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THE

CANADIAN

Naturalist & Geologist,

AND PROCEEDINGS OF THE

NATURAL HISTORY SOCIETY

OF MONTREAL.

CONDUCTED BY A COMMITTEE OF THE NATURAL HISTORY SOCIETY.

VOL. VII. DECEMBER, 1862. No. 6.

(*Published January* 12, 1863.)

Montreal:
DAWSON BROS., No. 23, GREAT ST. JAMES STREET;
BAILLIERE BROS., LONDON, PARIS AND NEW YORK.

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ARTICLE XXXIX.—*On the Mammals and Birds of the District of Montreal.* By ARCHIBALD HALL, M.D., L.R.C.S.E.

(Concluded from page 316.)

ORDER VI. PALMIPEDES.

Fam. I. Brachyptera.

Genus Colymbus.

Gen. char. Bill straight, smooth, compressed, and more or less acuminate; nostrils basal, lateral, linear; feet more or less completely palmated.

Sub genus Podiceps.

Sub gen. char. Bill moderate, robust, straight, hard, compressed; points more or less subulate; upper mandible furrowed deeply and broadly to the centre in which are situated the nostrils which are basal, lateral, and pervious, the posterior half covered by a membrane; feet situated far back; the tibia mostly hidden in the body; tarsus compressed; front toes depressed, connected at base by a membrane which forms a broad lobe round each toe; hind toe compressed; nails wide and flattened; wings short and narrow; 2nd and 3rd primaries subequal and longest; tail wanting, but in its place a small tuft.

P. cornatus. Horned Grebe.
Colymbus cornutus of Gmelin.
Podiceps cornutus. Baird!

v. s. p. Bill shorter than the head, bluish black with a white tip; legs and feet brown pale anteriorly; irides red; orbits and rictus lake colour; eggs 3 to 4 white spotted brown.

Dorsal aspect. Crown of head, nuchal region and cheeks black, with a greenish iridescence; space between eyes and nostrils chesnut; upper part of the ruff commencing above the eye buffy orange, the remainder of the ruff black; interscapulary region and scapulars black, the feathers margined with whitish; great and small wing coverts and primaries clove brown; secondaries white; rump blackish brown.

Ventral aspect. Chin, upper part of throat, cheeks and auriculars glossy greenish black; lower part and sides of the throat glossy chesnut of a very deep tint; vent and tail coverts cinereous; flanks chesnut brown mixed with black; the remainder of this aspect glossy white sometimes tinged with yellow.

2nd primary longest; *long scapulars longer than the primaries*; length 16½ inches; alar expanse 19 inches; middle toe nail pectinate. The young bird is deficient in the ruff; its chin and cheeks with the ventral aspect is white; all the other parts except the secondaries are brownish cinereous. This young bird forms the *Podiceps obscurus et caspicus* of Latham and the *Colymbus nigricans* of Scop, and var. *A.* of Latham.

P. cristatus. Crested Grebe.
Colymbus urinator of Gmelin.
Podiceps cristatus. Baird!

v. s. p. Bill longer than the head about two inches, reddish white at the point; legs and feet blackish, interiorly yellowish white; naked space from the bill to the eye red; irides carmine; eggs 3 to 4 greenish white waved with deep brown.

Upper surface of head, occipital crest and lateral ruff, shining black; bases of the latter and sides of the nape tinged with rufous; back of neck, dorsal plumage and wings blackish brown; upper border of the wing tertiaries and all the secondaries, except 3 or 4 posterior ones, a spot before the eye, chin, sides of head and under plumage of the neck and body, white silvery below; length 23 to 24 inches. (Nuttall),—I have never met with the old bird, but a young bird beside me has the following distinctive characters:

Bill white, livid on the ridge; irides red.

Dorsal aspect. Crown of head, occipital crest, nuchal region, lower half of the neck on the sides, interscapulary region, rump, scapulars and wing coverts, including the primaries, cinereouss brown; secondaries white, as well as a space between the nostrils and orbit; chin, upper half of the throat, front of the remaining half, and remainder of ventral aspect, including the shoulders white; silvery on the belly and breast; the white is tinged on the flanks with cinereous; the ruff is wanting, but the occipital crest is present.

1st and 2nd primaries subequal and longest; long scapulars equal to the primaries; length 22 inches; alar expanse 28 inches; length of bill from the angle of the mouth 2½ inches.

P. minor. Little Grebe.

V. S. P. Bill short, strong, compressed, black, with the base of the lower one, white in the adult; ridge brown, sides and lower one yellowish in the young bird; legs and feet greenish brown externally, flesh colour internally; irides reddish brown, dark brown in the young; eggs 5 to 6 dirty white.

Dorsal aspect of a young bird after its first month as it lies before me: Crest wanting; crown of head brown, varied with yellowish brown; nape of neck and dorsal region including the primaries and rump blackish brown with olivaceous reflections, which are wanting in the primaries; secondaries white on the inner vanes and at the base.

Ventral aspect. Chin and middle of the breast and belly white; cheeks and sides of throat white tinged with rufous, and with irregular streaks and bands of the latter colour; upper part of the breast and sides banded with rufous brown and black, in which faint white streaks may be discerned; sides of belly and flanks blackish ash.

2nd primary longest; 1st and 4th subequal; long scapulars longer than the longest primary; length 11½ inches; alar expanse 16 inches; length of the bill from the angle of the mouth 1 inch and 2 lines.

P. rubricollis. Red necked Grebe.
Colymbus rubricollis et subcristatus of Gmelin!
Podiceps griseagena. Baird!

D. C. Bill as long as the head, black, yellow at the base, from the front to the tips 1½ inches; irides reddish brown; legs and feet black, internally yellowish green; eggs 3 to 4 whitish green, soiled with yellowish brown.

Adult with the cheeks and throat ash colour, neck and breast rufous; crown and nape with a narrow black space, a short occipital black crest, but no ruff; front black; secondaries white; young duller coloured and spotted; no occipital crest; cheeks and throat white, the former striped with black. This bird will likely be found in this district, but I have not hitherto met with it.

P. Carolinensis. Red bill Dobchick or Grebe.
Colymbus podiceps of Gmelin!
Colymbus Ludovicianus of Catesby!

V. S. P. Bill pale with a black band across the centre including the nostrils; legs and feet blackish brown; irides hazel; eggs unknown.

