUPEIDÆ (Cuv.)

CLUPEINÆ (Bon.)

Body much compressed, fusiform. Head conic, with oral cleft longtitudinal and the lower jaw projecting.

Genus *Clupea* (Linn.)

Scales simple. Upper jaw little emarginated at symphysis. Mouth well toothed.

Clupea elongata Les.

Clupea elongata, Storer, Mem. Am. Ac. vi, 330, pl. 26, fig. 1.

Genus *Alosa* Cuv.

Scales simple. Pre-opercular with a very short horizontal process; cheeks very high. Upper jaw deeply notched at symphysis. Mouth toothless, or with supramaxillars only toothed.

Alosa tyrannus Gill ex Lat.

Alosa praestablis, Storer, Mem. Am. Ac. vi, 332, pl 26, fig 2.

Genus *Pomolobus* (Raf.) Gill.

Scales simple. Pre-operculum with an oblong horizontal process; cheeks longer than high. Upper jaw notched at symphysis. Roof of mouth edentulous.

Pomolobus pseudo-harengus Gill ex Wilson. Alewife; Gaspereau. (Perley.)

Alosa cyanonoton, Storer, Mem. Am. Ac. vi, 339, pl. 27, fig. 1.
Alosa tyrannus, Storer, Mem. Am. Ac. vi, 337, pl. 26, fig. 3.

Genus *Brevoortia* Gill.

Scales ciliated or pectinated behind!

Brevoortia menhaden Gill ex Mitch.

Alosa menhaden, Storer, Mem. Am. Ac. vi, 336, pl. 26, fig. 4.

ESOCIDÆ (Cuv.)

Genus *Esox* Linn.

Esox reticulatus Les. Pike; Pickerel. (Fortin.)

Esox reticulatus, Storer, Mem. Am. Ac. vi, 311, pl. 24, fig. 1.

STOMIATIDÆ Gill.

Genus *Malacosteus* Ayres.

Body naked. Gape rectilinear. Opercular bones much reduced.

* *Malacosteus niger* Ayres.

Malacosteus niger, Ayres, Boston Journ. Nat. Hist.

SUB-ORDER EVENTOGNATHI Gill.

1. Lower pharyngeal bones with 1–3 rows of teeth, the primary row containing only 5–7. CYPRINIDÆ.

2. Lower pharyngeal bones with a row of numerous pectiniform teeth. CATASTOMIDÆ.

CYPRINIDÆ (Cuv.) Gill.

Genus *Stilbius* (Dek.) Gill.

Head and body much compressed, silvery. Back much arched. Lateral line very low.

Stilbius Americanus Gill ex Lac. Shiner; Carp. (Perley.)

Leucosomus Americanus, Storer, Mem. Am. Ac. vi, 283, pl. 21, fig. 2. D. 9–10, A. 15–16, P. 15–17, V. 9.

Genus *Hypsilepis* Baird.

Head and body thick, the former large and short, with tubercles in the breeding season. Scales higher than long. Lateral line submedian, little decurved.

*Hypsilepis cornutus** Grd. ex Mit. Roach; Red-fin. (Perley.)

Hypsolepis cornutus, Storer, Mem. Am. Ac. vi, 284, pl. 21, fig. 3.
D. 8, A. 9, P. 15, V. 8.

Genus *Semotilus* Raf.

Head and body thick, elongated. Scales quadrate or oblong. Lateral line submedian, little decurved.

Semotilus pulchellus * Gill. Roach-dace. (Perley.)

Cheilonemus pulchellus, Storer, Mem. Am. Ac. vi, 286, pl. 22, fig. 2.
D. 9–10, A. 9–10, P. 16–17, V. 8.

Genus *Rhinichthys* Ag.

Head and body thick, elongated. Scales oblong. Lateral line nearly straight, and generally with a black band extending from snout to caudal.

Rhinichthys atronasus * Ag. ex Mit. Brook minnow.

Argyreus atronasus, Storer, Mem. Am. Ac. vi, 288, pl. 21, fig. 4.
D. 8, A. 8, P. 14–15, V. 8.

CATASTOMIDÆ GILL.

CATASTOMIDÆ (Heck.) Gill.

Dorsal short, above ventrals.

Genus *Catastomus* (Les.) Ag.

Snout long. Lateral line present, nearly straight. Lips papillated.

Catastomus Bostoniensis * Les. Sucker.

Catastomus Bostoniensis, Storer, Mem. Am. Ac. vi, 290, pl. 22, fig 3.
D. 14–16, A. 9, P. 18, V. 10.

Genus *Moxostoma* (Raf.) Ag.

Snout short. Lateral line obsolete. Lips plicated.

Moxostoma oblongum Ag. ex Mit. Chub. (Perley.)

Catastomus gibbosus, Storer, Mem. Am. Ac. vi, 291, pl. 22, fig. 4.
D. 15–17, A. 9–10, P. 16, V. 10.

ORDER APODES.

ANGUILLIDÆ Kaup.

Body with patches of oblong scales diagonally disposed.

Genus *Anguilla* Thunberg.

Anguilla Bostoniensis St. ex Les. Eel. (Perley.)

Anguilla Bostoniensis, Storer, Mem. Am. Ac. viii, 409, pl. 33, fig. 1.

The fish (*Leptocephalus gracilis*, Storer) regarded by me as being probably the larva of the conger, has been found along the coast of Maine.†

ORDER NEMATOGNATHI GILL.

SILURIDÆ (Cuv.) Blkr.

BAGRINÆ.

Genus *Amiurus* (Raf.) Gill.‡

Head depressed, with the supra-occipital free behind. Adipose fin well developed; caudal nearly even.

Amiurus———. Cat-fish. (Perley.)

Species uncertain; not seen by me.

ORDER PLECTOGNATHI.

SUB-ORDER SCLERODERMI.

BALISTIDÆ Cuv.

BALISTINÆ (Bon.)

First dorsal fin with two or three spines.

Genus *Capriscus* Sw.

Postbranchial scales enlarged; dorsal and anal elevated in front.

Capriscus fuliginosus Gill ex Dekay.

Balistes fuliginosus, Dekay, N. Y. Fauna, p. 339, pl. 57, fig. 188. (Nova Scotia. J. M. Jones, Esq., in litt.)

MONACANTHINÆ Kaup.

Dorsal spine single.

Genus *Stephanolepis* Gill.

Scales with a coroniform crest.

Stephanolepis Massachusettensis * Gill ex Storer. (Jones.)

Monacanthus Massachussettensis, Storer, Mem. Am. Ac. viii, 425, pl. 34, fig. 4.

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† The *Anguilla* or *Isognatha oceanica* Dekay is the American Conger.

‡ As the etymology of the name *Amiurus* has been variously misunderstood, one deriving it from *Amia* and ουρα, and another from Αημ (shovel) and ουρα, it will not be superfluous to state that it alludes to the "tail entire" (Raf.), and is formed of the privative α and μειουρος (curtailed). The name is a most happy one both in its reference to a marked generic character and in its concordance with its derivatives.

It may be here remarked that the Siluroids, Mormyroids, Stervarchoids, and Gymnotoids, are closely related.

ORDER LOPHOBRANCHII.

SYNGNATHIDÆ (Bon.)

Syngnathinæ (Bon.)

Head and body much elongated and straight. Males with a caudal egg-pouch open throughout.

Genus *Syngnathus* Linn.

Body heptagonal, slender, with the breast-shields rugose, and the jaws sub-equal.

Syngnathus Peckianus Storer. (Dawson.)

Syngnathus Peckianus, Storer, Mem. Am. Ac. viii, 412, pl. 33, fig. 3.

GANOIDEI.

ORDER CHONDROSTEI.

Sturonidæ (R' ɔh.)

Genus *Acipenserinæ* (Bon.)

Both pseudobranchiæ and spiracula developed.

Acipenser oxyrhinchus, Storer, Mem. Am. Ac. viii, 431, pl. 35, fig. 4.

ORDERS OF ELASMOBRANCHI.

Branchial apertures lateral. Squali.
Branchial apertures inferior. Ralæ.

FAMILIES OF SQUALI.

I. Anal fin present.

A. Branchial apertures entirely in front of pectorals. Caudal nearly lunate. Lamnidæ.

AA. Branchial aperture behind above pectoral.

B. Caudal with its upper lobe extremely long. Nictitating membrane obsolete. Alopecidæ.

BB. Caudal with it upper lobe moderately elongate. Nictitating membrane of eyes present. Galeorhinidæ.

II. Anal fin absent.

Dorsals with spines in front. Spinacidæ.
Dorsals without spines. Scymnidæ.

LAMNIDÆ Mull. et Henle.

Lamninæ Gill.

Branchial aperture moderate. Teeth well developed.

Genus *Isuropsis* Gill.

Teeth nail-shaped, long, prismatic and acute. Dorsal nearly midways between pectorals and ventrals.

Isuropsis glaucus Gill ex M. & H. Porbeagle. (Fortin.)
Lamna punctata, Storer, Dekay.

CETORHININÆ Gill.

Branchial apertures extremely large. Teeth minute.

Genus *Cetorhinus* Blainv.

Cetorhinus maximus Gray ex Linn. Basking-shark. (Perley.)
Selachus maximus, Dekay.

ALOPECIDÆ Owen.

Genus *Alopias* Raf.

Alopias vulpes Bon. ex Linn. Thresher-shark. (Perley.)
Carcharias vulpes, Dekay.

GALEORHININIDÆ Gill.

GALEORHININÆ Gill.

Teeth compressed, trenchant, entire or crenulated.

Genus *Scoliodon* Mull. & Henle.

Teeth with smooth edges, and with point directed towards the corners of the mouth.

* *Scoliodon terræ-novæ* Gill ex Rich.
Squalis (carcharias) terræ-novæ, Rich., F. B. A., Fishes, 289.

SPINACIDÆ (Owen).

Genus *Squalus* (Linn.) Raf.

Teeth of jaws similar, subquadrate, with a nearly horizontal cutting-edge.

Squalus Americanus Gill ex St. Dog-fish. (Perley.)
Spinax acanthias? Dekay.

SCYMNIDÆ (Owen).

Genus *Somniosus* Les.

Teeth above narrow, triangular; below subquadrate, with a nearly horizontal cutting-edge.

Somniosus micrcocephalus (Gray).
Scymnus brevipinna, Dekay.

FAMILIES OF RALÆ.

RAIIDÆ (Bon).

Genus *Raia* Linn.

Raia laevis Mitchill. Skate (Perley.)

Raia lævis, Dekay, N. Y. Fauna, 370.

Raia erinacea Mitchill. Hedge-hog ray. (Perley.)

Raia erinaceus, Dekay, N. Y. Fauna, 372, pl. 78, fig. 276.

The identification of these species requires confirmation.

MARSIPOBRANCHIÆ.

ORDER HYPEROARTÆ.

SUB-ORDERS.

Palate not perforated. HYPEROARTII.

Palate perforated by the posterior aperture of the naso-palatine tube. HYPEROTRETI.

PETROMYZONTIDÆ Bon.

Genus *Petromyzon* (Linn.) Gray.

Palatal teeth two, conic, closely approximated. Lingual teeth two, serrate.

Petromyzon Americanus Say. American lamprey. (Perley.)

Petroyzon Americanus, Dekay, N. Y. Fauna, 379, pl. 66, fig. 216.

ORDER HYPEROTRETI.

MYXINIDÆ Mull.

Genus *Myxine* Linn.

Myxine glutinosa Girard.*

Myxine glutinosa, Girard Proc. Acad. N. S. Phila. 1588.

SUPPLEMENTARY NOTE.

Having been recently engaged in a revision of the classification of the fishes of our coast, I embrace this opportunity of remarking that the Sparoids are among those hitherto misunderstood. The *Pagrus argyrops* Cuv., *Sargus arenosus* Dekay, and *Sargus ambassis* Gunther, should be united and referred to a new genus which differs widely from both *Pagrus* and *Sargus;* the teeth in front are trenchant and compressed but very narrow, and in front of the dorsal there is a recumbent spine. The genus may be named *Stenotomus.** The *Sargus probatocephalus* agrees with *Stenotomus* and differs from *Sargus* in being armed with a recumbent dorsal spine, and may be called *Archosargus.*† The anatomical and full generic characters will be hereafter exposed.

I may also add that among the Cyprinodonts, the *Fundulus zonatus* Cv., *F. cingulatus* Cv., and *Hydrargyra luciæ* Baird, should be separated from *Fundulus* and *Hydrargyra,* to form a distinct genus, (*Micristius* ‡) distinguished by its physiognomy and the small number of dorsal rays. The nominal species probably represent sexual conditions.

Another family involvéd in great confusion is that of the Clupeidæ. An examination of extensive material has convinced me that the number of species has been very much over-estimated and that too much àttention has been paid to the dentition. The various osteological modifications, &c. afford much safer characters I can only recognize with certainty seven species of Clupeinæ as inhabitants of the eastern coast to the northward.

1. Clupea harenqus *L.* (Greenland fide Reinhardt, &c.)
2. Clupea elongata *Les.*
3. Pomolobus mediocris *Gill* ex *Mitch.* = *Meletta mattawocca*, Cv. —Alosa lineata *Storer.*
4. Pomolobus pseudo = harenqus *Gill* ex *Wilson* = *Clupea virescens* Dekay.—*Alosa cyanonoton* St. = *Meletta venosa*, Cv. = *Alausella parvula* Gill, (y.g.) = *Alosa tyrannus* Storer —Clupea fasciata *Les.*
5. Clupanodon thrissa *Lac.* = *Meletta thrissa* Cv. = *Opisthonema thrissa* Gill.
6. Alosa tyrannus *Gill* ex *Latrobe* = *Alosa praestabilis* Dekay.
7. Brevoortia menhaden *Gill* ex *Mitchell* = *Alosa menhaden* Cuv.

Washington City, U.S.A., Aug., 1865.

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* Στενος, narrow; τομὸς, incisive. The narrow incisors are especially characteristic of *Stenotomus.*

† Αρχων, ruler; Σάργος, *Sargus.* The sheeps-head (*Archosargus probatocephalus*) is pre-eminent among the Sparoids for the delicacy of its flesh as well as its size.

§ Μικρος, small; ιστιον, sail. *Micristius* is well distinguished by its small dorsal fin.

GEOLOGICAL SKETCH OF THE NEIGHBORHOOD OF ROSSIE.

BY THOMAS MACFARLANE.

Having in April last spent nearly a week in and around Rossie, St. Lawrence County, State of New York, and made some observations which appear to me of importance in connection with the economic minerals occurring there, I have thought myself justified in attempting briefly to describe the relations of the rocks and ore deposits of this interesting locality. This has no doubt been already done to some extent by the officers of the Geological Survey of the state of New York, and I should not probably have ventured on this sketch had I not satisfied myself of the existence, in the district to which it has reference, of certain zones of rock which in Norway are termed "fahlbands," and which are found there to exercise a very important influence on the contents of mineral veins. In a paper contained in vol. vii. of this Journal, I gave a full description of these fahlbands, the presence of which in the Laurentian rocks affords another proof of the identity of that series with the Primitive Gneiss of Scandinavia.