Dorsal aspect. Crown of head and nape of neck blackish ash colour mixed with cinereous; dorsal region, rump, and scapular olive brown; great and small wing coverts, primaries and outer vanes of secondaries brown; inner vanes of secondaries white; cheeks and sides of the neck ashy.

Ventral aspect. Chin and orbicular space down the throat jet black; the remainder of the throat, its sides, and the cheeks as far as the nuchal region cinereous mixed with white; breast and its sides blackish brown, the feathers broadly tipped with soiled yellow; belly and sides glossy white, internally cinereous; the latter colour visible through the white vent and flanks, glossy blackish brown.

2nd primary longest; 1st shorter than the 3rd but longer than the 4th; length 13½ inches; alar expanse 16½ inches; length of bill from the angle of the mouth 1¼ inch. In the young bird the transversal band of the bill is obsolete or at most very faintly delineated; the chin is white, the breast and flanks light chesnut brown, and the belly silvery white tinged with brown. The inner and middle toes of the bird are connected beyond the first articulation, and the outer and middle toes are subequal in length.

Sub genus Colymbus.

Sub gen. char. Bill longer than the head, stout, straight, subcylindrical, compressed, with a subulate tip; nostrils basal, lateral, oblong, semiclosed by a membrane; feet placed far back; tarsus compressed; anterior toes wholly palmated; hind toe small, barely touching the ground; wings moderate, small and acuminate; 1st and 2nd primaries longest; tail short, composed of 12 or 10 feathers. This genus appears to be the last of a connecting link between the true palmipedes and those whose toes are free. Their acuminate bill approximates them to the latter, while their really webbed feet induces us to classify them among the former. In general systematic works they have obtained a station after the Duck tribe; unjustly so; Cuvier's arrangement is decidedly the best, ranking them in their present position, which I have adopted.

C. Septemtrionalis. Red throated Diver.
C. striatus
C. stellatus } Young bird in its different states.
C. borealis
C. Septemtrionalis. Baird!

V.S.P. Bill black; tip brown colour; legs and feet blackish green; irides red; eggs 2, of a pale oil green colour.

Dorsal aspect. Crown of head, cheeks and sides of neck lead colour, approaching to black in the centre of the crown; a stripe along the back of the neck, branching off to the sides of the neck, black streaked with white; interscapulary region and scapulars black, with a couple of faint white spots on the tip of each feather; rump and tail black; great and small wing coverts brownish black; primaries and secondaries black, tipped with green brown and white on the inner borders at the base.

Ventral aspect. Chin lead colour; throat with a mesial line of deep purplish red; breast, belly, vent and tail coverts white; sides of flanks streaked with black; inner wing linings white.

1st primary longest; scapulars short; length 31 inches; alar expanse 37 inches; length of bill from the rictus 3 inches 1 line; the lower mandible is navicular; the upper one is about a line longer than the lower; the ridge of the upper mandible is inclined to yellowish brown in the specimen before me, and an irregular streak of white runs along the side of the lower one.

A female shot in the Lachine rapids in the spring of 1837 and in my possession has the following distinctive characters:

Dorsal aspect. Crown, nape of neck cinereous; dorsal region including the scapulars dark ash colour with a couple of white streaks on the tip of each feather, giving this region a crossed or zigzag appearance; rump and tail blackish ash; primaries black, as well as the secondaries, white on the inner vanes towards the base.

Ventral aspect white; sides of flanks streaked with black. In another female, probably a younger bird, the anterior part of the throat and cheeks is mixed cinereous and white, imparting a grey or hoary appearance to these regions. The length of the latter specimen is 27 inches, that of the former 28 inches. Nuttal gives as the length of the male bird 29 inches. The stuffed specimen of the male, the description of which is given above, measured as stated 31 inches, probably owing to an irregularity in the manner in which the specimen has been set up. The bird is a rare one in our markets. The male specimens are even rarer than the female.

C. glacialis. Loon or Great Northern Diver.
C. immer of Gmelin! Young bird.
Colymbus torquatus. Baird!

V.S.P. Bill, legs and feet black; irides red; eggs 3 to 4 smoky olive, blotched with umber brown.

Dorsal aspect. Crown, cheeks, chin and whole neck jet black, deep black on the head, glossy at the lower part of the neck, with a purple reflection; on the front of the neck, a narrow band, scarcely reaching the sides, and about two inches below it, a collar commencing broadly behind and narrowing to the front, white, with broad longitudinal black lines, the black streaks occupying the centre of the feathers; interscapulary region, scapulars, great and small wing coverts; rump and tail coverts, black, verging to brown on the coverts, with rows of white spots; these spots being square and in pairs on the scapulars; suborbicular and in pairs on the dorsal region, and single and round on the coverts and rump; primaries, secondaries and tail blackish brown, white on the inner vanes of the two former near the base.

Ventral aspect. Shoulders white, streaked with black, like the collar; wing and tail coverts, and breast and belly white; sides and flanks black, streaked and spotted with white.

1st primary longest; length 34 inches; alar expanse 51 inches; length of the bill from the rictus 4¾ inches. The female is in every respect analogous to the female of the *C. Septemtrionalis*, but on a larger scale; the feathers of the head and neck of this bird are uncommonly velvety in feel, and from its approximation to the characters of fur and from its durability is often used for the same purpose by our Aborigines. The *C. Arcticus*, the only other species of this genus met with on this continent does not visit us. It is a peculiarly northern sea bird, never met with beyond the sea coasts.

Fam. II. Longipennes.

Genus Sterna.

Gen. char. Bill as long or as longer than the head, compressed, slender, more or lest acuminate with sharp edges; upper mandible, curved at the tip, never hooked, and equal in length to the lower; nostrils in the middle of the bill, longitudinally cleft and pervious; legs and feet slender and small, with a naked space above the knee; tarsus shorter than the middle toe; the 3 front toes webbed; hind toe very short barely touching the ground; wings long, acuminate; 1st primary longest; tail of 12 feathers long and forked.

S. Hirundo ? The Great or Common Tern.

V.S.P. Bill fine orange, faintly delineated with black, near the tip, which is pale lake; irides deep hazel; legs and feet black.

Dorsal aspect. Crown, occiput, including the eye, black, descending for a short distance down the nuchal region, the remainder of which, with the rump and tail, is white; mantle pearl colour; the three first primaries greyish black, the others hoary pearl colour, all of them with a faint streak of white, running longitudinally along the inner vanes; shafts white; lower eyelid white.

Ventral aspect white.

1st primary longest, the others graduated; the tail moderate furcate; length from the lateral tail feather to the tip of the bill 20 inches; alar expanse 46 inches; the specimen a female, length of bill from the rictus 3½ inches; length of the tarsus 1⅔ inch. This bird differs in several particulars from the *S. Hirundo* of Nuttall, so much so that I feel almost inclined to rank it a separate species, were it not for the risk of multiplying species. The points in which they differ are the following:

S. Hirundo.	*S. Hirundo ?*
Crown and occiput wholly black, including the eyes.	Crown and occiput wholly black including the eye, lower eyelid white.
Mouth bluish white or pale lead colour.	Mouth pearl colour.
Tail greatly forked.	Tail moderately forked.

Bill reddish yellow or crimson tipped with black.	Bill orange, with a faint streak of black on both mandibles near the tip, which is pale.
Tarsus red, 1 inch long.	Tarsus and web black, the former 1⅝ inch long.
Length 15 inches; alar expanse 30 inches.	Length 20 inches; alar expanse 46 inches.

From this comparative view of these two birds, there can be little doubt but that they are distinct. Under present circumstances, however, I do not wish to establish a new species, for they are sufficiently numerous; I much rather prefer ranking it under the head of *S. Hirundo* with a point of interrogation after it, thus implying my doubt as to its being in reality the bird mentioned by authors under that name. The specimen from which my description is taken is in the Museum of the Natural History Society of Montreal. This bird differs also very materially from the *Sterna Boysii.*

S. arctica. Arctic Tern.
S. argentea of Brehm!
S. macroura of Newman.
Sterna macroura. Baird!

V.S.P. Bill orange tipped with black; legs and feet scarlet; irides brown; eggs 2 to 3, light yellowish brown or bluish grey potted irregularly with brown.

Dorsal aspect. Crown and nuchal region jet black; mantle pearl grey; rump and tail coverts white; outer vane of the 1st primary black; outer vanes of all the others, as well as the tips, and a stripe down the inner vanes along the shafts, hoary grey, verging to black at the tips; outer vane of the lateral tail feathers black; of all the others pearl grey; inner vanes of primaries, secondaries, and tail feathers white.

Ventral aspect. Cheeks, throat, vent, tail coverts, and wings linings pure white; all other parts pearl colour.

1st primary longest; wings extending long over the tail; length 14 inches; alar expanse 30 inches; length of the bill from the rictus 1 inch 9 lines; tarsus and toes small; middle toe, without the nail, equal to the tarsus. In two other specimens before me, the new lateral tail feathers only have their external vanes pearl grey, and not black at all, and all the other tail feathers white. This Tern is the most common one in this district.

S. nigra. Black Tern.
S. fissipes of Gmelin!
S. obscura of Latham!
S. plumbea of Wilson!

V.S.P. Bill black, pale towards the base of the lower mandible; legs and feet brown or purplish black; irides brown; eggs 3 to 4 olive brown, mottled brown, and black.

Dorsal aspect of the young bird. Frontlet ashy white; crown and nape blackish ash; interscapulary region and scapulars dark ash, tipped with rufous white; wings, rump and tail pale ash; the former with a narrow edging of white on the inner vanes; crescent in front of the eyes, and auriculars black.

Ventral aspect. Throat and its sides, chin, middle of the breast, belly, tail and wing coverts white; sides, flanks, and axillaries pale ash; shafts of all the wings and tail quills black.

1st primary longest; wings extending about 1½ inch beyond the tail which is subfurcate; length 9½ inches; alar expanse 20 inches; middle toe, without the nail, longer than the tarsus.

The adult plumage in nuptial dress: coverts of wholly blackish ash; the winter dress of adult birds is lead colour, with the head and neck deep black, and the front, throat and vent white. This bird is not often met with in this district.

Genus Larus.

Gen. char. Bill moderate, rather stout, straight, compressed, naked at the base, with sharp incurved edges; upper mandible rounded above with the apex curved; lower one shorter, gibbous and angular beneath the point which is blunt; nostrils medial, lateral, longitudinal and open; tail slender; thumb small, not touching the ground; hind nail occasionally wanting; wings long and acute; 1st and 2nd primaries subequal and longest; tail, more or less square, of 12 feathers.

L. atricilla. Black headed Gull—Laughing Gull.
L. ridibundus of Wilson!
Chroïcocephalus atricilla. Baird!

V.S.P. Bill, legs and feet red; irides hazel; eggs 3 olive grey, spotted, pale purple, and dilute brown.

Mantle dark bluish ash, quills black; above and below the eyes a spot of white; eyelids and sides of the mouth lake red; head and neck black; the whole ventral aspect white; 5 first primaries black towards their tips and except the 1st and 2nd tipped with white, the secondaries broadly so; the closed wings extending two inches beyond the tail. In winter, the hood is wanting, and the young birds have a subterminal band of black on the tail, while their dorsal and ventral aspects are brownish, tipped with rusty white. Length of an adult 17 inches; alar expanse 36 inches. A specimen of this bird is in the Museum of the Natural History Society; it is a rare one in this vicinity.

L. tridactylus. Kittiwake Gull.
L. rissa of Pennant!
L. rissa tridactyla. Baird!

V.S.P. Bill of the old bird yellowish; of the young bird black, brownish at the base; legs and feet yellowish, (black according to Nuttall); orbits orange; irides hazel; eggs 3, olivaceous white spotted light and dark grey.

Old bird summer plumage. Mantle bluish grey; 5 exterior quills and outer web of 1st black; 4th and 5th tipped with white; all the other parts white. In winter plumage, the occiput and neck are French grey, and the rictu-orbital space streaked with black. *A young bird before me presents the following characters:*

Crown of head, occiput, and scapulars grey skirted with brownish white; rump and wing coverts, except the upper row of the small wing coverts which is brownish black, bluish ash colour; tail white with a subterminal band of black, and tipped with white; all the primaries black towards the extremities, the black running down the outer and inner margins in a narrow streak; the whole outer vanes of the 1st primary black; all the primaries except the 1st tipped with white; auriculars brown.

Ventral aspect white.

1st primary longest; length 14 inches; alar expanse 30 inches; the tarsus and web have dried pure white, so that I doubt very much whether a black colour, as given by Nuttall, could even characterize this part in the young bird. I have never met with an old specimen.