The rocks which occur in the neighbourhood of Rossie belong almost exclusively to the Laurentian formation. Here and there the gneissoid rocks are unconformably overlaid by patches of Potsdam sandstone, and the latter rock most likely at one time covered the whole area of the district, but has since been removed by denudation. The following are the principal rocks which occur in the neighbourhood of Rossie, and which belong to the Primitive Gneiss or Laurentian formation:

Gneiss, both micaceous and hornblendic. The feldspar, quartz, and mica in the former sort, are often intimately combined with each other in bands of considerable thickness. Quite as frequently, however, the mica with a smaller quantity of feldspar and quartz forms narrow bands alternating with other bands destitute of lamination, and consisting of a coarsely granular mixture of feldspar and quartz; so that this gneiss in reality is a compound of very micaceous gneiss and pegmatite. The micaceous varieties of the gneiss occur principally to the south and southeast of the village of Rossie, while that of a hornblendic character is principally developed on the north and west. It is worthy of remark that while the feldspar in the micaceous gneiss is for the most part white, in the hornblendic variety it is reddish coloured. On the road to Depeyster the latter sort of gneiss predominates; and there tourmaline often occurs in it, forming a very beautiful rock. Occasionally the quartz disappears, and a schistose syenite is the result. There are even bands wherein very little slaty structure is discernible, and the rock of which, did it occur in larger masses, would undoubtedly be termed syenite.

Mica schist would appear to exist in this district, at least in such narrow bands as those of the micaceous gneiss above referred to. It would seem also occasionally to occur as the rock of the fahlbands hereafter to be described.

Gneiss-granite. In many places to the south of Rossie, and especially near the lead-veins on the farm of John Robb, the gneiss, at least when hand-specimens of it are examined, exhibits mere traces of parallel structure; and on this account, as well as because of its being finely granular, it might reasonably be termed gneiss-granite.

Granite. Besides the narrow granitic bands above referred to which enter into the composition of gneiss, many veins of granite occur which cross the gneissoid strata, sometimes in very great numbers, and presenting an appearance similar to that described by Macculloch as visible at Cape Wrath.

Tourmaline rock. In the district of syenitic gneiss which lies to the north-west of Rossie, there occur some irregular masses of quartz in which tourmaline is so plentifully disseminated as to form the schôrlfels of German geologists.

Crystalline limestone is very extensively developed in the neighborhood of Rossie, and indeed it constitutes the storehouse from which are obtained the greater number of the rare and beautiful minerals, for which Rossie is celebrated. Like the same rock in Canada, it is coarsely granular and sometimes saccharoidal. The general color is white, although grey bands are of frequent occurrence. These latter seem to owe their color to disseminated laminæ of graphite,—and indeed it is difficult to find a piece of the limestone which is entirely free from this mineral.

Diorite. This name may probably with justice be given to a rock which occurs to the west of Rossie, and which forms the side-rock of a vein of magnetic and iron pyrites which has been explored to a considerable extent for copper. It consists mainly of greenish-white albite (some of the cleavage planes of which exhibit a slight change of color), dark-green hornblende, and translucent quartz. Besides these minerals there are also crystals of sphene present in small quantity.

The general strike of the schistose rocks above mentioned is north and south (magnetic). Although there are often very wide deviations from this course, they seldom go beyond N. 45° W. and N. 45° E., the deviations to the eastward being much more frequent than those in a westerly direction. Occasionally the rocks may seem to run due east and west, but this is only in small areas, and owing to local contortions of the strata. These contortions are often of the most surprising and intricate character, and remind the observer of the figures formed by the foam of a river when it has reached comparatively still water, and is acted on by currents flowing with different degrees of rapidity or in different directions. They also bear a resemblance to the contortions visible on many pieces of slag which may be picked up on the heaps produced at the Rossie iron-furnaces. In fact, the edges of such pieces, showing bands of different color and grain in beautiful convolutions, present a miniature counterpart of the upturned edges of the contorted gneissoid strata. As in all primitive regions, these strata assume in Rossie an almost vertical position. On the east side of the Indian River a few beds are observable dipping about 5° west; but very generally the strata are highly inclined, and if not quite vertical, only a very few degrees removed from it.

It will be observed that the rocks of this district coincide closely in their various characters with the same rocks in other and far-distant primitive regions; and when we reflect that they possess the same general strike and inclination, the same mineralogical constituents and modes of aggregation, it is impossible to avoid forming the conclusion that they are the products of some processes of vast magnitude and force, which must have been in operation at the same time over the whole of the earth's surface, and during the very earliest stages of its development. Assuming these processes to have been of plutonic nature, the general north and south strike of all primitive stratified rocks might be supposed to represent the general direction of the flow of the igneous material from the solidification of which the rocks resulted.

Among the economic minerals occurring in Rossie, an important place is occupied by the ores of lead and iron. Several very important veins containing the former were explored many years ago with success, and are at present being worked quite extensively. The veinstone of the Coalhill, Victoria and Union lodes consist principally of calcspar and galena, with occasional traces of fluorspar and copper pyrites. These lodes cut the gneissoid strata almost at right angles to the run of the latter, and their dip deviates but very little from the vertical. Sir W. E. Logan (Geology of Canada p. 689) considers it possible that the lead-veins of Bedford and Landsdowne, C. W., belong to the same series as those of Rossie. The former seem however to be especially associated with crystalline limestone, and it would seem to be a question of interest and importance as to whether the lodes of Rossie traversed this rock, and if so, whether it had any influence upon them. To judge from a plan of the workings of the Coalhill mine, shown to me at Rossie, there would seem to occur in it so-called *shoots* of ore; but whether these bear any definite relation to the character of the side-rock, has not been ascertained. The investigations of Herman Müller of Freiberg have shown that the nature of the wall-rock has much influence on the contents of the metallic veins of the Erzgebirge, and he divides the gneiss of that region into grey and red, the former exerting a favorable and the latter an unfavourable influence on the contents of the lodes passing through them. It is not improbable that the same varieties of gneiss may occur near Rossie, and influence in a like manner the lodes of that district.

Besides the lead-veins which are now being worked, numerous others have been discovered, especially on the lands of John and William Robb. The ore is galena, in calcspar, which occasionally contains also iron pyrites in small quantity. The wall-rock is the granitic gneiss mentioned among the rocks of the district, and the general strike of these veins differs from that of the older ones of Coalhill, Victoria, and Union mines. They would seem to belong to a different series, having a general strike of about N. 50° W. and an almost vertical dip. Several of these veins are well worthy of exploration, not only in depth, at the points where they have been uncovered, but also where they cross the other rocks of the country, especially the limestones and fahlbands.

Rocks of the latter description exist in the immediate neighborhood of the lead-veins just referred to. My attention was first attracted to them by observing pieces of rock much resembling a well-weathered fahlband on a ploughed field in the farm of William Robb. By tracing these southward the rock itself was soon found exposed on the road leading across the farm. It had here a strike of almost north and south (the bearings given are to be always understood as magnetic), which carried it to the southward beneath another ploughed field. On crossing this to the south it was again found out-cropping, and from this point to beyond John Robb's house it was traced uninterruptedly. About half way between the latter place and the spot where the rock was first found, the strike changes to N. 22 East, which direction it maintained to the southward as far as it was followed. This fahlband was therefore actually traced for a distance of about a mile, but it doubtless extended much further. I have in the paper already referred to (Canadian Naturalist, vol. vii, p. 7) given a minute description of these rocks and the ore-deposits which occur in connection with them in Norway, but it may be advantageous here to recapitulate their general characters. A fahlband (the first syllable being most probably derived from the German word *fahl* or *faul*, rotten) is a zone of rock occurring in the Primitive Gneiss formation varying from a few to several hundred feet in thickness, having a length on the strike of several miles, and possessing the same dip and strike as the rocks adjoining it, but distinguished from them by the decomposed appearance and reddish-brown color which it assumes on exposure to the atmosphere. This peculiar brown weathering is caused by the oxidation of the magnetic and iron pyrites with which the rock is impregnated, the ferric oxide resulting from their decomposition being the coloring substance. The quantity of these sulphurets of iron necessary to produce this effect is often exceedingly small; and indeed it is sometimes scarcely possible to distinguish them even in the freshly broken and undecomposed rock, so finely disseminated are they through it. By the help of the magnifying glass they can, however, always be detected in any part of the rock which exhibits the reddish-brown surface above mentioned. The impregnation is altogether independent of the nature of the rock; gneiss, mica-schist, and hornblende-schist being alike found constituting fahlbands. Their course is often marked by depressions in the rocks, caused probably by their greater proneness to decomposition. Almost all the mines of any importance in the south of Norway, with the exception of those of iron, occur on bands having the characters above described. Silver, cobalt, nickel, and copper have all been found in very remunerative quantities within this peculiar rock, either in veins crossing the band (silver) or disseminated through it more or less plentifully in fine grains (cobalt), or in irregular masses sometimes rudely parallel with the strike (copper, nickel).

The band of red-weathering rock above described as occurring to the south-west of Rossie has all the characters of a fahlband. The impregnating sulphurets are distinctly recognisable; the breadth is sometimes over 200 feet; the length on the strike is considerable; (one mile at least), the strike is the same as that of the enclosing rocks, and the fahlband itself is a micaceous gneiss. Depressions on its course are frequent, and it would seem to occupy the low cultivated land which lies behind John Robb's house. The only particular wherein it differs from the same rock in Norway is in being accompanied on the east side by a band of crystalline limestone, which often weathers brown and is much decomposed, and in being, so far as explorations have heretofore shown, destitute of any valuable minerals. Its true character being now known, however, it is possible that future exploration, if concentrated upon this zone of rock, may develope some metalliferous deposits of value.

On the east side of Indian River, and near the town-line between Rossie and Antwerp, another fahlband occurs, this time unaccompanied by crystalline limestone, containing traces of copper-ore, and therefore presenting a complete analogy with the fahlbands of Norway. This fahlband is found on the land of Mr. Lyon in Antwerp, close to the road which, towards the north, joins the plank-road between Clarkshill and Oxbow. Owing to the decomposed state of the rock of this fahlband, it is difficult to recognise its mineralogical constituents; but it is more micaceous in character than the one on John Robb's farm. Its strike when first observed was N. 37° E, the strata being as usual almost vertical. A few fathoms distant from it, on the eastern side, some exploration had been done, and pieces of copper-ore said to have been discovered. In the excavation itself I could discover no trace of copper; but lying among the debris from it pieces seemingly of pyrites very much decomposed were observed, which, on assay, were found to contain 4.6 per cent of copper. The rock in this excavation was altogether different from that of the fahlband, and much resembled the diorite described among the rocks of the district. A short distance from this place, towards the north on the fahlband, a small vein ($\frac{1}{4}$ to $\frac{3}{4}$ inch wide) occurs crossing it at right angles nearly, and containing almost pure copper pyrites. A small quantity picked out of the vein assayed 25.4 per cent copper. Following the fahlband to the northward, it continues on the east side of the road, changing its strike to N. 31° E. (dip to N. W., 89°), then to N. 50 E, when it diverges further from the road. A few hundred yards to the eastward of the road a three-feet vein of calcspar occurs, containing copper pyrites in small grains scattered through it, the quantity so small as merely to bring the contents of the best pieces up to $\frac{1}{2}$ per cent. The strike is, however, such as to intersect the fahlband, and it might be important to explore it where it does so, as its character might there alter, and possibly its contents in copper pyrites increase. This fahlband was traced altogether a distance of three quarters of a mile on the strike, but had time been devoted to its exploration, it would *probably* have been found continuous along a much greater distance.

Traces of fahlbands, or at least of brown-weathering rocks, occur at many other points, and there would seem good reason for supposing that there exist in Rossie a tolerable number of such fahlbands running rudely parallel with each other, the tracing out of which, and their exploration for minerals of value, might be attended with important results.

In the south-eastern part of the town of Rossie, the very extensive deposits of iron ore occur, which formerly supplied the Rossie iron furnaces, and the working of which has very lately been resumed. Open workings have been carried on at four different points, called respectively the Old Caledonia, New Caledonia, Kearney and Keene ore-beds. The first-named working consists of several excavations made into the face of a ridge consisting mainly of iron ore. The rock which forms the most elevated part of this ridge is probably a part of the Potsdam sandstone. The upper layers are comparatively soft and of undoubted detrital character. As it approaches the underlying iron ore, however, it becomes excessively hard, assumes almost the vitrified appearance of some quartzites, and becomes slightly mixed with ore. A little below this, and filling the interstices between fragments of ore, a brown-spar is sometimes found, which seems to be a mechanical mixture of the carbonates of iron and lime in the proportion of 16.2 per cent of the former to 83.8 per cent of the latter. Beneath the indurated sandstone lies a great mass of iron ore which is at least forty feet thick vertically. It consists of compact amorphous hematite, with which more or less silicious and calcareous matter is intermixed. Occasionally cavities are found in the interior of the ore filled with various minerals, and one of these I observed contained calcspar and transparent rhombic prisms of heavy spar. In the richest and densest pieces of the ore small fissures occur containing graphite, and indeed this mineral seems to be disseminated through all the ore in more or less considerable quantity. A specimen of this best ore contained, on examination,

Matter insoluble in acid, principally graphite.........	18·90
Peroxide of iron = 57·45 per cent. of the metal.......	82·05
	100·95

Another specimen which was considered less rich than that just mentioned, but containing less disseminated graphite, and more of it in crystalline scales occurring in the cracks, gave,

Silicious matter, insoluble in acids..................	7·4
Peroxide of iron = 64·84 per cent. of the metal........	92·6
	100·0

Besides these qualities, an immense quantity of ore is worked which is evidently mixed with very considerable portions of argillaceous and calcareous matter. A specimen of this character gave on analysis as follows:

Silicious matter, insoluble in acid....................	36·20
Peroxide of iron = 34·76 per cent. metallic iron........	49·65
Carbonate of lime..................................	12·90
	98·75

In none of the excavations does the underlying rock appear to have been reached, and since outside of the workings the underlying red shales have a strong dip towards the deposit, there would seem reason for supposing the existence of a large body of ore even below the level of the present excavations. To the west of the ore-bed, and apparently dipping underneath the above-mentioned red shales, other slates occur, very richly impregnated with iron pyrites. Beyond these, and nearer the New Caledonia bed, vertical strata of micaceous schist are observable. The excavation on the New Caledonia bed was filled with water, but similar relations seem prevail there as at the Old Caledonia. At the former deposit, however, the overlying sandstone is not only very much hardened in contact with the ore, but is broken up into a breccia, the interstices of which are filled up with highly siliceous ore. On the whole, it would seem as if all the iron deposits of this neighborhood had been formed at the same time and in the same manner, and they may have even constituted parts of one and the same original mass. At Keene's ore-bed, about a mile distant from the Caledonia workings, the geological relations are the same, although the overlying sandstone is much brecciated, and it, as well as the bed of the ore, and the underlying shale, deviates very much from the horizontal. Two specimens of ore taken from this bed contained,

	Best ore.	Inferior ore.
Silicious matter	4·80	2·18
Peroxide of iron........	93·15 = 65·22 iron	66·00 = 46·21 iron.
Carbonate of lime......	2·05	32·40
	100·00	100·55

Since the ore together with silica often forms the cement of the breccia above mentioned, it is highly probable that the sandstone was deposited, and also disturbed prior to the formation of the masses of ore. With regard to the origin of the latter, it is impossible to regard them as igneous products, when we consider the large amount of earthy matter which they contain. And, further, the absence of specular iron ore would seem to indicate that they could not have been the result of any process of sublimation. There only remains, therefore, as adequate to explain their mode of formation, the theory that the ore was introduced into its present bed in the state of solution, and deposited there by means of some precipitating agent. A slight degree of heat may subsequently have been instrumental in converting the *precipitate* into anhydrous peroxide of iron.