L. canus. Common Gull or Mew.

V.S.P. Bill yellow; legs and feet blackish grey, blotched with yellow on the webs; irides hazel; eggs 3, bluish or ochraceous, spotted with cinereous and blackish.

Summer plumage. Mantle bluish grey; the first six primaries with black near the tips, forming a narrow bar on the 6th; the

1st and 2nd with a long white space near their tips; all the others including the scapulars and secondaries broadly tipped with white; all the other aspects white.

In winter plumage, the head and neck are spotted with black and the young is brownish cinereous varied with rusty.

Length 19 inches; alar expanse about 36 inches.

L. fuscus. Silvery Gull.

V.S.P. Bill yellow, angle on the lower mandible lively red; legs and feet yellow; irides hazel; orbits red; eggs 2, olive brown or grey, blotched with dusky.

Winter plumage. Mantle slate black; 1st and 2nd primaries with an oval white spot; all the other parts of the quills black, except a white tip, which is also observable on the scapulars and secondaries; head and neck streaked with light brown; ventral aspect and tail white. In summer the head and neck are pure white, and the young bird is bluish grey, mottled with yellowish rusty.

Length 20 inches; alar expanse about 38 inches.

L. argentatus. Herring Gull.
L. argenteus of Brehm!
L. argentatus. Baird!

V.S.P. Bill and orbits yellow, the former with the angle of the lower mandible lively red; irides hazel; legs and feet flesh colour; eggs 2 or 3 olivaceous, spotted with dark cinereous.

Summer plumage of adult. Ventral aspect, head, neck, rump, and tail pure white; mantle bluish ash colour; primaries black towards their extremities; the first one with a spot of white near the tip, which is obsolete on the second; and all of them, as well as the secondaries and scapulars, tipped with white. In winter the head and neck are varied with brown lines. The young bird blackish ash, mottled with rusty.

Length 24 inches; alar expanse 50 inches. The female is about an inch shorter than the male. This gull is commonly met with in the autumn.

L. glaucus. Burgomaster.
L. glaucus. Baird!

V.S.P. Bill brown colour at the base, blackish near the tip; legs and feet flesh colour; irides dark hazel; eggs 3 pale purplish grey, spotted with umber brown and pale purple.

Summer adult plumage. Mantle bluish ash colour; quills greyish white; primaries, secondaries, scapulars, tipped with white; all the other parts white. In winter the head and neck are streaked and mottled with pale wood-brown. The young birds have longitudinal pale brown streaks on the head and neck, and the upper plumage transversely barred with ash grey and greyish yellow.

Length 29 inches; alar expanse 44 inches.

Fam. IV. Lamellirostres.

Genus Anas.

Gen. char. Bill broad and large, furnished on the edges with thin salient laminæ placed transversely; feet placed far back, not sufficiently so as to incapacitate them from walking, but so as to render them a weak and uneasy kind of waddle; their wings moderately long, and their tail more or less acute or round.

Sub genus Anser.

Sub gen. char. Bill short, thick, rather compressed, deeper than broad at the base, and depressed at the apex; marginal teeth short, conic and acute; nostrils lateral, medial, elliptical, large, open, pervious, covered by a membrane; tongue fringed on the sides, short and thick; 1st, 2nd, and 3rd primaries longest; tail rounded, of 16 to 20 feathers.

A. Canadensis. Canada Goose.
Bernicla (*Leucoblepharon*) *Canadensis.* Baird!

V.S.P. Bill, legs and feet black; irides reddish hazel; eggs 6 to 7 greenish white.

Dorsal aspect. Head and neck black; a spot on the brown eyelid, and a uniform patch from the auriculars, meeting its fellow on the chin, white; interscapulary region and scapulars dark brown, with pale edgings; secondaries and wing coverts pale brown; primaries and tail black; rump black; tail coverts white.

Ventral aspect. Lower part of the neck and sides greyish brown, with pale edges; centre of the breast and belly greyish white; vent, flanks, and tail coverts white.

2nd primary longest; 1st and 2nd subequal; length 37 inches; alar expanse 60 inches; length of bill from frontal feathers 2 inches and 2 lines; length of the middle toe and tarsus together 6½ inches.

A. hyperboreus. Snow Goose.
A. (*Chen*) *hyperboreus.* Baird!

D.C. Bill, feet and orbits deep or aurora red; irides dark hair brown; eggs yellowish white.

General colour white; quills pitch black, their shafts white at the base; head glossed with ferruginous, extending sometimes to the neck and even to the middle of the belly.

Length 32 inches; alar expanse 33 inches (Nuttall). This species and the two following are extremely rare in this district, being only birds of passage, through it, an occasional straggler only being killed. I never met with a specimen of this bird and I have never seen but a single specimen of each of the following:

A. leucopsis. Barnacle Goose.
Anas leucopsis of Linnæus!
Anas erythiopsis of Temminck!
Bernicla or *Clakis* of Latham!
Bernicla (*Leucopareia*) *leucopsis.* Baird!

D.C. Bill, legs and feet black; irides blackish brown.

Front sides of the head and throat pure white; a small stripe between the eye and bill, occiput, nape, neck, upper part of the breast, tail and quills black; feathers of the back scapulars and wings of an ashy grey from their origins, with a wide band of black towards their ends and all tipped with whitish grey; lower parts pure white, with the exception of the flanks which have a cinereous tint.

Length 25 to 27 inches (Nuttall).

A. bernicla. Brant or Brent Goose.
A. torquatus of Veillot!
Anas bernicla of Linnæus and Latham!
Bernicla (*Bernicla*) *brenta.* Baird!

D.C. Bill, legs and feet black, the former shorter than the head; irides hazel.

Head and neck with shoulders and breast greyish black; quills, tertiaries, rump and tail greyish black; back scapulars and outer and inner wing coverts clove brown, margined with yellowish grey; a mottled spot on the side of the neck; tail coverts above and below, sides of the rump and vent, white; belly yellowish grey; flanks narrowly barred with bluish grey and white; tail coverts as long as the tail, which is much rounded.

Length 24 inches; alar expanse 42 inches (Nuttall).

Sub-genus Cygnus.

Sub gen. char. Bill higher than broad at the base, gibbous, obtuse, and equally broad throughout; teeth lamelliform; nostrils central, oval, pervious, and covered by a membrane: tongue fringed at the sides; lores naked; neck long; feet placed far back; tarsus shorter than the middle toe; primaries and secondaries subequal in length; 2nd and 3rd longest; tail cuneiform.