There only remains to mention, in connection with the economic minerals of Rossie, the vein of magnetic and iron pyrites occurring in the diorite already described. A very considerable amount of exploration has been done on this vein in search of copper, but mere traces only of copper pyrites are sometimes observable close to the quartz which forms part of the veinstone. The magnetic pyrites contains no nickel, and the least trace of cobalt. The iron pyrites, on the other hand, contains no nickel and 0·85 per cent. of cobalt.

I here conclude this geological sketch of Rossie. It is necessarily very incomplete from the limited time at my disposal when visiting that place. I trust, however, that it will be found to contain a few facts of interest.

Acton Vale, C. E., 29th May, 1865.

CONTRIBUTIONS TO THE CHEMISTRY OF NATURAL WATERS.

By T. Sterry Hunt, LL.D., F.R.S.; of the Geol. Survey of Canada.

III.

Chemical and Geological Considerations.

§ 52. Salts of the Alkaline Metals.—These salts abound in most saline waters, and except in the few cases in which sulphate of magnesia prevails, form a large part of the soluble matters present. The salts of sodium are by far the most abundant, and the proportion of potassium salt is generally small. The chlorid of potassium in modern sea-water constitutes three or four hundredths of the alkaline chlorids, while in the brines from old rocks, and in saline waters of the first two classes alike from Germany, England, the United States, and Canada, its proportion is much less, sometimes amounting to traces only. In the waters of classes III and IV, where alkaline carbonates appear, and even predominate, the proportion of potassium salt becomes greater.

Thus of the waters of the latter class (§ 45), the alkalies of the Nicolet spring calculated as chlorids contain 1.89 per cent of chlorid of potassium, and those of the Jacques-Cartier 2.95; while for the St. Ours spring the chlorid of potassium is equal to not less than 25.0 per cent. There does not however appear to be any relation between the proportion of alkaline carbonate and that of potassium, since the salts from the waters first named are more alkaline than those of St. Ours: while those of the alkaline water of Joly contain less than one per cent of potassic chlorid.

The amount of this salt obtained from the water of the Ottawa River is worthy of notice, being equal to not less than 32.0 per cent of the alkaline chlorids, while in the waters of the St. Lawrence it amounts to 16.0 per cent.* A large proportion of potassium relatively to the sodium has already been observed in the case of many ordinary river and spring waters, and this is readily explained when we consider the extent to which potash is set free by the decomposition of both vegetal and mineral matters at the earth's surface. The process by which this base is eliminated in filtering through soils has already been explained in § 5. The occasional presence of considerable amounts of potash in sulphated mineral waters (Lersch, Hydro-chemie, p. 346) is explained by the power of solutions of gypsum to set free this alkali from soils (§ 7), and also probably in some cases by the dissolution of double potassic salts like polyhallite. Strata holding glauconite, which occurs alike in paleozoic and more recent formations,† may also be conceived to yield potash salts to infiltrating waters.

§ 53. It will be seen that the waters above noticed, in which the proportion of the potash to tl ›da is large, are but feebly saline, so that the real amount of potassium is in no case great. I have however recently examined the water of a borax lake from California, which contains in 1000 parts 17.250 of solid matters of which 1.818 is carbonate of potash, the remainder being soda-salts, carbonate, borate, chlorid, and a little silicate, with no sulphate

* T. S. Hunt, L. E. and D., Phil. Mag. (4) xiii. 239; and Geology of Canada, page 565.

† For a notice, with analyses by the author, of a green hydrated silicate of alumina, iron and potash, allied to glauconite, from the paleozoic rocks of Canada and of the Mississippi valley, see the Geology of Canada, pages 487, 488; where also will be found an analysis by the author of the glauconite from the Cretaceous formation of New Jersey. See also illiman's Journal [2], xxxiii. 277.

(§ 64). This amount, if represented as chlorid of potassium, is equal to 1.963, or to 11.46 per cent of the alkalies calculated as chlorids. The amount of potassium salt in this water is consequently about forty times greater than in that of St. Ours.

The fact of special importance as regards the alkaline metals in the waters whose analyses we have given in this paper is the very small amount of potassium in the strongly saline muriated waters of the first three classes, which we conceive to be more or less directly derived from the waters of the ancient ocean. To this primeval sea, almost destitute of potassium, the process of mineral decay has been for ages adding potash salts, and despite the partial elimination of these by vegetation (§ 5), and by the formation of glauconite, we find a notable proportion of potash in the waters of the modern ocean.

In the analyses of the saline waters here given lithia was sought for in a few instances, and was detected in the waters of Varennes. Most of these analyses were made before the discovery of the new metals cæsium and rubidium.

§ 54. Salts of Calcium and Magnesium.—We have to consider under this head the relations both of the chlorids and the carbonates of these bases. The bitter saline waters of the first class, although containing large quantities of chlorids of calcium and magnesium, are, as we have seen, generally destitute of earthy carbonates. These latter, however, are found in small quantities in the alkaline waters of the fourth class, and in somewhat larger amounts in those intermediate waters which form classes II and III, and are apparently formed by admixtures of the two classes previously mentioned. Besides the carbonates of lime and magnesia which the waters of the fourth class hold in solution, the carbonate of soda which they contain gives rise, by its re-action with the chlorids of calcium and magnesium, to additional quantities of the carbonates of these bases. In the waters of Kingston, (§ 36), a large amount of chlorid of calcium is associated with earthy carbonates, and these waters thus offer a passage from the first to the second class.

In most of the waters of the second class, as will be seen from the table § 42, there appears but a small amount of chlorid of calcium; and even this depends upon the manner in which the analysis has been conducted. We may suppose in the recent water such a partition of bases between the chlorine and the carbonic acid that chlorid of calcium, chlorid of magnesium, bicarbonate of lime and bicarbonate of magnesia co-exist. When such a solution is submitted to evaporation at ordinary temperatures, provided there is present a sufficient amount of chlorid of calcium, carbonate of lime alone is deposited, and chlorid of magnesium remains in solution.

In case the chlorid of calcium is insufficient, the lime is still first deposited as carbonate, and the more soluble magnesian carbonate is precipitated by further evaporation. When however such a water is boiled, a reverse process takes place; the carbonate of lime slowly decomposes the magnesian chlorid, and carbonate of magnesia is deposited, while chlorid of calcium remains in solution. Hence if the amount of chlorid of magnesium be great enough, and the ebullition sufficiently prolonged, the precipitate will at length contain only carbonate of magnesia; while an equivalent of chlorid of calcium, now found in the solution, represents the carbonate of lime which the analysis of the precipitate at an earlier stage of the ebullition would have furnished.

As an example of this may be cited the analysis of the water of Ste. Genevieve (§42, No. 8), where the precipitate after a few minutes boiling contained carbonates of lime and magnesia in the proportion 12 : 750. When however another portion was boiled down to one sixth, the precipitate was found to be pure carbonate of magnesia. Again, the Plantagenet water gives, by ebullition, the results set forth in §42, No. 1; showing chiefly carbonate of magnesia, together with a portion of chlorid of calcium. When however this water is left to spontaneous evaporation, the whole of the lime separates as carbonate, and the liquid remains for a time charged with carbonate of magnesia, probably as sesqui-carbonate. This solution is however after a time spontaneously decomposed even in closed vessels, with deposition of a portion of crystalline hydrated carbonate of magnesia; another portion remains in solution, together with chlorid of magnesium, but is precipitated by ebullition. (Silliman's Journal [2], xxvii. 173.)

§ 55. Bicarbonate of magnesia and chlorid of calcium, when brought together in solution, undergo mutual decomposition with separation of carbonate of lime if the solutions are not too dilute. At the ordinary temperature and pressure, water saturated with carbonic acid will not hold in more than about one gram of carbonate of lime to the litre (1 : 1000); equal to only 0.88 grams of carbonate of magnesia. (The solubility of carbonate of lime in pure water is well known to be much less, and is, according to

Bineau, equal to 1 : 30,000 or 1 : 50,000.) We should not therefore expect to find that water holding chlorid of calcium in solution would yield, by boiling, more than the latter amount of magnesian carbonate; so much might evidently be formed by the action of dissolved carbonate of lime which the water might hold as bicarbonate. I have elsewhere described a series of experiments on the solubility of bicarbonate of lime both in pure water and in saline solutions, and have shown that the presence of salts of soda, lime and magnesia does not increase the amount of bicarbonate of lime which water is capable of holding *permanently* in solution. In view of these facts it seems at first sight difficult to explain how a mineral water like that of Kingston (§ 36, No. 7), holding a large quantity of chlorid of calcium, could yield, as appears from Dr. Williamson's analysis, 1.287 grams of carbonate of magnesia, equal to 1.462 of carbonate of lime to the litre. Recent experiments have however shown me that supersaturated solutions of a certain stability may be obtained, in which comparatively large quantities of neutral carbonates of lime and magnesia exist in the presence of sulphates and chlorids of calcium and magnesium. Reserving for another occasion a description of the details of these investigations, I shall briefly state the results obtained.

§ 56. In a memoir on the salts of lime and magnesia published in 1859 (Silliman's Journal [2] xxviii. 171), it was shown that by the addition of bicarbonate of soda to a solution holding chlorids of sodium calcium and magnesium, with or without sulphate of soda, and saturated with carbonic acid, it was possible to obtain transparent solutions holding from 3.40 to 4.16 grams of carbonate of lime to the litre; of which however the greater part was deposited after twenty-four hours; when the solutions were found to contain somewhat less than 1.0 gram in the form of bicarbonate. Boutron and Boudet had previously shown that by saturating lime-water with carbonic acid, solutions were obtained holding in a litre 2.3 grams of carbonate of lime; of which one half was soon deposited, even when the solution was kept under a pressure of several atmospheres. It would thus seem that saline liquids favor this temporary solubility of the carbonate of lime.

In all of the above experiments, an excess of carbonic acid was present, but this I have since found is not essential, since super-saturated solutions may be obtained holding as much as 1.2 grams of carbonate of lime, together with sulphate of magnesium and chlorid of calcium, in a litre of water, without any excess of carbonic acid. The power of alkaline chlorids and of chlorid of calcium to prevent the precipitation of chlorid of calcium by carbonate of soda has already been observed by Storer, (Dictionary of Solubilities, p. 110). I have found that the precipitate produced by the admixture of solutions of these two salts is readily dissolved, when recent, by a solution of chlorid of calcium, or of sulphate of magnesia; and thus liquids may be prepared holding at the same time from 1.0 to 1.2 grams of neutral carbonate of lime, and 1.00 of neutral carbonate of magnesia, in presence of sulphate of magnesia. These solutions of carbonate of lime, which are strongly alkaline, may be kept for twelve hours or more without perceptible change at ordinary temperatures, but after a time deposit crystals of hydrated carbonate of lime. The addition of alcohol immediately throws down the whole of the carbonate of lime in an amorphous condition.

The carbonate of magnesia is still more soluble than the carbonate of lime under similar conditions, and it is possible to obtain 5.0 grams of neutral carbonate of magnesia dissolved in a litre of water holding seven per cent of hydrated sulphate of magnesia, without any carbonic acid. These solutions, which are strongly alkaline to test-papers, yield a precipitate by heat, which re-dissolves on cooling.

It is evident that the mingling of saline and alkaline waters may give rise to solutions like those just described, and thus explain apparent anomalies in composition like that of the Kingston water. See also in this connection the observations of Bineau, and my own on the properties of solutions of sesqui-carbonate of magnesia. (Silliman's Journal [2] xxvii. 173.)

§ 57. SALTS OF BARIUM AND STRONTIUM.—As will be seen from the preceding tables, the salts of these two bases are found in very many of the saline and alkaline waters of Canada. Their carbonates probably sustain to the magnesian chlorid a similar relation with that of calcium, and hence these bases appear in some of the analyses partly as carbonates, and partly as chlorids of barium and strontium. The precipitate formed in the concentrated and acidulated water by dilute sulphuric acid was, whenever submitted to analysis, found to contain both barium and strontium. For the separation of these the mixed sulphates were first converted into chlorids; the barium was then thrown down as silico-fluorid, and the strontium subsequently precipitated by a solution of gypsum.

The insolubility of its sulphate must have excluded baryta from the waters of the primeval sea, and when set free, as we may suppose by the decomposition of its silicated compounds existing in the primitive crust, (§ 81) its soluble bicarbonate carried down to the sea would there be precipitated by the sulphates present. A similar process must still go on with all the dissolved barytic salts which find their way to the ocean.

The sulphate of baryta thus accumulated in sedimentary strata, may be partially decomposed by infiltrating solutions of alkaline carbonates; and thus be rendered capable of being subsequently dissolved as carbonate; but the most probable mode of its solution, is, we conceive, through its previous reduction by organic matters to the form of a soluble sulphuret (§ 10), ready to be converted into carbonate or chlorid of barium. In this way we may explain the frequent occurrence of baryta salts in the saline waters of the first three classes, and the consequent absence of sulphates, which will be further considered in § 61. From the similarity of its chemical re-actions, the preceding remarks apply to strontia as well as baryta.

§ 58. Iron, Manganese, Alumina and Phosphates.—None of the waters of the four classes here described contain any notable quantity of iron, yet this element is never wanting in those waters which contain earthy carbonates. Whenever a portion of one of these waters, or better the earthy precipitate separated from it by boiling, is evaporated to dryness with an excess of hydrochloric acid, the residue treated with acidulated water yields a portion of silica, and the solution will then be found to yield with ammonia a precipitate. This, which is partially soluble in caustic alkalies, is often colorless, and will be found to consist of alumina and peroxyd of iron, with phosphoric acid and a trace of manganese, which latter metal is seldom or never absent. The small quantity of alumina which these waters contain appears not to be derived from suspended argillaceous matters, but to be held in a state of solution.

The phosphates are generally present only in very small quantities in these waters, for the reason pointed out in § 5. The largest amount which I have met with was in an alkaline water from Fitzroy (§ 43, No. 4); where it is equal to ·0124 of tribasic phosphate of soda in 1000 parts of water.

§ 59. Bromids and Iodids.—The chlorids in these ancient mineral waters are always accompanied by bromids and iodids, but the proportion of the bromids to the chlorids appears to be much less than in the waters of the modern seas. According to Usiglio, 100 parts of the salts from the Mediterranean contain 1·48 of bromid of sodium; while ten analyses by Von Bibra of the waters of different oceans, give from 0·86 to 1·46, affording for 100 parts of salts, a mean of 1·16 of bromid of sodium, equal to 1·04 parts of bromid of magnesium. The waters of Whitby and Hallowell, on the contrary, which are the richest in bromids of those described in this paper, contain only 0·54 and 0·69 parts of bromid of sodium in 100 parts of solid matters; while few of the saline springs of the second class contain more than one-half of this proportion, and some of them very much less.

With regard to the iodids in many of these waters, however, the case is very different. The waters of the modern ocean, as is well known, contain but traces of iodine, and in some strongly saline springs of the first class, like that of Whitby, it is only in the alcoholic extract of the salts from this water that iodine can be detected. The Hallowell water (§ 36, No. 3), which closely resembles this in its general composition, and in the proportion of bromids, is however so rich in iodine that its presence can readily be discovered without previous evaporation. It is sufficient to add to the recent water acidulated by hydrochloric acid, a little solution of starch, and a few drops of nitrite of potash to produce an intense blue color. The iodid of sodium in the first-named water was found equal to 0·0017 parts of the solid matters, and that of the second to 0·019 or nearly twelve times as much. The unconcentrated saline waters of Ste. Genevieve, of the second class, also give a strong re-action for iodine, and when acidulated with hydrochloric acid, without previous evaporation, yield with a salt of palladium an insoluble precipitate of iodid of palladium after a few hours. The salts from these two springs of Ste. Genevieve, though poorer in bromids, are much richer in iodids than the waters of Hallowell; the spring No. 8, containing in 100 parts of salts no less than 0·138 of iodine, so that there appears to be no constant proportion between the chlorids, bromids, and iodids of these saline waters.

§ 60. The relations of bromids and iodids to argillaceous sediments have yet to be determined. It would appear from the facts just cited that bromine has in the course of ages been slowly eliminated from insoluble combinations, and like potassium, has accumulated in the waters of the ocean; while the facts in the history of iodine seem to point to a process the reverse of this;

in other words, to a gradual elimination of iodine from the sea-waters, and its fixation in the earth's crust. The observations of numerous chemists unite to show the frequent occurence of small portions of iodine in some unknown combination, in sedimentary rocks of various kinds; from which we may conjecture that it was in former times abstracted from the sea, either directly or through the intervention of organic bodies (as in the case of potash, which is separated and fixed by means of algæ, § 5). Experiments after the manner of those of Way and Voëlcker may throw light upon this interesting question. We are aware that insoluble combinations of soluble chlorids with silicates of alumina are formed under certain conditions, as appears in the generation of sodalite, eudyalite, and the chloriferous micas, and it is not improbable that the soluble iodids may give rise to similar compounds. By such a process might be explained the rarity of this element in modern seas, while the occasional re-solution of the iodine from these insoluble compounds by infiltrating waters, would help to explain the variable and often large proportions in which this element is met with in some of the waters noticed above.

§ 61. Sulphates.—In the preceding sections we have already discussed the principal facts in the history of those neutral waters in which sulphates predominate, or prevail to the exclusion of chlorids (§ 50, 51.) The history and the probable origin of those curious springs which contain free sulphuric acid has also been considered (§ 31, 48, 49); and it now remains to notice the relation of sulphates to the muriated waters. The first fact that excites our attention is that of the total absence of sulphates from numerous springs of the first, second and third classes; as shown in the preceding analyses, and also in the observations of Lenny and others on the saline waters over a great area in western Pennsylvania (§ 40).

The elimination of sulphate in the form of gypsum from evaporating waters containing an excess of chlorid of calcium, has already been discussed in § 37; but the bitterns resulting from such a process still retain small portions of sulphates; while it is to be remarked that the saline waters under consideration contain no traces of sulphates, and in many instances hold portions of baryta and strontia, bases incompatible with the presence of sulphates. The modes in which this complete elimination of sulphates may be effected are two in number. The first has already been suggested in § 10, and depends upon the deoxydizing power of organic matters, which reduce the sulphates to sulphurets. These in their turn may be converted into carbonates, the sulphur being separated either as sulphuretted hydrogen (giving rise by oxydatiorn to free sulphur,) or as insoluble metallic sulphurets. This reducing action not only decomposes the soluble sulphates of soda, lime and magnesia, but also, as has been pointed out in § 57 may extend to sulphate of baryta and thus sulphuret or carbonate of baryta be formed. It is the action of these soluble baryta salts which constitutes the second mode of desulphatizing waters; and this, if we may judge from the frequence with which baryta salts occur in the saline waters in question, appears to have been the most general process.

It is a fact worthy of notice that a saline spring at Sabrevois near Lake Champlain, which holds both baryta and strontia in solution, is at the same time slightly impregnated with sulphuretted hydrogen. Another saline and sulphurous spring, which rises within ten feet of this, contains however a portion of sulphates. (Geology of Canada, page 542.)

§ 62. I am indebted to Prof. Croft of Toronto, for some notes of a recent examination by himself of a saline of the first class, which contains at the same time a soluble sulphuret. This water, from a boring sunk to a depth of several hundred feet through the Devonian limestone at Chatham, Canada West, had a specific gravity of 1039.3, and yielded for a thousand parts about 51.0 of solid matters. It contained large portions of chlorids of calcium and magnesium, with very little sulphate, traces of carbonate, and no free carbonic acid. The water, which gave an alkaline reaction with turmeric, was greenish in color, very sulphurous to the taste, and yielded a purple color with nitro-prussid of sodium, and a black precipitate of sulphuret with a solution of sulphate of iron. A current of carbonic acid rendered the recent water opalescent, and by exposure to the air it deposited sulphur. A quantitative analysis of this water is to be desired.

§ 63. BORATES.—The reddening of the yellow color of turmeric paper in presence of free hydrochloric acid, affords, with certain precautions, the ordinary means for detecting small portions of boric acid. Most of the waters of the third and fourth classes, and some of those of the second have been tested in this way, and have never failed when reduced to a small volume, and acidulated with hydrochloric acid, to give this reaction; which was however most marked with the waters of the fourth class. The determination of the amount of boric acid in saline waters presents no small difficulty. In the case of the alkaline water of Joly (§ 45, No. 3) the following process was however attempted. The salts left by its evaporation were treated with carbonate of ammonia to separate a portion of silica, and then with recently precipitated carbonate of silver, by which the alkaline chlorids were converted into carbonates. The solution now retained in some undetermined form a portion of silver, which was separated by fusing the evaporated saline residue in a silver crucible. By a second evaporation and fusion there was obtained a mixture of soda and potash, combined only with carbonic, sulphuric and boric acids. By directly determining the other ingredients the boric acid was estimated from the loss, and was found equal to 0·028 parts in 1000 of water, which contained 0·752 of solid matters. The conversion into carbonate of the sulphates in the mixed salts, by the aid of bicarbonate of baryta, would simplify this process. In § 35 it has been explained that the amount of carbonate of soda in the waters of the third and fourth classes was generally calculated from the excess of the alkaline bases, and controlled by the amount of carbonate of baryta precipitated from chlorid of barium by the alkaline salt. It was found, however, that this last method always presented a certain deficit, due to the borate of soda, whose quantity in many of the waters, is too large to be disregarded. The precipitate of carbonate of baryta contained a portion of sparingly soluble borate of baryta, which was not completely removed by long and continued washing.

§ 64. I have recently had an opportunity of examining from California the waters of a borax lake, which contains, beside borate and carbonate of soda, a portion of chlorid, and a little silicate, traces only of phosphate, and no sulphate. It held in solution very small quantities of earthy carbonate, and was remarkable for a large proportion of potash, already referred to in § 53. The evaporated and fused saline residue was treated by the ordinary methods for the determination of the chlorine, carbonic acid and silica; while the bases were obtained in the form of sulphates by the aid of sulphuric and hydrofluoric acids, and afterwards separated as chlorids by the aid of chlorid of platinum. From the data thus obtained the following ingredients were found by calculation for 1,000 parts of the water :

Carbonate of soda	9.476
Biborate of soda	4.395
Chloride of sodium	1.702
Carbonate of potash	1.818
Silica	0.129
	17.520

The potassium, as above determined, equals 11.46 per cent. of the bases weighed as chlorids; another trial gave 11.41. Although for convenience we have represented the potassium as carbonate, it will be seen that the amount of chlorine is such that it might, for the greater part, have been represented as chlorid of potassium, with an equivalent portion additional of carbonate of soda.

§ 65. CARBONATES.—In describing in § 43 the alkaline-saline waters of Caledonia it has been shown that these contained a quantity of carbonic acid insufficient to form bicarbonates with the carbonated bases present. It was partly with this fact in view that, after an interval of more than seventeen years, I undertook the new analyses of these waters, which in § 47 are given side by side with the earlier results. In these recent analyses, as there remarked, a slight excess of carbonic acid was met with. In the interval the springs had undergone changes in composition, and while the third one still retained in a slight degree its alkaline character, the other two had become waters of the second class, holding instead of carbonate and sulphate of soda, chlorid of magnesium, and baryta salts. The amount of carbonic acid had however undergone but little change; and as will be seen by comparing the figures below with those in the table in § 47, the slight diminution in the first and third corresponds very closely with the falling off in the amount of solid matters between 1847 and 1865: while, on the contrary, the augmentation in the amount of carbonic acid in the second is accompanied with a corresponding increase in the amount of fixed matters present.

CARBONIC ACID IN ONE LITRE OF THE CALEDONIA WATERS.

	1847.	1865.
Gas spring.............	.705 gram.	.671 gram.
Saline spring...........	.648 "	.664 "
Sulphur spring..........	.590 "	.573 "

While the amounts of fixed matters and of carbonic acid in the several waters have undergone but little change, we find, however, that there has been a great diminution in the proportion of carbonated bases. Thus in the Gas spring in 1847 the carbonic acid required for the neutral carbonates found in the analysis was .356, while for the same water in 1865 only .278 of carbonic acid was required. In the Sulphur spring, in like manner, the neutral carbonates required .449*. or more than three-fourths of

* By mistake this is printed .349 in § 43.

the carbonic acid present; while the falling off in the amount of carbonates in 1865 is such that only .191 of carbonic acid, or just about one-third of the carbonic acid present, is required for the neutral carbonate. Nor is this change due entirely to a less amount of carbonate of soda; the carbonates of lime and magnesia in 1847 required .246, and in 1865 only .153 of carbonic acid The changed conditions which we here meet with may be explained by supposing that the carbonated bases are due to the mingling in different proportions of neutral carbonate of soda (generated by the reaction indicated in § 13,) with an earthy saline water holding a constant amount of free carbonic acid; which, in some cases, is more than is required to form bicarbonates, but in others, as we have seen above, presents a deficiency.

§ 66. If we admit, as I have already assumed, that the waters of the second and third classes have been generated by the mingling of solutions of carbonate of soda with waters of the first class, it can readily be shown that these solutions contained chiefly or exclusively the neutral carbonate. If we add a solution of bicarbonate of soda to earthy saline waters of the first class it is easy to obtain solutions of holding twenty grams or more of bicarbonate of magnesia to the litre; while in none of the natural waters of the second class do our analyses show the existence of much over one gram to the litre. Again, if we suppose any considerable amount of chlorid of calcium to be decomposed by bicarbonate of soda, the separation of the lime in the form of neutral carbonate, and the liberation of the second equivalent of carbonic acid, would yield waters holding an excess of carbonic acid above that required to form the bicarbonates of the solution. From the absence of such an excess, as appears in the case of the waters of Caledonia, Varennes, St. Leon and Caxton, and from the small amount of bicarbonate of magnesia in these waters, it may be concluded that the alkaline salt whose addition has changed their character was the neutral carbonate of soda.

§ 67. Examples are not wanting of waters in which, as in those of Caledonia in 1847, the carbonic acid is insufficient to form bicarbonates, or even neutral carbonates, with the bases uncombined with sulphuric acid or chlorine. Thus, according to Pagenstecher and Müller, the spring and well-waters of Berne do not contain sufficient carbonic acid for the lime present, a part of which they suppose to be held in solution as a silicate. See Bischof, Chem. Geology, i. 5; who remarks that Löwig seems to have observed the same fact in the thermal spring of Pfäffers. For further examples of this kind, see Lersch, Hydro-Chemie, page 333. The carbonic acid in the water of Töplitz is, according to him, not sufficient to form bicarbonates unless the silica present be supposed to be combined with a portion of bases; while in the alkaline thermal spring of Bertrich, according to the analysis of Mohr, a similar deficiency of carbonic acid exists; leading to the conclusion that a part of the earthy bases present is in combination with silica and organic matters. The existence of solutions holding comparatively large amount of neutral carbonates of lime and magnesia, as described in § 56, is not without interest in this connection; since it at once affords an explanation of the nature and origin of all such alkaline waters, and waters deficient in carbonic acid, as contain earthy sulphates and chlorids.

§ 68. It was found that the waters of Chambly in 1864, and of the Sulphur spring of Caledonia in 1865, gave with lime-water a precipitate which was soluble in an excess of these mineral waters, but to a much less extent than in the acidulous saline water from the High-Rock spring of Saratoga. The latter, which contains bicarbonate of soda, and is highly charged with carbonic acid, turns to a wine-red the blue color of litmus tincture, which is not changed by the Chambly or the Caledonia water. The Saratoga water, after some time, gives a feeble alkaline reaction with dahlia paper; this is more distinctly but slowly changed by the Caledonia water, and almost immediately turned to green by that of Chambly. This latter water readily browns yellow turmeric paper, which is scarcely affected by the water of Caledonia.

§ 69. Silica. The silica which exists in solution in cold saline springs is generally very small in amount, as might be expected from the insolubility of earthy silicates, which is such that superficial drainage waters in filtering through the soil lose the silica which they held in solution (§ 5). We have further shown that as a result of this tendency to the formation of insoluble silicates, the silicate of soda liberated in the sediments by the decomposition of feldspar, generally appears at the surface as *carbonate of soda*, having been decomposed by earthy carbonates (§ 13).