C. ferus. Wild or Whistling Swan.
C. musicus of Bechstein and Buonaparte!!
Anas C. ferus of Linnæus!
Anas cygnus of Linnæus and Latham!!
Cygnus Americanus. Baird!

V.S.P. Bill black; care and space round the eyes yellow; irides dark hazel; legs and feet black; eggs 5 to 7 olivaceous, green and rough.

Dorsal and ventral aspects. White, except the crown of head and neck. which are more or less tinged with yellowish.

The young bird is pale grey, with a dull black bill and a livid care, and reddish grey feet.

Length of a specimen killed opposite Longueuil, and at present a conspicuous object in the Museum of the Natural History Society, 66 inches; alar expanse 90 inches; length of the bill from the frontal feathers 4 inches, 10 lines: do of tarsus and middle toe with nail 11¾ inches. The specimen alluded to is the only one of the species known at present to have been killed in this District. It is an extremely rare bird. I do not think that the *C. buccinator* has ever been met with here. The specimen in the Natural History Society has the frontal feathers only tinged yellow.

Sub genus Anas.

Sub gen. char. Bill broader than deep at the base, becoming slightly contracted, and then widening towards the tip, which is obtuse and flattened; marginal teeth lamelliform and weak; upper mandible entirely covering the under; nostrils basal, open, pervious, and covered by a membrane; tongue fringed at the sides; neck about the same length as the body; tarsus about equal to the middle toe; wings moderate, acute; 1st or 2nd primaries longest; tail rounded or cuneiform, composed of 14 to 16 feathers. In most species the lower row of wing coverts is very gaudily coloured, and extremely glossy, and is the part alluded to in the following description of the species under the name of "speculum."

A. boschas. Common Mallard.
A. domestica of Richardson and Swainson ! !
Boschas major of Ray !
Anas boschas. Baird !

V.S.P. Bill livid, the nail yellow (Bill wax yellow, Nuttall !); irides reddish brown; legs and feet orange; eggs 10 to 18 bluish white.

Dorsal aspect. Head and neck rich glossy emerald green; collar white, interrupted on the nape of neck; interscapulary region light chesnut brown with paler edgings; shoulders and scapulars whitish grey, elegantly undulated with clove brown; the exterior row tinted with rich chesnut; small wing coverts greyish brown, the outermost ones margined with white; speculum rich glossy purple, with a deep sea green iridescence, and bounded above and below with jet black and white; rump and tail coverts, black, with a deep emerald green iridiscence; the two central tail coverts recurved; tail composed of 16 feathers, brown in the centre along the shafts, broadly margined with white; the feathers acuminate; primary quills pure brown.

Ventral aspect. Chin and throat to the breast like the head; breast dark chesnut; wing linings and axillaries white; belly sides and flanks greyish white, finely undulated with clove brown; tail coverts velvet black.

2nd primary longest; length 23½ inches; alar expanse 34 inches; length of bill from frontal feathers, 2 inches and two lines; length of tarsus, middle toe and nail together, 4 inches.

"The female and young are wholly brownish, varied with yellowish and bluish."

A. clypeata. Shoveller.
A. rubens of Gmel. ! var. young male !
Spatula clypeata. Baird !

V.S.P. Bill livid black; legs and feet orange; irides reddish brown (yellow ?) eggs 12 to 14, pale greenish yellow.

Dorsal aspect. Space in front of the orbits, frontlet and medial line to the interscapulary region, and interscapulary region umber brown, tinted with green on the head and margined with wood brown in the latter situation; cheeks and sides of the neck, dusky emerald green; lower half of the neck, short scapulars and sides of the rump, white; long scapulars, with the outer vane pale blue, and the inner vane white, margined with jet black, tinted with green; small wing coverts pale blue; speculum brilliant grass green, bounded above and below with white; rump brownish black, tinted with sea green; tail coverts sea green; tail cuneiform; the four central feathers umber brown, all the others white, more or less spotted with brown; primaries umber brown, their shafts white.

Ventral aspect. Chin and upper half of throat umber brown; breast and wing linings white; belly, vent, and sides chesnut; flanks chesnut, finely undulated with dark brown; tail coverts black with a sea green iridescence.

2nd primary longest, 1st subequal to 2nd, the others graduated; length 20 inches; alar expanse 35 inches; length of bill from the frontal feathers 2⅝ inches. The female is liver brown above, with broad borders of pale wood-brown—beneath, pale wood-brown with obscure livid brown marks; the lesser wing coverts are slightly glossed with pale blue, and the speculum is less vivid than in the male.

A. strepera. The Gadwell.
Chaulelasmus streperus. Baird!

D.C. "Speculum white bordered with black and chestnut; feet "orange; their webs blackish; tail of 16 feathers; male blackish, "waved with white; rump black. Female duller and rump uni-"form in colour with the rest of the plumage."

Length 23 inches; do of bill 1 inch 7 lines. I have no doubt that this species is to be met with in this District, but it has as yet escaped my notice.

A. obscura. Dusky duck—Black duck.
A. obscura. Baird!

V.S.P. Bill livid, its nail black; legs and feet yellowish; irides hazel; eggs 8 to 15, white.

Dorsal aspect. Crown of head blackish brown; frontlet streaked with drab; cheeks and sides of the neck drab, streaked with blackish brown; interscapulary region, rump, scapulars, and lower wing coverts umber brown, margined with pale chesnut; tail coverts black, margined with pale chesnut; tail cuneiform, blackish brown edged with brownish white; primaries dusky; speculum purplish green, bordered above and below with jet black, the lower border terminated by white.

Ventral aspect. Chin and throat drab, streaked with blackish brown; the remaining parts of this aspect umber brown, streaked with chesnut in the centre of each feather on the breast, belly and flanks, and margined with pale chesnut in the two latter situations.

2nd primary longest, 1st next, the others graduated.

The female resembles the male.

A. discors. Blue Winged Teal.
Querquedula discors. Baird!

V.S.P. Bill livid black; legs and feet yellow; irides hazel; eggs.

Dorsal aspect. Crown of head and border of a crescentic white patch extending from the crown to the chin, between the orbits and bill, brownish black; cheeks, sides of the neck and nape greyish, with a lavender purple iridescence; interscapulary region and short scapulars umber brown, zigzag barred, and margined with cream colour; long scapulars striped with blackish green, pale blue, and deep cream colour, some of them wholly blue; rump umber brown with pale margins; lateral tail coverts blackish green, centre ones wood-brown; tail subrotund with acuminate feathers which are umber brown with pale margins; small wing coverts pale blue; upper row of great wing coverts blackish brown at their bases, with white distal halves; speculum dark green; primaries umber brown, pale on their inner vanes.