In two cases, however, considerable quantities of silica are found dissolved in natural waters. The first is met with where the rapid solvent and decomposing action of heated waters is exerted upon alkaliferous silicious minerals (§ 14), as seen in springs like the Geysers. The second case is that of those rivers and streams which drain surfaces covered with decaying vegetation and decomposing silicates, from both of which they derive dissolved silica. Such waters contain but small amounts of solid matters, but the proportion of silica is relatively considerable, amounting, as we have seen in the water of the Ottawa River, (which contains in 10,000 parts, 0·6116 of solid matters), to 0·2060, or thirty-two per cent.; while in the St. Lawrence, which contains for the same amount of water, 1·6058, the silica equals ·3700, or twenty-four per cent. of the solid ingredients. The analysis by H. Deville of the river-waters of France show, in like manner, large amounts of silica, which seem to have been hitherto overlooked in the analyses of most chemists. (Ann. de Chim. et Phys. [3], xxiii, 32.)

It will be seen by a reference to the tables of analyses given in the second part of this paper, that in the waters of the second class the amount of silica is equal to from 0·15 to 0 60 parts for 100·00 of solid matter. In the alkaline waters of the third and fourth classes its proportion is greater, and up to a certain point appears to increase with that of the carbonate of soda. In the following table the proportions of carbonate of soda and silica for 100·00 parts of solid matters are given for certain springs, whose analyses will be found in tables III and IV:

	III 1	III 5	III 2	III 6	III 4	III 8	III 3	III 7	IV 1	IV 3	IV 2	IV 5
Carb. soda.....	·6	1·6	2·4	3·4	7·0	8·0	9·2	21·0	25·0	30·0	56·0	6·7
Silica.........	·4	·4	·6	·6	1·6	1·5	1·7	2·9	3.0	3·2	3·2	32·0

The amount of silica which these waters contain does not in any case exceed one or two ten-thousandths, and it is well known that water at the ordinary temperature may dissolve very much more than this amount of silica, even in the presence of alkaline chlorids and of bicarbonates.

§ 70. Inasmuch as carbonic acid, according to Bischof (Chem. Geol. i, 2), decomposes not only the silicates of soda, but those of lime and magnesia when they are in solution, it might be supposed that the silica in the above waters exists either in a free state or as a soluble silicate with a great excess of acid. The latter view, especially in the case of magnesia, is rendered probable by numerous experiments which I shall describe in another paper, which form a part of the series already mentioned in § 41. From these it appears that free soluble silica, when mingled with a solution of bicarbonate of magnesia, or with the neutral carbonate dissolved in sulphate of magnesia in the manner described in § 56, whether separating immediately or by a slower process of gelatinization, always carries down with it, in combination, a few hundredths of magnesia.

In these experiments, besides the carbonate of magnesia, sulphate or chlorid of magnesium was present; but the silicated natural waters now under discussion are alkaline from the presence of carbonate of soda, and whatever partition of bases between carbonic and silicic acids may exist in the recent waters, we may suppose that when they are boiled a silicate of soda is formed, with the expulsion of carbonic acid. The silicate thus produced reacts on the earthy bases present with the production of silicates of lime and magnesia, which are in part precipitated with the earthy carbonates. Berzelius and Kersten long since observed the separation of such silicates during the evaporation of the waters of Carlsbad and of Marienbad (Bischof. i, 5); while a silicate of lime is said to be deposited from the waters of Wiesbaden. But the silicates thus formed are but partially precipitated—a portion remaining in solution till a late period of the evaporation. Dr. J. Lawrence Smith long since remarked the existence of a dissolved silicate of lime, apparently combined with soda, in the concentrated alkaline waters of Broosa in Asia Minor. (Silliman's Journal [2], xii, 377.)

Many facts in accordance with the above were observed in the analyses of the waters described in this paper. Thus the water of Belœil, which held in 1000 parts .114 of silica, when evaporated to one-tenth deposited with the carbonates .050 of silica, and the hydrochloric solution of the precipitate became gelatinous during evaporation. The solution still retained in solution, besides a portion of lime, .064 of silica; which was completely separated when the alkaline liquid was evaporated to dryness in contact with the earthy carbonates previously precipitated. When however these were removed by filtration it was found that during the evaporation to dryness a reaction took place by which the precipitated silicate of lime was partially decomposed, the separated silica being redissolved by the alkaline carbonate. In the case of the Chambly water of 1852, which contained in 1000 parts .073 of silica, .042 parts still remained in solution in the water evaporated to one twentieth; and in that of the Ottawa River when reduced to one fortieth there still remained in solution from 10.000 parts of water, ·075 of silica and .028 of lime. Similar results were observed with the alkaline saline waters of Varennes and Fitzroy; and all of these yielded, by further evaporation, precipitates containing silica ' ıd lime, and in one instance magnesia.

It is not however from alkaline waters like these, but from neutral sea-water that the silicates of magnesia (and of lime), which abound in stratified rocks, have been for the most part formed. See farther on this point, § 41.

§ 71. Organic Matters. In § 44 we have described some of the reactions of the organic matter found in the Chambly water, and it is to be remarked that small portions of a similar substance were found in all alkaline waters of the third and fourth classes, and caused them to become brownish when evaporated to a small volume. This, it has been already suggested, may have a superficial origin, the organic matters carried down by surface-waters being kept in solution by the alkaline salts; it is not however impossible that this same menstruum may remove the organic matters which abound in the pyroschists and other materials of organic origin in the ancient rocks. Thus for example the coprolites of the Lower Silurian limestones contain so much animal matter as to evolve an odor like burning horn when exposed to heat. (Geology of Canada, 462).

The Ottawa water (§ 45, No. 5), when boiled to one-tenth, deposits a precipitate in small bright brown iridescent scales. This was found to contain silica, carbonate of lime and a small portion of an organic substance which was dissolved in dilute potash ley. The brown solution thus obtained was not disturbed by acetic acid and acetate of copper, but by the subsequent addition of carbonate of ammonia yielded a white precipitate. The concentrated water retained a large proportion of organic matter, and when reduced to a small bulk, was dark brown, alkaline to turmeric paper, and continued by evaporation to deposit opaque films of silicate of ime. The finally dried residue was dark brown in color, and carbonized by heat, burning like tinder and diffusing an agreeable odor. The residue of 10,000 parts dried at 300° F. weighed .6974, and lost by gentle ignition .1635, consisting partly of organic matter.

No chemical examination was made of this matter held in solution by the concentrated water. From the late researches of

Peligot, however, it appears that the organic matter precipitated by nitrate of lead from the water of the Seine has nearly the composition of the apocrenic acid of Berzelius. It gave on analysis carbon 53.1, hydrogen 2.7, nitrogen 2.4, oxygen 41.8, and is evidently related to the soluble form of vegetable humus. (Comptes Rendus, April 25th, 1864.) When exposed to heat this substance evolved ammonia, with the odor of burning wool, while the organic matter from the Ottawa water, on the contrary, gave an odor like burning turf.

GEOLOGICAL POSITION OF THE PRECEDING WATERS.

§ 72. The great paleozoic area of the St. Lawrence basin is divided into two basins by an axis extending from Deschambault, not far above Quebec on the St. Lawrence, in a south-west direction to Lake Champlain. The eastern part of the western basin is more or less affected by undulations subordinate to the great fault that brings up the Quebec group against the Hudson-River formation, and also by other undulations of minor importance. It is in this disturbed region that by far the greater number of the mineral springs already described occur; and although it is often difficult to establish the presence, or to trace the extent of faults in the strata, on account of the alluvial deposits which generally cover the paleozoic strata of the region, it is apparent that in a great number of cases the mineral springs occur along the lines of disturbance, and it is probable that a constant relation of this kind exists.

As the eastern limit of the western basin is approached, the mineral springs become more numerous, but this boundary once passed, a region is soon reached where the rocks become profoundly altered, and furnish no more mineral waters. The great western portion of the occidental basin, which is less disturbed than its eastern part, presents but few mineral springs; yet the wells of strongly saline water which have been obtained by boring at Kingston, Hallowell, St. Catherines, Chatham, and elsewhere, show that the undisturbed rocky strata are charged with saline matters. For a better understanding of the relations of these waters, a list of the paleozoic formations in which the mineral springs here described occur, is given on the next page, numbered in ascending order.

PALEOZOIC FORMATIONS.

15. HAMILTON,—shales.
14. CORNIFEROUS,—limestone.
13. ORISKANY,—sandstone.
12. ONONDAGA OR GYPSIFEROUS,—dolomite.
11. GUELPH,—dolomite.
10. NIAGARA,—dolomite.
9. CLINTON,—limestone and shale.
8. MEDINA,—sandstone.
6. HUDSON RIVER,—shales.
5. UTICA,—shales.
4. TRENTON,—limestone.
3. CHAZY,—limestone.
2. CALCIFEROUS,—dolomite.
1. POTSDAM,—sandstone.

§ 73. Of the above series the Trenton group includes the Birds-eye and Black River limestone, as well as the Trenton limestone of the New York geologists, and is non-magnesian, enclosing beds of chert, silicified fossils, and petroleum; in all of which characters it resembles the Corniferous limestone above. In like manner the Potsdam is represented by the Hudson-River and Medina formations, while the gypsiferous dolomite of the so-called Calciferous sand-rock corresponds to the great mass of dolomite which constitutes Nos. 10, 11, and 12, and includes the gypsum and the salt-bearing strata of the Onondaga formation. These repetitions of similar strata, marking successive recurrences of similar geological and geographical conditions, which form great cycles in the history of the continent, have been already considered in a paper by me on Bitumens, etc., in Silliman's Journal [2], xxxv, 166.

§ 74. In the eastern basin, which includes not only south-eastern Canada, but the whole of New England, the strata are in an altered and crystalline condition, if we except a narrow belt along the north-west border of the basin. These unaltered strata present a great series of shales, conglomerates, and limestones, pure and magnesian, succeeded by 2000 feet or more of sandstones, with shales; the whole forming what the Canadian Geological Survey has named the Quebec group, whose aggregate thickness in the vicinity of Quebec is about 7000 feet. The geological horizon of this group of strata corresponds to that of the Chazy, the Calciferous, and perhaps of the Potsdam. It was in great part a deep-sea deposit, of which the formations just named are but incomplete and littoral representatives. Of the waters described in this paper none are from this eastern basin, although the unaltered portions of it present several mineral springs, some of which are described in the Geology of Canada. Of these, the salines of Cacouna, Green Island, Rivière Ouelle and Ste. Anne, are bitter waters belonging to the first class; while a sulphurous spring at the latter place, and another at Quebec are alkaline waters of the fourth class.

§ 75. Of the waters of the western basin, which alone are noticed in this paper, many have been qualitatively analyzed which are not here described. Including two from Vermont, twenty-one alkaline waters of the third and fourth classes have been examined. Of these, as already stated, the waters of Caledonia rise from the Trenton group, and that of Fitzroy from the Chazy or Calciferous, while two others, at Ste. Martine and Rawdon, appear to have their source in the Potsdam. All the other waters of these two classes issue from the Hudson-River shales, with the exception of those of Varennes and Jacques Cartier, which seem to rise from the Utica formation.

Of the waters of the second class, of which about thirty have been examined from the western basin, some five or six issue from the shale formations Nos. 5 and 6, but all the others are from the underlying limestones. The bitter salines of the first class flow from the limestones of the Trenton group, with the exception of that of Ancaster, which is from a well sunk in the Niagara formation, and that of St. Catherines, from a boring carried through the Medina down into the Hudson-River shales. The source of both of these is probably, like that of the other very similar waters, the Lower Silurian limestones.

§ 76. From this distribution of the waters of the first four classes it would appear that the source of the neutral salts, which consist of alkaline and earthy chlorids, is in the limestones and other strata from the Potsdam to the Trenton inclusive, while the alkaline carbonates are derived from the argillaceous sediments which make up the Utica and Hudson-River formation. These sediments are never deficient in alkaline silicates, whose slow decomposition yields to infiltrating waters (§ 13) the alkaline carbonates which characterize the mineral springs of the fourth class. These, mingling in various proportions with the brines which rise from the limestones beneath, produce the waters of the second and third classes in the manner already explained. The appearance of several springs of the third class, as those of Caledonia and Fitzroy, from the Lower

Silurian limestones is not suprising, when it is considered that the Chazy formation in the Ottawa valley includes a considerable thickness of shales, sandstones and argillaceous limestones, approaching in composition to the sediments of the Hudson-River formation.

§ 77. As an evidence that the different classes of waters have their origin in different strata may be cited the fact that springs very unlike in composition are often found in close proximity, and apparently rising from a common fissure or dislocation. Thus in the seigniories of Nicolet and Labaie du Febvre, I have examined six springs, all of which rise through the Utica formation along a line, in a distance of about eight miles. Of these springs two belong to the second, two to the third, and two to the fourth class; these last being probably derived entirely from the shales, while the others have their source in the underlying limestones, and are more or less modified in their ascent. Again, at Sabrevois, within a few feet are two springs of the second class, of which one contains salts of baryta and strontia, and the other soluble sulphates. In like manner at Ste. Anne, in the Quebec group, a spring of the second class and one of the fourth are found not far apart. The springs of Caledonia offer another and not less remarkable example. In 1847 there were to be seen, not far from a spring of the second class, three others of the third class very near together, one of them sulphurous, but all sulphated, and differing in the proportions of carbonate of soda present. In 1865, while one of these still retained its character of a sulphurous sulphated water of the third class, the others were changed to waters of the second class, and held salts of baryta in solution. These relations, which we have already pointed out (§ 47), not only show waters holding incompatible salts issuing from different strata along the same fissure, but mingling in such varying proportions as to produce from time to time changes in the constitution of the resulting springs.

§ 78. The temperature of none of the springs which we have here described exceeds 53°, which has been observed for two springs at Chambly, about twelve miles from Montreal. Inasmuch as the mean temperature of this city, as deduced from the observations of twenty-seven years, is 44°.67, the Chambly waters are to be regarded as slightly thermal. No other springs in Canada are known to present so high temperature, unless possibly the acid waters of the fifth class, for which we have pointed out the importance of farther observations (§ 48). The St. Léon spring was found to be 46°, and that of Caxton, 49° F.

§ 79. The extended series of analyses which we have given in the preceding pages presents many points of interest. Nowhere else, it is believed, has such a complete systematic examination of the waters of a region, and of a great geological series been made. Additional importance is given to these results by the fact that the waters are all derived from paleozoic strata, and we are thus enabled to compare these saline materials of an ancient period with those which issue from, and in may cases owe their saline impregnation to strata of comparatively modern origin. Comparisons of this kind, such as I have already instituted between brines of different geological epochs in § 39, possess great geological interest.

It is a consideration not without interest, that the valley of the St. Lawrence under different meteorological conditions might become a region abounding with saline lakes, affording sea-salt, natron and borax, the results of the evaporation of the numerous saline and alkaline springs which have just been described.