Ventral aspect. Chin and upper half of the throat like the cheeks; remainder of the throat, breast, belly, vent, sides and flanks, pale chesnut, with orbicular black spots on the breast and sides, and black bars on the belly and flanks; sides of the rump white; under tail coverts umber brown; axillaries white.

1st primary longest; length 16 inches; alar expanse 23½ inches; length of bill from the frontal feathers to the tip 1 inch 9 lines; length of tarsus, middle toe and nail 3 inches.

The female wants the white patch on the rump, and the crescent before the eye, and the purple iridescence on the head and neck. Her long scapulars are uniform in colour with the rest of the interscapulary region, and her ventral aspect has the chesnut tinge less developed, and irregularly blotched with black. The young birds are deficient in the green speculum, but resemble the mother in other respects.

A. crecca. American Teal.
Nettion crecca. Baird!

V.S.P. Bill bluish black; legs and feet reddish grey; irides hazel; eggs dusty white spotted with brown.

Dorsal aspect. Crown of head, cheeks, and sides of the neck glossy chesnut; encircling the eye and proceeding backwards from it a glossy emerald green band bordered inferiorly by black, and then faintly with white; nuchal crest indigo blue; lower part of the neck white, elegantly waved with fine lines of brownish black; interscapulary region and rump pale brown or ash, finely waved with white near the tips of the feathers; long scapulars and small wing coverts ash colour, outer ones bordered on their outer vanes with jet black; short scapulars finely waved with white and blackish brown; tail coverts black, margined with cream colour, the lateral ones having a deep purple iridescence; quills of the tail and primaries dusky, the former having pale edges; speculum glossy grass green, bounded superiorly by brownish white, inferiorly by white, and on either side by jet black; the shoulder with a crescentic white band.

Ventral aspect. Chin brownish black, remainder of the throat half chesnut and half white, waved with brownish black; breast wood-brown with semi-orbicular black spots; belly and vent white glossed with wood-brown; sides and flanks white, waved with blackish brown; lateral tail coverts white, glossed with wood brown, central ones jet black, the long ones of which are edged with white.

1st primary longest, 2nd subequal to it, the rest are graduated in réspective lengths; length 15½ inches; alar expanse 23 inches; length of bill from frontal feathers 1 inch and 4 lines; length of middle toe, nail, and tarsus 2½ inches.

The female wants the crest, the brilliant colours on the head, the stripes on the scapulars, the black under tail coverts, the orbicular spots on the breast, and the wavy markings on the back and sides. In lieu of which her dorsal aspect is liver brown with pale margins, and her chin and belly white, the latter marked with brown. (Nuttall.)

A. Americana. American Widgeon.
Mareca Americana.
Mareca Americana. Baird!

V.S.P. Bill bluish grey on the upper mandible, which is tipped with black; lower mandible wholly black; legs and feet red; irides hazel; eggs 6 to 8.

Dorsal aspect. Front and crown to the occiput white; a patch on the side of the head, including the orbits, and proceeding backwards to the nuchal crest, black, with a bronzy and sea green iridescence, and irregularly barred with white; space before the orbits, remainder of the cheek and sides of neck, white, barred with dull black; on the cheeks the white is tinged with yellow; interscapulary region and scapulars elegantly waved with fine lines of black, reddish brown, and white, the last colour only met with on the outermost of the short scapulars; long scapulars half velvet black, with a green reflection and half clove brown, bordered on the outer vane with white, with shafts of the same colour; rump clove brown with cinereous margins, finely waved with white; tail coverts black, margined on the inner vanes with white; tail cuneiform; the two long central feathers hair brown, the lateral ones cinereous, margined and tipped with white; primaries clove brown, pale in tint on the inner webs; small wing coverts crimson; speculum velvet black, inferiorly green above, bordered superiorly with black and internally with crimson white.

Ventral aspect. Chin blackish brown spotted with white; upper part of throat cream colour, minutely spotted with black, remainder of throat white, spotted black; breast and sides reddish brown, with a shining grey gloss to the feathers; belly, vent and sides of the rump white; femorals greyish white finely waved with brown; under tail coverts jet black, the centre ones brown tipped with white.

1st primary longest, the others graduated; the longest scapular subequal to the 6th primary; length 21½ inches; alar expanse 32 inches; length of bill from the frontal feathers 1 inch 8 lines. In the female, the dorsal aspect is liver brown, edged and barred with pale brown and white; the bronzy green iridescence on the head is wanting, and the tail is more rounded.

A. acuta. Pintail duck.
A. caudacuta of Richardson!
Dafila acuta. Baird!

V.S.P. Bill livid with a black ridge; legs and feet grey; irides reddish hazel; eggs, 8 to 9, greenish blue.

Dorsal aspect. Crown and front, with the occiput, umber brown, with pure brown edgings; cheeks and sides of the neck hair brown with a lavender purple iridescence on the side of the neck below the occiput; nuchal region blackish brown, divided from the hair brown side of the neck by a white stripe, which runs up from the lower half of the throat to near the occiput; anterior part of the back, interscapulary region, short scapulars and rump white, beautifully waved with transverse lines of black; long scapulars blackish green with cinereous borders, the outermost ones striped with white; short tail coverts brownish white, with a brown streak along the shaft; long coverts blackish brown on the outer vanes, brownish white on the inner vanes; wing coverts cinereous; primaries and tail quills clove brown; the shafts of the former white, and the outer vanes of the former edged with brownish white; the two long central feathers blackish green, extending more than two inches beyond the longest of the other feathers of the tail; speculum bronzy green bounded above by ferruginous, and below by white.

Ventral aspect. Chin and upper half of the throat umber brown; remaining half, breast, and belly white; sides and flanks white, waved with black like the back; vent white, minutely sprinkled with grey; sides of the rump cream white; tail coverts jet black, half of the outer vanes of the outermost ones white.

1st primary longest; 2nd subequal; length 29 inches; alar expanse 36 inches; length of bill from the frontal feathers, 2 inches and 2 lines. In the female the two long tail feathers are wanting, together with the wavy flanks and sides, and the speculum wants the bronzy gloss; her dorsal plumage is brownish black, with a spot on each side of the shaft, with borders of reddish white. The speculum is wholly deficient in the young bird.