§ 80. A few considerations are here suggested by the fact already mentioned of the apparent absence of mineral springs from the altered paleozoic strata of the Quebec group. Metamorphism and disturbance or displacement of strata are generally concomitants, not, as I conceive, because the process of alteration is in any way connected with the disturbance of the rocks, but because a great accumulation of superincumbent strata, a necessary preliminary of metamorphism, is the efficient cause of the folding of the deeply buried and subsiding rocks, in a way which I have already elsewhere pointed out.* The subsequent continental uplifting of the altered, plicated, and more or less fissured strata, and their irregular erosion, give rise to the broken surfaces of metamorphic regions, and at the same time permit the saline solutions impregnating the strata to flow out; while solid soluble salts, unless enclosed by impermeable strata, are removed by lixiviation. Hence we shall rarely find muriated waters issuing from crystalline and disturbed strata. Those saline products which result from the decomposition of feldspathic minerals, and the separation of alkaline carbonates; or from the decomposition by these, or other agents, of the gypsum which is often present in metamorphic strata, may, however, readily give rise to waters of the fourth and sixth classes; so that we are not surprised to find alkaline and sulphated waters issuing from crystalline strata.

* Silliman's Journal [2], xxxi, 412.

§ 81. I have in a previous section (§ 57) alluded to the condition of the primeval ocean, and in this connection it may be well to refer to a hypothesis which I some years since advanced to explain the origin of its salts and the primeval sediments, Starting from the notion "of a cooling globe, such as the igneous theory supposes our earth to have been at an early period, and considering only the crust with which geology makes us acquainted, and the liquid and gaseous elements which now surround it, I have endeavored to show that we may attain to some notion of the chemical conditions of the cooling mass by conceiving these materials to again re-act upon each other under the influence of an intense heat. The quartz, which is present in such a great proportion in many rocks, would decompose the carbonates and sulphates, and, aided by the presence of water, the chlorids both of the rocky strata and of the sea; while the organic matters and the fossil carbon would be burned by the atmospheric oxygen. From these re-actions would result a fused mass of silicates of alumina, alkalies, lime, magnesia, iron-oxyd, etc.; while all the carbon, sulphur and chlorine, in the form of acid gases, mixed with watery vapor, nitrogen, and a probable excess of oxygen, would form an exceedingly dense atmosphere. When the cooling permitted condensation, an acid rain would fall upon the heated surface of the earth, decomposing the silicates, and giving rise to chlorids and sulphates of the various bases, while the separated silica might take the form of crystalline quartz. In the next stage of the process, the portions of the primitive crust not covered by the ocean would undergo a decomposition under the influence of hot moist atmosphere charged with carbonic acid, and the felspathic silicates become converted into clay, with separation of the alkali. This, absorbing carbonic acid from the atmosphere, would find its way to the sea, where, having first precipitated from its highly heated waters various metallic bases then held in solution, it would decompose the chlorid of calcium, giving rise to chlorid of sodium on the one hand, and to carbonate of lime on the other. In this way we obtain a notion of the processes by which from a primitive fused mass may be generated the silicious, calcareous and argillaceous rocks which make up the greater part of the earth's crust; and we also understand the source of the salts of the ocean."*

* Canadian Journal, May, 1859, 201, and Silliman's Journal [2], xxv, 102; also Comptes Rendus, June 9th, 1862, and Can. Naturalist, vii, 202.

§ 82. A further development of this view would lead us too far for the scope of this paper. It will however be seen that the first precipitates from the ocean would contain most of the metals, and that in the subsequent re-solution and deposition of these precipitates is to be found an explanation of the origin of metalliferous deposits, and of their distribution in various formations; either as integral parts of the strata, or as deposits in veins, the former channels of mineral springs. In an essay on American Geology, published in Silliman's Journal in 1861 [2], xxxi, 405, I have already sketched the outlines of what I conceive to be the true theory of metalliferous deposits, a subject to which it is proposed soon to return.—*Silliman's Journal.*

Montreal, July 4, 1865.

NATURAL HISTORY SOCIETY.

MONTHLY MEETINGS.

The ordinary monthly meeting of the Society was held on Monday evening, March 27th, the President, Principal Dawson, in the chair.

THE MUSEUM.

A donation of a collection of Canadian and Prince Edward Island insects from Mr. Horace L. Smith, was announced.

NEW MEMBERS.

Major Healy, Lieut. Boyle, and Messrs. Wm. Gunn and H. Rose, were elected ordinary members; and Com. Fortin a corresponding member.

PROCEEDINGS.

Prof. Eaton's paper on the genus Woodsia was read by the Secretary.

The President read a paper entitled "Notes on the Post-Pliocene Deposits at Rivière du Loup and Tadousac."

The Corresponding Secretary read an abstract of a paper entitled "Notes on the Trees and Shrubs of Canada," presented to the Society by the Hon. William Sheppard of Fairymeade, C. E.

The ordinary monthly meeting of the Society was held on Monday evening, April 24th, the President in the chair. Various donations to the library and museum were announced.

NEW MEMBERS.

Messrs. James Ewan, Wm. Muir, and J. A. Harte were elected ordinary members.

PROCEEDINGS.

Dr. Hunt read an abstract of a paper entitled " Contributions to the Chemistry of Natural Waters." Dr. Hunt also read an abstract of a paper on " The Extraction of Copper from its Ores in the Humid Way, by Thomas Macfarlane."

ANNUAL MEETING.

The annual meeting of the Society was held at its rooms on the evening of May 18th, the President, Principal Dawson, in the chair. Mr. Whiteaves, the Recording Secretary, read the minutes of the last annual meeting; after which the usual annual address by the President was delivered, as follows:—

THE PRESIDENT'S ADDRESS.

GENTLEMEN:—In the midst of the many exciting occurrences of the past year, we have reason for thankfulness and mutual congratulation that we have been enabled to pursue in peace our unobtrusive work, and that we have to record the past as one of the most successful years of this Society. More than twenty original papers on various departments of Natural History have been contributed, the greater part of which have been published in our Journal. Our course of Somerville Lectures and our Annual Conversazione have been eminently successful. Large additions have been made to our Museum, and much progress has been made in its arrangement. An Entomological club has been established in connection with the Society, and arrangements have been made for retaining for another term of two years the services of our efficient scientific curator, Mr. Whiteaves.

In Geology many important communications have been received. Among these I may particularly mention, in the first place, several papers by Dr. Hunt on Canadian lithology, on the silicification of fossils, on mineral waters and on the economical uses of peat. While all of these are of great value, I may direct particular attention to the very remarkable facts stated in the paper on mineral waters, in relation to the saline springs so abundant in this country, when regarded as affording evidence of the composition of that primeval ocean in which our Silurian beds were deposited. As treated by Dr. Hunt, mineral springs cease to be merely objects of curiosity or for medicinal use, but acquire great geological interest, as indications of conditions of the ocean which have long since passed away, but which may have had an important influence on animal life and mineral accumulation in the paleozoic period; and also as illustrations of the causes of chemical change now in action in the crust of the earth.

The remarkable discovery by Mr. Billings of locomotive organs probably of the nature of swimming feet, in *Asaphus platycephalus*, read before the Society, but not yet published, deserves to be reckoned as one of the most important facts developed in connection with Canadian Geology in the past year. As an addition to this discovery, I may place the view which I presented to this Society, in a paper on the fossils known as *Rusophycus*, that these are in reality casts of burrows of trilobites, and entitled to the name *Rusichnites*.

In my address of last year I dwelt at some length on the question of the mode of formation of the boulder clay, and on the alleged action of glaciers in the post-pliocene period; and stated my reasons for the belief that floating ice was the agent in the striation of rock surfaces, and the transport of boulders in Canada; and that our lake basins had been eroded by the slow action of cold ocean currents. I have since followed up this subject, and in a paper on the post-pliocene deposits of Rivière du Loup, have endeavored to show the true marine character of the boulder clay of that locality, so rich in fossil shells of the post-tertiary period. I have also obtained facts which prove conclusively that the boulder clay of Montreal and its vicinity could not possibly have been sub-aerial, and that throughout Eastern Canada this deposit does not form a continuous sheet, but rather a series of old sea margins extending from an elevation of two or three hundred feet above the sea to the present sea level, and in time from the newer Pliocene period to the present day.

Lastly, under the head of Geology, but passing from the latest formations to the far distant dawn of organic life on our planet, our last number contains the re-publication of papers by Sir W. Logan, Dr. Carpenter, Dr. Hunt, and myself, on *Eozöon Canadense*, shewing that the views which I illustrated here a year ago, of the character of that remarkable fossil, have been fully confirmed by the greatest living authority on the group of animals to which the specimens were assigned, and that this great discovery has been accepted as an unquestioned fact by all the leading minds in Geology.

Before leaving this part of our work, it is proper to state that the utility of our collection to students of Geology and Mineralogy has been much increased by the arrangement and display of our specimens of fossils, rocks and minerals, through the exertions of Mr. Whiteaves, aided by other members of the Society.

Among the numerous papers received on Zöology, Botany and Physical Geography, I may, without attempting any detailed notices, mention those of Mr. Jones on Ocean Drift, and on the fishes of Nova Scotia, communicated to our Journal by the Natural History Society of New Brunswick; of Mr. J. G. Bowles on *Pieris rapæ;* of Dr. Bowerbank on Canadian Sponges; of Prof. Brunet on the Travels of Michaux; of Prof. Lawson, Prof. Eaton, and Mr. McCord on Canadian Ferns; of Mr. Drummond on the Geographical Botany of Canada; of Hon. Mr. Sheppard on Canadian Timber trees; of Mr. Vennor on the Night Heron; of Mr. Whiteaves on Canadian Mammals; of Mr. Ritchie on the structure of Insects; and lists of plants of various localities in Canada contributed by Dr. Thomas, Mr. Drummond, Mr. Macoun, and other botanists. We owe also to the gentlemen of the Entomological club our cordial thanks for the generous donations which have filled our cabinet of insects with one of the most valuable collections of entomological specimens as yet accumulated in this city.

It is proper, on this occasion, to congratulate the Society on the completion of the first series of its Journal, the Canadian Naturalist, and on the commencement of the second volume of a new and improved series. The inception of the Canadian Naturalist is due to our colleague Mr. Billings, the palæontologist of the Canadian Survey; and the first volume was ably sustained by his unaided exertions. Adopted by the Natural History Society in 1857, it has now entered on its tenth year of publication, and contains in the volume already published a mass of information on the Natural History of British America, indispensable to every student of the subject. It has established its reputation wherever science is cultivated, and is now a recognized medium of communication between Naturalists in Canada and in foreign countries. It is only to be regretted, both for the sake of the interests of science and of the publishers of the work, who have heretofore issued it without any expense to the Society or any public aid, that it should not be more extensively circulated. When we consider the difficulties experienced by scientific periodicals both in Britain and the United States, it is not surprising that a scientific journal in Canada should be slenderly supported. Still I think that, if the value of the articles contained in the Naturalist, and the *importance* of sustaining it, were properly understood, its subscription list would be largely increased. I earnestly commend this matter to the attention of members of the Society. It will be proposed in connection with this, in the Report of the Council, that a new class of members should be created in connection with the Society, namely, non-resident ordinary members, who should pay a subscription equivalent to that for the Naturalist, and should enjoy the advantages of the meetings and museum of the Society, during any visits they might make to the city. In this way I have no doubt that something might be done toward the introduction of a taste for Natural History, as well as toward the extension of the circulation of the Naturalist. It is to be hoped that these subjects will receive the early attention of the officers of the Society.

In conclusion, gentlemen, allow me to say that in cultivating here the amenities of science, and directing our attention and that of others to the works of God, we are in our humble way doing something for the welfare of this country. We are seeking to mingle the pursuit of merely utilitarian objects in the development of the resources of this country, with higher and more philosophical conceptions of nature. In the midst of many perturbed social and political elements, we are studying things that make for peace, and which are for the common benefit of all. While we are so constantly drawing closer the links of connection between ourselves and kindred institutions in other parts of the great empire to which it is our happiness to belong; and while, in common I believe with all scientific men and educators in British America, we feel that it is above all things desirable that still more intimate and mutually helpful relations should be established with the good heart of that empire, so that the political, social, and scientific power of Great Britain may be more strongly felt in these colonies, we can at the same time extend the most earnest sympathy and lively appreciation to the labors of scientific men in other lands, and can more especially ally ourselves in the closest manner with our numerous and able fellow-workers in the United States, who have always been so ready to recognise in our case that bond of brotherhood which should unite all the cultivators of science in every country.

In now resigning the office with which, contrary to my own desire, you have honored me twice in succession, I have only to express my regret that the pressure of other duties has prevented me from devoting more time to the interests of this Society, and my earnest wish that its prosperity in the past, and more especially since it entered on an enlarged career of usefulness in its new building, may prove an earnest of still greater success in the future.

REPORT OF THE COUNCIL.

The Chairman of the Council, Mr. Rimmer, then submitted the following Report.

Your Council beg to offer the following report of the proceedings of the past year. They regret to say that even the Society has not been quite free from the effects of the general commercial depression. The number of new members is fourteen, but on the other hand there have been many resignations. The list of members has not been revised for some years, and on careful scrutiny several names have been removed, many of whom have long ceased to belong to the Society.

The debt upon the building is still $2400, bearing interest. The number of ordinary members is about 220, which should procure an income of about $880; and two new life-members, Messrs. H. Fraser and John Molson, have been added during the year. This sum is, of course, exclusive of the government grant, which has not been received so far; but your Council have every reason to believe it will be when Parliament meets. We are again indebted to our treasurer Mr. Ferrier, for the liberality with which he has come forward and advanced money to liquidate the more pressing claims. The Society owes him now $190, and the other claims against it are about $300 for current expenses. Mr. Ferrier, by a system of cash payment for advertising, printing, and other items, has been able to reduce the expenditure from $2100 to $1700. The price charged for the use of the lecture-room has been reduced to $6, and for the library to $2 per evening.

Your Council would suggest, as a means of improving the income of the Society, that a new class of members might be introduced, viz. non-resident paying members, who might have all the advantages of the Society when they visit the city; and as they cannot attend our meetings, a copy of the Naturalist might be sent to their address. This would also give us the advantage of being in constant communication with the residents of country places, from whom specimens of interest to the Society might be procured.

PUBLIC LECTURES.

The Somerville lectures this year have been extremely interesting; their subjects were as follows:

February 16th, 1865. On the Oldest Fossil known, and its living representatives: by Principal Dawson, LL.D., F.R.S.

March 2nd, 1865. On the Occurrence of Metals in Nature: by Dr. T. Sterry Hunt, F.R.S.

March 9th, 1865. Shells, considered from a popular and a literary point of view: by J. F. Whiteaves, F.G.S.

March 16th, 1865. On Ferns: by D. R. McCord, B.A.

March 21st, 1865. On Certain Chemical Manufactures which might be advantageously introduced and carried on in Canada: by Prof. Bell, F.G.S.

March 28th, 1865. On Combustion, illustrated with experiments: by Dr. Girdwood.

CONVERSAZIONE.

The Annual Conversazione of the Society was held on the evening of February 21st, and was unusually successful, upwards of 400 persons being present. [A report of this meeting will be found on page 75.]

MISCELLANEOUS.

It is a matter of congratulation that we have secured the services of Mr. Whiteaves for two years longer, commencing from the first of April, 1865, at a salary of $400 per annum; and for this sum he undertakes to conduct the correspondence, to act as sub-Librarian, and to edit the Naturalist if necessary.