A. sponsa. Wood duck.
Dendronessa sponsa of Richardson and Swainson!
Aix sponsa. Baird!

V.S.P. Bill red, a stripe on the ridge, its tip and its margins black; lower mandible wholly black; legs and feet orange; irides red; eggs 12 to 13 yellowish white.

Dorsal aspect. Crown of head and space round the eyes deep sea green; a stripe from the projecting base of the bill to the crest, and another from above the auriculars to the crest white; the iridescence from the eye to the crest is bronzy, and on the cheeks purple and reddish purple; a crescent from the auriculars to the chin, and another on the side of the throat, white, below which crescents the plumage is deep purplish black; nuchal crest, composed of bronze, deep purple, purplish red, sea green, and white hair like feathers; interscapulary region and rump bronze; tail coverts bronzy green, the lateral ones hanging gracefully over the side of the tail in a hair like manner; short scapulars jet black, with a faint bronzy reflection; long scapulars half black and half bronzy green; long scapulars half black and half purple;

wing coverts einereous, the lower internal ones with a purplish iridescence; speculum purplish blue, tipped inferiorly with white, and bordered internally with bronze; tail feathers blackish green, the form of the tail round; primaries hoary white on the outer vanes; clove brown on the inner vanes, which are also tipped with purple.

Ventral aspect. Chin and upper half of the throat white, remainder of the throat and breast bright glossy chesnut brown with terminal triangular spots of white; belly and vent white; shoulders with a crescent of white, the feathers of which are broadly tipped with jet black; sides yellowish brown, elegantly waved with blackish brown; flank yellowish grey finely waved with black, the tips of the long feathers broadly barred with white and black; sides of the rump purplish red; axillaries white, barred with blackish brown; tail feathers bronze; inner aspect of the wings cinereous.

2nd primary longest; 1st longer than the 3rd; length 20 inches; alar expanse 28 inches; length of bill from frontal feathers 1½ inch.

The female has the head and crest and a white patch round the eye brownish; the wavy lines on the flanks and the pendant tail coverts are wanting; the crest is shorter, and on the whole the plumage is less vivid.

Sub-genus Clangula.

Sub-gen. Char. Bill short, narrow at the base, not much elevated, slightly curved or scolloped from the base to the curve at top; nostrils suboval and subcentral; tail moderately long.

A. albeola. The Spirit duck.
Clangula albeola. Richardson and Swainson!
Fuligula albeola. Bonaparte!
Anas bucephala of Pennant!
Bucephala albeola. Baird!

V.S.P. Bill blueish black, yellowish at the tip; legs and feet yellow; irides yellow; eggs unknown.

Dorsal aspect. Crown of head and sides of neck glossy reddish purple; front, cheeks, and lower part of crest on the nuchal region, dark green; a broad band from the eye to the occipital crest, and lower part of the neck at its sides and back, white; interscapulary region, long and inner short scapulars, rump, and primaries, black; outer scapulars, and outer wing coverts, white, the former fringed with black; speculum white; tail coverts blackish grey; tail hoary blackish grey, edged with brownish white.

Ventral aspect. Chin and upper half of the throat splendent reddish purple; lower half of the throat, breast, sides, and flanks, white; belly, vent, and tail coverts, glossy greyish white.

1st and 2nd primaries subequal and longest; length 19 inches; alar expansiou 20 inches; length of bill from the frontal feathers 1 inch and 1 line; length of tarsus, middle toe and nail, 3 inches 4 lines.

The female is smaller. Head and dorsal plumage dark blackish brown; fore part of back, scapulars and tertiorus edged with yellowish brown; fore part of neck, sides, flanks, and vent, blackish grey; breast and belly white,glossed with browish orange; lower coverts blackish brown. The young males resemble the females. "Individuals vary much in size." Nuttall. This bird is not uncommon, and it is without exception one of the loveliest of the tribe met with in this district. None of them are more difficult to kill on the water, diving with the greatest rapidity on the least noise, whether from the pull of the trigger or other causes.

A. clangula. Golden eye.
A. glaucyon. Young bird of Pennant!
Fuligula clangula of Bonaparte!
Clangula vulgaris of Leach and Fleming!
Bucephala Americana. Baird!

V.S.P. Bill black; legs and feet orange yellow; irides golden yellow; eggs 7 to 10, white.

Dorsal aspect. Frontlet dull blackish brown; crest, crown, nuchal region, cheeks, and sides of neck, splendent dark green; lower half of the neck white; interscapulary region, long scapulars, outer wing coverts, rump, and primaries, black; long outer scapularies white; outer short scapulars white, with a streak of black; inner wing coverts and speculum, white; tail coverts black; tail hoary greyish black. A round patch before and below the eye, and at the base of the bill, and a spot on the auriculars, white.

Ventral aspect. Chin, and upper third of the throat, blackish brown; remainder of throat, breast, belly, and sides, white; vent feathers greyish black, tipped with white; tail coverts greyish black, broadly margined and tipped with white; flank feathers white, margined with jet black on the upper vanes.

2nd primary longest; 1st next; length 22 inches; alar expanse 29 inches; length of bill from the frontal feathers, 1 inch 4 lines. The female resembles that of the *A. albeola*. The white patch in the cheek does not make its appearance until the second year. The trachea of this species presents a singular conformation in the male.

A. histrionica. Harlequin duck.
Fuligula histrionica. Bonaparte!
Clangula histrionica of Leach, Richardson, and Swainson!
Histrionicus torquatus. Baird!

v.s.p. Bill bluish black, orange red at the tip; legs and feet blackish brown; irides hazel; eggs 12 to 14, white.

Dorsal aspect. Space between the eye and bill, a spot on the auriculars, a streak on each side the nuchal region, collar at the base of the neck, a transverse stripe on the shoulders, the outer vanes of the scapulars, white; a stripe from the base of the bill to the occiput bluish black, bounded on the sides by a stripe of chestnut, commencing over the eye, and meeting on the occiput; the remainder of the head and neck dark plumbeous blue; commencement of back and shoulders dull blue; interscapulary region, rump, and wing coverts, blackish brown; tail coverts blackish green, as well as the speculum; tail acuminate, hoary blackish brown; primaries blackish brown; the white on the shoulders bounded by black.