Mr. Whiteaves will give, in his capacity of curator and sub-librarian, an account of the alterations in and additions to the museum and library. Your Council respectfully urge upon their successors the desirability of increasing the membership as far as possible. There are so many advantages that we can offer to the public, and such facilities afforded for studying Natural History in the city and its vicinity, that we believe the Society requires to be more generally known than it is at present. There are many inhabitants of Montreal who have never seen the Museum; and it might be worth while to consider how far it could be thrown open to the public on certain occasions, free of charge, as is done by kindred institutions in Great Britain.

They are also, in conclusion, glad to find that more enlightened views are prevalent with regard to the protection of small birds; this is partly owing to the representations made by our Society, and in part to the efforts of the Fish and Game Protection Club, with whom we cannot too cordially co-operate.

REPORT OF THE SCIENTIFIC CURATOR.

The most important work of the past summer has been the formation of a good entomological collection. Nearly all the old Canadian specimens which had become injured, and faded by exposure, have been replaced by fresh examples. By the exertions of friends our local collections have more than doubled lately; not only have we filled the twenty-six drawers of our cabinet, but we have four cases full over and above these. As much has been done in the way of naming and classifying our specimens as the present state of our knowledge of Canadian insects warrants. The Coleoptera and the diurnal Lepidoptera are for the most part named. Many of the nocturnal Lepidoptera, and most of the Hymenoptera, Diptera, Neuroptera, Orthoptera, and Hemiptera of this country have yet to be determined. It is hoped that with the assistance of the Entomological branch of our Society, some steps may be taken in this direction. The large and interesting collection of minerals contained in the Museum has occupied a considerable portion of my time. A number of cases that have not been opened for years, have been unpacked, and their contents carefully looked over. Several specimens that were missing in Dr. Holmes' collection, have been restored to their place, and labelled. Including these, and several specimens placed in this collection for the sake of comparison, the series now consists of upwards of 1400 specimens from various parts of the world, all of which are carefully labelled. A collection of Canadian rocks and minerals has been formed to illustrate the prominent features of the lithological part of Canadian geology. A number of new specimens has been procured, and about 200 rocks and minerals are now named and exhibited. Two packages were found to contain a series of the rocks, lavas, and other minerals of Vesuvius and its neighborhood, a collection of great interest, and containing many fine specimens. The labels attached to these were written in Italian, and often incorrectly spelled. Signor de Angelis, who has lived many years in the immediate neighborhood of Vesuvius, has kindly helped me to identify the exact localities of the specimens, and Dr. Hunt has determined some of the more difficult minerals. The set consists of about 380 specimens, all of which are now labelled and exhibited. These two last collections, which have never been exposed to view until now, occupy one of the new cases which were got last winter. A number of miscellaneous minerals of interest have been labelled and placed temporarily in the case in the aquaria room. The number of specimens labelled is about 165. A great many duplicates and worthless specimens have been selected and put away. The number of specimens of rocks and minerals that are now named and exhibited in the museum may be approximately summed up as follows:

Dr. Holmes's Collection, with additions, over	1400	specimens.
Canadian Rocks and Minerals	200	"
Rocks and Minerals of Vesuvius	370	"
Miscellaneous do	165	"
In all upwards of	2135	specimens.

Some 500 or 600 specimens remain without any localities; they are mostly duplicate examples, and are in some cases undetermined.

The second new case has been entirely devoted to our collection of fossils. The old series was totally unnamed and devoid of any attempt at arrangement. Many new specimens have been added during the past session. Dr. Dawson has contributed several Devonian, Carboniferous and Post Tertiary species, Prof. Dana some Carboniferous and Cretaceous forms; and during last summer I received several donations to this part of our collection from various friends in the United States. The local fossils of the neighborhood of Montreal I have collected in person: most of these will be found in the collection. To Mr. Billings I am indebted for the determination of the Silurian and Devonian species, and to Principal Dawson for the nomenclature of the Carboniferous fossils; those of the Mesozoic and Tertiary periods were determined by myself.

The following is an estimate of this branch of our Collection.

Lower Silurian	61	species.
Middle "	23	"
Upper "	1	"
Devonian	31	"
Carboniferous	57	"
Lias	21	"
Oolite	42	"
Cretaceous	30	"
Tertiary	12	"
Post Tertiary	36	"
In all about	314	species.

The Polyzoa or Bryozoa of the Gulf of the St. Lawrence have been determined by Principal Dawson, and may now be conveniently studied. The Annelida, from the same district, have also been classified and named. The synonyms of the Canadian species of reptiles and fishes have been studied, and printed labels have been attached to the specimens. A few of our foreign birds have been determined and labelled. During the past summer several additions have been made to our collection of shells and radiates: these have been named and incorporated with the general series. During the past winter the making arrangements for the Somerville course of lectures devolved upon me. These I have often reported from notes taken during the evening, and when this has not been the case, care has been taken that reliable abstracts should appear in the daily press. It is hoped that the series as a whole has not proved inferior in point of interest to those of past years.

During the month of April, 1865, I devoted some time to the library, having been appointed sub-librarian on the first of that month.

The Treasurer of the Society, Mr. Ferrier, then gave an account of the financial position of the Society, showing what had been its receipts and expenditure during the past session. The details will be found on another page.

It was moved by the Right Rev. the Lord Bishop, and unanimously resolved:

That the special thanks of the Society be voted to the President of the past session for his valuable services during that time.

A vote of thanks to the other officers of the past year, was also unanimously carried.

The following gentlemen were elected as officers of the Society for the coming session:

OFFICERS FOR 1865-6.

Pesident.—C. Smallwood, M.D., LL.D., D.C.L.

Vice-Presidents.—Principal Dawson, LL.D., F.R S.; Rev. A. De Sola, LL.D.; Sir W. E. Logan, LL.D., F.R.S.; Dr. T. Sterry Hunt, LL.D., F.R.S.; E. Billings, F.G.S.; The Right Rev. the Lord Bishop and Metropolitan; John Leeming; Rev. A. F. Kemp, M.A.; and W. H. A. Davies.

Treasurer.—Jas. Ferrier, Jun.

Cor. Secretary.—Prof. P. J. Darey, M.A.

Rec. Secretary.—J. F. Whiteaves, F.G.S.

Librarian.—Stanley C. Bagg.

Council.—J. H. Joseph; E. Murphy; A. Rimmer; L. A. H. Latour; A. S. Ritchie; C. Robb; D. A. P. Watt; G. Barnston; and John Molson.

Library Committee.—(These with the Librarian, were elected also a Membership Committee) D. Mackay; G. H. Frothingham; Rev. Dr. Wilkes; Peter Redpath; and John Molson.

Editing Committee of the Canadian Naturalist.—D. A. P. Watt, Acting Editor; Principal Dawson; Dr. T. Sterry Hunt; E. Billings; J. F. Whiteaves; and Prof. P. J. Darey.

THE CANADIAN NATURALIST.

The Canadian Naturalist is sent to the following Institutions and Societies, &c.:

CANADA, ETC.

University College,........................Toronto.
Canadian Institute,........................Toronto.
Board of Arts,.............................Toronto.
Queen's University,........................Kingston.
McGill College,............................Montreal.
Laval University,..........................Quebec.
Literary and Historical Society...........Quebec.
Natural History Society,...................St. John's, N.B.
Nova Scotia Institute of Nat. Science....Halifax, N.S.

UNITED STATES.

Natural History Society....................Portland, Maine.
Harvard College,...........................Cambridge, Mass.
Amherst College,...........................Amherst, Mass.
Essex Institute,...........................Salem, Mass.
Yale College,..............................New Haven, Conn.
Silliman's Journal,........................New Haven, Conn.
Lyceum of Natural History,.................New York.
Natural History Society,...................Boston, Mass.
State Library,.............................Albany, New York.
Academy of Natural Sciences,...............Philadelphia, Penn.
Franklin Institute,........................Philadelphia, Penn.
Smithsonian Institution,...................Washington, D.C.

GREAT BRITAIN.

Geological Society,........................London.
Linnæan Society,...........................London.
Royal Society,.............................London.
British Museum Library,....................London.
Society of Arts,...........................London.
Geological Survey of Great Britain.......London.
The Geological Magazine,...................London.
Technologist,..............................London.

Quarterly Journal of Science,..............London.
Popular Science Review,....................London.
Naturalists' Field Club,...................Newcastle-upon-Tyne.
Bodleian Library,..........................Oxford.
University Library,........................Cambridge.
Literary and Philosophical Society,.......Manchester.
University Library,........................Edinburgh.
University College,........................Glasgow.
Royal Geological Society,..................Dublin.

CONTINENT OF EUROPE.

Société Géologique de France,.............Paris, France.
L'Académie des Sciences...................Dijon, France.
Imper. Geological Institute,...............Vienna, Austria.
Deutsches Geolog. Gesellschafft,...........Berlin, Prussia.
University Library,........................Bonn, Prussia.
Société Impériale des Naturalistes,.......Moscow, Russia.
Konigl. Bayerischen Akademie der Wissenschaften..........................Munich, Bavaria.
Academy of Sciences,.......................Stockholm, Sweden.
Christiana University,.....................Christiana, Norway.
Royal Library..............................Copenhagen, Denmark.
Bibliothèque Imperiale.....................St. Petersburg, Russia.
Batavian Academy,..........................Leyden, Holland.
Freiberg Royal Academy,...................Freiberg, Saxony.
Nederlandisch Metereol. Jaarboeck,......Utrecht.

MONTHLY MEETING.

This Society held its last meeting for the session, 1864-65, on Monday evening May 29. The chair was occupied by Dr. Smallwood, the newly-elected President. After the transaction of the usual routine business, the following donations were announced.

TO THE MUSEUM.

From Mr. H. Leggett,—A series of precious stones, consisting of thirty-six specimens, including four rubies (uncut) from the East Indies, one sapphire from Ceylon, two aquamarines, four chrysoprases, three turquoises, a fine *cat's eye* from Ceylon amethysts, heliotropes, agates, &c., &c.

From Mr. D. McKay,—Specimen of the bullfrog (*Rana piplens* Linn.)

From Mr. C. Foley—The Night heron (*Nyctsiardea Gardeni* Baird); and an example of the American crow (*Corvus Americanus* Audubon).

From Mr. W. Hunter—A stuffed specimen of each of the following birds: The swamp sparrow, male (*Melospiza palustris* Baird); the Nashville warbler, female (*Helminthophaga ruficapilla* Baird); and a male bay-winged bunting, (*Poocætes gramineus* Baird)—all shot on Montreal mountain.

From Mr. Dunn—A jumping mouse, (*Jaculus Hudsonicus* Zimmerman).

THE NATURAL HISTORY SOCIETY OF MONTREAL IN ACCOUNT WITH JAMES FERRIER, JUN., TREASURER.

Dr.	RECAPITULATION.		Cr.	RECAPITULATION.	
1864. May 1.			1865. May 1.		
To cash balance due Treasurer, May 1, 1864		$ 15 43	By Cash,	Government Grant	$750 00
1865. May 1.			"	Members' yearly subscriptions	301 00
To Cash paid,	Printing	300 38	"	Life member's subscription, H. Fraser, Esq.	50 00
" "	Furniture, cases, &c	70 00	"	Museum entrance fees	36 00
" "	Sundry petty charges, repairs, &c	51 65	"	Rent of Lecture Room	26 00
" "	P. O. accts	12 00	"	Donation from Captain Serocold,	5 00
" "	J. F. Whiteaves, salary	350 00	"	Proceeds Conversazione	66 05
" "	W. Hunter, salary	200 00	"	Balance due Treasurer	190 83
" "	W. McCormick, commissions	34 30			
" "	Wood and coals	165 49			
" "	Gas accounts	21 08			
" "	Water "	40 66			
" "	City taxes	40 00			
" "	Insurance	34 00			
" "	Interest	80 00			
		$1424 88			$1424 88

JAMES FERRIER, JUN., *Treasurer N. H. S.*

STATEMENT OF LIABILITIES OF THE NATURAL HISTORY SOCIETY, MAY 1ST, 1865.

Open Accounts	$ 303 38	
Mortgage on Society's Building held by Scottish Provincial Insurance Co	2000 00	
" in favor of William Watson, Esq	400 00	$2703 38

PROCEEDINGS.

ON THE FOSSILS OF THE TRENTON LIMESTONE OF THE ISLAND OF MONTREAL.

By J. F. Whiteaves, F.G.S., &c.

This paper is offered partly as a compilation of the results obtained by other observers, and is partly derived from original investigation. It is thought desirable to place upon record all that is known with any degree of certainty respecting the fossils of the Trenton limestone proper—exclusive of the Black River Group—so far as these rocks have been explored on the island of Montreal. The zone and locality that I have examined with most care is the upper part of the formation, as it occurs between the villages of St. Jean Baptiste and St. Michel. In this district fourteen species have occurred to me, which, so far as I am aware, have not yet been recorded as occurring on the island, two of which (*Atrypa deflecta* Hall, and *Holopœa symmetrica* Hall), have not previously been detected in Canada. In addition to this, I have obtained one Cystidean (?) new to science, two new bryozoa (one the type of a new genus), a new brachiopod (of the Orbicula group), and a new species of Ctenodonta. The list of fossils, however, must be looked upon only as a result of the commencement of an investigation which has yet to be carried out. To my friend, Mr. Billings, the Palæontologist of the Geological Survey of Canada, I am indebted for much valuable assistance in the determination of critical species. With the exception of *Strophomena deltoidea*, these fossils may perhaps be considered characteristic of the upper zone of the formation.

List of Fossils procured from the Trenton limestone proper, of the island of Montreal:

ZOOPHITA.

Stenopora fibrosa, Goldfuss.
" petropolitana, Pander.

CRINOIDÆ.

Dendrocrinus acutidactylus, Billings.
" proboscidiatus, "
" cylindricus, "
Heterocrinus Canadensis, "
" tenuis, "
Rhodocrinus pyriformis, " (columns only).
Cleiocrinus grandis, "

CYSTIDEŒ.

Pleurocystites squamosus, Billings.
" exornatus, "

Glyptocystites Logani, Billings and var. gracilis.
" multiporus, Billings.
Also a specimen of a supposed new genus.

EDRIOASTERIDŒ.

Edrioaster Bigsbyi, Billings.

BRYOZOA.

Intricaria reticulata, Hall.
Ptilodictya acuta, "
Two new species, one probably of a new genus.

BRACHIOPODA.

Lingula quadrata, Eichwald.
" riciniformis, Hall.
" Progne, Billings.
" Phelomela, "
" Daphne, "
Discina Pelopœa, "
Trematis Montrealensis, Billings.
Leptæna sericea, Sowerby.
Strophomena alternata, Conrad.
" deltoidea, "
" tenuistriata, Sowerby.
Orthis testudinaria, Dalman.
" lynx, Eichwald.
" subquadrata, Hall.
" pectinella, Conrad.
" Eurydice, Billings.
Rhynchonella increbescens, Hall.
" recurvirostra, "
Camerella hemiplicata, Hall. (A. circulus? young of this?)
Atrypa deflecta, Hall? (New to Canada.)

LAMELLIBRANCHIATA.

Avicula Hermione, Billings.
Modiolopsis carinata, Conrad.
" faba, "
Ctenodonta dubia, Hall? (Perhaps the young of Tellinomya anatiniformis, Hall.)
Ctenodonta Astartœformis, Salter.

GASTEROPODA.

Holopea symmetrica, Hall. (New to Canada.)
" Nereis, Billings.
Ciclonema Montrealensis, Billings.
" Hageri, Billings.
Subulites subfusiformis, Hall.
Eculiomphalus Trentonensis, Conrad.
Trochonema umbilicata. Hall?
Pleurotomaria Americana, Billings.
Metoptoma Trentonensis, Billings.

PTEROPODA.

Conularia Trentonensis, Hall.
Bellerophon bilobatus, Low.

CEPHOLOPODA.

Orthoceras proteiforme, Hall, and var. lineolatum.
" strigatum, Hall.
Cyrtoceras Juvenalis, Billings.
" macrostomum, Hall? or a new species.

CRUSTACEA.

Asaphus platycephalus, Stokes.
Calymene Blumenbachii, Brongniart.
Cheirurus pleurexanthemus, Green.
Trinucleus concentricus, Eaton.

ENTOMOSTRACA.

Leperditia Canadensis, var.—rare.

ANNELIDA.

Serpulites dissolatus, Billings.

(66 species).

REVIEW.

Geology of New Brunswick.

(*Continued from page* 239.)

One of the most important points in Prof. Bailey's Report, is the working out of the relations of the metamorphic rocks underlying the Devonian plant beds of St. Johns; and which, it now appears, constitute a series descending even to the horizon of the Laurentian. The following extracts relate to the Portland group, supposed to be Laurentian, the Coldbrook group in the horizon of the Huronian, and the Portland group, which yields Primordial fossils.

" Portland Group.—*Age.*—It might readily be supposed that the extreme metamorphism exhibited by the rocks of the Portland group would be accepted as conclusive evidence of their great antiquity. Indeed the fact of such antiquity could scarcely have been doubted, were it not for the intimate association and almost entire conformability between the beds of this and the overlying groups, which have heretofore induced all the observers who have examined the district to link them in a single series. As the latter are unquestionably of Upper Devonian age, the beds of Portland were supposed to represent either a portion of the lower division of the same formation, or possibly the upper part of the Silurian. Dr. Dawson alone, while still adopting the latter view, called attention to the great resemblance between these rocks and those of the great

Laurentian series of Canada. It is with much gratification that we are now enabled to confirm, with a good degree of certainty, this opinion of their antiquity and geological position.

"The facts upon which this decision is based are chiefly these: first, the great metamorphism of the series, and secondly, the position which it holds with reference to the overlying formations. It will be impossible clearly to explain the latter without anticipating the description of the groups which are to follow, but it will be sufficient here to say that one of these groups, that of Saint John, formerly supposed to be connected with the Devonian series, has been shown, upon the evidence, of its fossils to be undoubtedly Primordial, or to be the equivalent of the Potsdam rocks of other portions of North America—rocks at the very base of the Lower Silurian series. Were the rocks of Portland simply underneath the fossil-bearing beds of the Saint John group, we should still be obliged to regard them as Azoic; but, as will hereafter be shown, they are really separated from the latter by the entire mass of the Coldbrook group, representing certainly not less than 7000 feet of stratified deposits, which must have been formed in the interval between the laying down of the Portland beds, and the shales and sandstones of Saint John.

"If then, as is probable, the Coldbrook group is the partial representative of the Huronian beds of Canada, we cannot hesitate in assigning the subjacent syenites and limestones of Portland to the great and still more ancient Laurentian series, a group heretofore supposed to be unrepresented in this portion of the continent.

"In corroboration of this view, we have only to call attention to the great similarity of the two formations in their mineral composition, and their extreme metamorphism. Without entering into minute details, (for the study of which the reader is referred to the Reports of Sir William Logan on the Geology of Canada,) it may be sufficient here to say that this resemblance is apparent in the succession of stratified deposits, consisting in both, principally of gneiss, quartzite, limestone, anorthosite (?) and occasional bands of mica-schist, together with syenite, and rocks which can with difficulty be distinguished from intrusive granites. Both hold beds of graphite, sulphurets of the different metals, serpentine (in connection with the calcareous beds, producing ophiolites), as well as many simple minerals, such as hornblende, muscovite, pyrallolite (?) tourmaline, feldspar, and others. The abundance of magnesian silicates in the Portland rocks is also remarkable, as observed by Mr. Matthew, and suggests the possibility that the limestone may in part be dolomitic like the similar calcareous beds of the Laurentian.

"COLDBROOK GROUP.—*Characters.*—It has been stated that the Coldbrook group consists of two members, an upper, soft, red, and of aqueous origin, and a lower, in which the rock is chiefly a hard greenish-grey compact slate. There is but little variation in the characters of these members throughout their entire extent.

"In the neighbourhood of Saint John the development of the group is of too limited character to serve for illustration. Widening however, to the eastward, it is well exposed along the valley of the Coldbrook, and the following succession has been observed by Mr. Matthew:—

1. Hard greenish-gray slate, stratification very obscure.
2. Conglomerate, with bright red slaty paste.
3. Grey conglomerate.
4. Coarse reddish grit, and conglomerate with purple sandstone.

Apparent thickness of the whole, 5000 feet.

"In tracing the group to the eastward, along the northern side of the Loch Lomond Lakes, two sections have been made across the lower member of the series, the first extending from "the Thoroughfare" between the first and second lakes, to the Golden Grove settlement, the second from the latter to the third lake, thus recrossing the same ridge.

"Along the line of the first section, the rocks of the group differ from their development westward, chiefly in the occurrence of a middle band of sandstone and shale, resting upon a thick succession of porphryitic and amygdaloidal traps, associated with bands of ferruginous and white feldspathic quartzites. Near the lower part of Golden Grove, the base of the Coldbrook group is represented by the occurrence of heavy beds of dark-grey sandstones and coarse quartzose conglomerates, the latter much faulted and injected.

"The great thickening of the Coldbrook beds in this vicinity is probably, as suggested by Mr. Matthew, the cause of the decided easterly trend noticeable in the upper member of the present group, as well as in the overlying deposits.

"Along the second section referred to, no facts additional to those now given were observed, with the exception that a portion of the series near Brawly Lake has been exposed by an extensive slide, and now projects in wild and lofty overhanging cliffs above the ruin at its base.

"It has been stated that rocks apparently forming a portion of the upper member of the group now under consideration, occur along the southern side of the first Loch Lomond Lake. They consist of purplish-red trappeau and quartzose sandstone, but are not well exposed. Although probably belonging, as above stated, it is possible that these rocks may represent the upper member of the Blomsbury group, hereafter to be described.

"Southward of the above, along the line of Ratcliffe's Millstream, the exposures are more clearly visible, and the Celdbrook rocks may be again distinctly recognized. Nominally underlying the Saint John group, which is a newer series, they here lie above the latter, both formations having been reversed by a folding of the strata. They consist at this place of purple sandstone, greenish-grey, red and purple sandy shales. To the eastward the same member appears crossing Handford's and Harding's Brooks, on the old road from Quaco to Sussex.

"Returning for a moment to the neighborhood of Loch Lomond, we have next to consider the rocks of this group, occurring to the southward of the fault and downthrow at the Negro settlement. Near the last named place, and resting upon a ridge of eruptive syenite, Mr. Matthew has observed a series of compact slaty traps, with beds and dykes of greenstone, these in turn being overlaid by a broad band of white and pink felspathic and silicious slates. Upon them again repose a series of heavy ash-slates and amygdaloidal traps, forming the northern side of the valley of Black River. On the southern side of the latter, beds of the Saint John group appear.

"In the sequence of volcanic sediments detailed above, a close resemblance is apparent to the similar succession already given on the north side of Loch Lomond. The same sequence is also apparent along the old road to Quaco, being especially noticeable in the occurrence in each of fine pink felspathic quartzites, succeeding bluish, pink and grey porphyritic slates.

PRIMORDIAL FOSSILS.

"ST. JOHN GROUP.—*Age.*—The question of age in the Saint John series, is one of great importance, throwing light, as it does, upon the origin of all the associated groups. It has been our fortune to discover facts which leave this question no longer doubtful.

"It has already been remarked, when describing the character of this series as developed in the city of Saint John, that the remains of a lingula, an animal related to our modern shell-fish, had been found to characterize in considerable numbers some of the sandy beds, but that they were too imperfectly preserved, and too indecisive in their character to throw any positive light upon the age of the rocks which hold them. The other markings before mentioned, such as worm-burrows, shrinkage-cracks, and rain-drop impressions, although they furnished conclusive evidence as to the physical conditions under which the beds were formed, did not serve to remove the obscurity which enveloped the discussion of their age.

"Subsequently, during an examination of the valley of the Coldbrook by Mr. Matthew and his brother, organic remains were observed of a more decided character. These latter consisted, besides some obscure relics of a small orthoceratite, and numerous trilobites of two or three species, but these were so excessively distorted that no satisfactory conclusions could be based upon their study. Until the present summer, therefore, the age of this great series, although vaguely surmised, remained a subject of discussion and doubt. The discovery of finely-preserved Trilobites and Brachiopods at Ratcliffe's stream, and in the valley of the Coldbrook, has now removed this doubt, and left no uncertainty as to the age and origin of the group which holds them. We regard this discovery as among the most interesting and valuable results of our summer's labour.

"That the discussion of this question might have the careful and attentive study which its importance demanded, the fossils above referred to were placed in the hands of Mr. Hartt, who, as will be seen below, has enjoyed peculiar facilities for their determination and comparison. It had been hoped that the entire results of that gentleman's labours might have been embodied in the present Report, but the want of sufficient leisure for their complete analysis, has prevented this from being accomplished. The following notice is, however, introduced as preliminary to a more detailed description to be given hereafter:

Preliminary Notice of a Fauna of the Primordial Period in the vicinity of St. John, N. B.

By C. Fred. Hartt, A.M.

"My examination of the fossils collected last August, from the Saint John group, at Ratcliffe's millstream, by Prof. Bailey, Mr. Geo. Matthew, and myself, and of a collection made from the same group at Coldbrook, in 1863, by Messrs Geo. and C. R. Matthew, is not yet sufficiently complete to enable me to give an extended description of them here. I shall therefore limit myself, at present, to a notice of the genera, and of the aid they afford in the determination of the geological position of the Saint John group, leaving the descriptions and figures of the species to be given in a paper which will appear in the Appendix to this Report.

"The fossils as yet known to occur in the rocks of the Saint John group, are principally Trilobites, which are represented by quite a large number of species, and Brachiopoda, which last are of more rare occurrence. All these fossils are preserved as casts or impressions, the tests of the crustacea and the shells of the Brachiopoda being usually transformed into oxide of iron.

"All the specimens have suffered more or less from distortion through pressure and the metamorphosis to which the rocks enclosing them have been subjected. The Trilobites occur also as detached fragments, so that their accurate determination is not easy, and more material is required in order satisfactorily to figure and describe all the species.

"Representatives of four genera of Trilobites have been obtained thus far from the Saint John rocks, viz:—*Paradoxides*, *Conocephalites*, *Agnostus*, and a new genus (?) allied to *Conocephalites*.

"The number of species in each genus has not yet been satisfactorily made out; but of *Paradoxides* there are at least five, of *Conocephalites* seven, and of *Agnostus* and the new genus each one.

"All the species appear to be new. One of the *Paradoxides* bears a close resemblance to *P. rugulosus*, Corda, from the Etage C of Barrande, in Bohemia, and one of the *Conocephalites* is allied to *C. coronatus*, Barrande, from the same fauna and horizon, though neither is identical with the European species.

"There are six species of Brachiopoda, belonging to the genera *Orthisina, Discina, Obolella, and Lingula.* I have not been able to identify any of the forms with described species.

"Though all the species from the Saint John group are apparently new, yet the occurrence of *Paradoxides* and *Conocephalites*, genera confined entirely to the so-called Primordial fauna of Barrande, and everywhere characteristic of it, together with the strong likeness borne by the Saint John species, in their facies, to those of the same genera of the faunæ of the Primordial in Europe and America, enable us unhesitatingly to assign to the Saint John group, or at least to that lower part of it which has afforded Trilobites, a geological position equivalent to Barrande's Etage C, or to the Potsdam proper of America.

"As Agassiz has shown, Barrande uses the word fauna, in his term primordial fauna, in a sense equivalent to epoch or horizon, A fauna is strictly a collection of animals confined within a limited geographical area. The terms 'primordial fauna,' 'second fauna,' are used with propriety when applied to the groups of fossils characterizing the Etages C and D in Bohemia; but these terms, unless limited, should not be extended to equivalent groups of the same age, but forming distinct faunæ, in other parts of the world, for such a double sense is incompatible with that precision which should mark the use of scientific terms. Primordial zone is objectionable; if the term Primordial is used, and it is very appropriate, it would be much better to say Primordial Period, period as used by Agassiz, being equivalent to Barrande's *etage*.

"The lower part of the Saint John group, at Coldbrook, has been divided by Mr. Matthew on lithological grounds, into three bands, viz:—

No. 1. The lower arenaceous band, with no determinable fossils, and constituting passage beds from the Coldbrook group.

No 2. Argillaceous shales, rich in fossils, *Paradoxides, Orthisina* (?), *Conocephalites, Obolella.*

No. 3. Carbonaceous shales, full of fossils, *Paradoxides, Conocephalites, Orthisina, Discina, &c.*, all much distorted.

"I have not observed No 2, at Ratcliffe's millstream. No. 3, at Coldbrook, corresponds exactly, in its fossil remains, to the bed at the millstream, from which the Trilobites, &c., were obtained. Nearly, if not all, the fossils I have seen from No. 2, at Coldbrook, are entirely distinct from those of No. 3 of the same locality and the Millstream; but more material is required to establish the claim of these two beds to be considered as being characterized by distinct successive faunæ. At all events, all the species from both beds are different from those elsewhere occurring, and for at least bed No. 3, we have in the vicinity of Saint John a distinct fauna of the Primordial period.

"Through the kindness of Prof. Agassiz, under whose supervision my work is being done, and to whose suggestions I am largely indebted, I have been able to compare my specimens with the fine suite of Bohemian and other Primordial Trilobites in this Museum. The results of these comparisons I shall leave to be brought out in my forthcoming paper."

As might be expected, both reports contain much important information as to the carboniferous rocks of New Brunswick; but for this we must refer to the publications themselves, which should be on the shelves of every geologist.

Published, Montreal, September 20, 1865.