Ventral aspect. Chin and throat bluish black; breast bluish slate colour; belly, vent, and tail coverts, dark blackish brown; sides and flanks chesnut, faintly barred with black; sides of the rump bluish black.

1st primary longest, the others graduated; length 18½ inches; alar expanse 26 inches; length of bill from the frontal feathers 1 inch 1 line; length of the middle toe, tarsus and nail, 3½ inches.

Sub-genus Oidemia.

Sub-gen. Char. Bill broad; gibbous above the nostrils, with dilated margins; teeth lamelliform and coarse; nostrils central, large, oval; tail short for the size of the bird.

A. perspicillata. Black or surf duck.
Fuligula perspicillata of Bonaparte!
Oidemia perspicillata of Richardson and Swainson!
Pelionetta perspicillata. Baird!

D.C. Bill reddish orange; the nail paler; a square black spot on the lateral protuberance; legs orange; the webs blackish brown; irides yellow; eggs 4 to 6, white.

Dorsal and ventral aspect. Velvet black, with a reddish reflection; a broad white band between the eyes, and a triangular patch of the same on the nape; throat brownish; no speculum; female sooty brown, whitish near the bill and auriculars.

Length 24 inches; the wing 9½ inches; the bill above, 1 inch 4½ lines; tarsus 1 inch 3 lines. This bird is occasionally met with. A specimen exists in the museum of the Natural History Society.

A. fusca. Velvet duck.
Fuligula fusca of Bonaparte!
Oidemia fŭsca of Richardson!
Melanetta velvetina. Baird!

V.S.P. Bill, protuberance, posterior part of the upper mandible, margins, and a spot at side of the tip, black; the rest orange; legs scarlet, with black webs; irides pale yellow; eggs 8 to 10, white.

Dorsal aspect. Blackish brown, of a velvety hue and feel; a crescent of white on the lower eyelid, extending behind the eye; speculum white.

Ventral aspect. Throat and breast blackish brown, and velvety like the back; belly, vent, and sides, sooty brown,—brightest on the sides.

1st primary longest; length 24½ inches; alar expanse 38 inches; length of bill from the frontal feathers, and along the protuberance, 1 inch 10 lines; from the rictus to the tip 2 inches and 10 lines.

A young bird in the museum of the Natural History Society is wholly sooty brown, with greyish white on the auriculars, lower eyelid, and on the toes. It measures 21½ inches long, and its bill is wholly black, and the protuberance but very slightly elevated. This bird is common in the spring of the year.

Sub-genus Harelda.

Sub gen. Char. Bill short, tip much arched, high at the base; laminæ distant, prominent, and cutting, lower ones divided into two rows; nostrils sub-basal, large, and oblong; tail long and tapering.

A. glacialis. Long-tailed duck.
Harelda glacialis of Richardson and Swainson!!
Fuligula glacialis of Bonaparte!
Anas caudacuta harelda of Ray!
' *Harelda glacialis.* Baird!

V.S.P. Bill black, with an orange transversal band near the tip; legs and feet dusky; irides red, approaching to hazel; eggs 5, pale greenish grey.

Dorsal aspect. Frontlet, crown, and cheeks, dusky drab,—lightest on the crown, and darkest on the cheeks; auriculars black, this colour descending down the sides of the neck in the form of an irregular broad patch; remainder of the neck to the interscapulary region white; interscapulary region, rump, and wing coverts, shining black; long and short scapulars ashy white, the long scapulars hanging gracefully over the wings; four central tail feathers black, and very long; the four adjoining ones on each side cinereous along the shafts, broadly margined with white, the other lateral ones wholly white; central tail coverts black; lateral tail coverts white on the outer vanes, and black on the inner vanes; primaries blackish brown, secondaries brown, the tips of the latter forming a shining brown speculum.

Ventral aspect. Chin and throat white; breast and half of the belly black; remainder of the belly, vent, and sides of the rump, white; sides and flanks greyish.

2nd primary longest; 1st next. and subequal to the 2nd; length 23 inches; alar expanse 29 inches; length of bill from the frontal feathers 1 inch and 2 lines.

The female has the tail short; a spot on the throat and eye-bands, white; crown of head blackish; breast varied with ash and brown; and the feathers of the back black, margined and tipped with ashy rufous; the irides pale brown. "Nuttall."

Sub-genus Fuligula.

Sub-gen. Char. Bill long, broad and flat, gibbous at the base, and more or less dilated at the extremity; nostrils basal, oval.

A. ferina. The Pochard, or Red-headed duck.
Fuligula ferina of Stephens!
Aythya Americana. Baird!

V.S.P, Bill greyish blue, with a black tip; legs and feet black; irides reddish hazel; eggs 12 to 13, greenish white, Dorsal aspect. Whole head and two-thirds the neck rich chesnut, with a reddish iridescence; remainder of neck and commencement of back, with the shoulders, black; interscapulary region, rump, and short scapulars, finely zigzag waved with clove brown on a white ground; inner long scapulars grey, with a reddish iridescence; outer margin of the external long scapulars black; tail coverts blackish brown; tail hoary greyish ; wing coverts grey, faintly sprinkled with white; primaries pale grey, tipped with clove brown, which is also the colour of the outer vane of the two first primaries; speculum whitish grey, fringed with white inferiorly,

Ventral aspect. Chin and throat like the dorsal aspect; remainder of the throat and breast black, fringed with white as it approaches the belly; belly pure white; vent white glossed with chesnut, and with faint wavy lines of grey; tail feathers brownish black; sides and flanks waved with clove brown on a white ground.

1st primary longest; length 21¼ inches; alar expanse 30½ inches; length of bill from the frontal feathers 2 inches 1 line. The bill of this bird is recurved.

The female is liver brown, with pale edgings, and the chesnut of the head is margined with yellowish brown. The white of the ventral aspect is tinted with grey.

A. Labradorica. Labrador duck.

Fuligula Labradorica. Anderson!

Camptolæmus Labradorus. Gmel.! Gray! Baird!

V.S.P. Cire flesh colour; remainder of bill blackish horn colour; tarsi and irides yellow.

Dorsal aspect. With the exception of a streak of black stretching from the base of the bill to the occiput, and a very light brown streaky stain stretching from the cire to below the ear, all the rest of the head, with the secondaries, pure white; remainder of the back black; tail, which is rather acuminately rounded, blackish brown; the distal third of the outer edge of the outer scapulars coloured with black, and the whole of the inner vanes of the inner half dusky, terminating in blackish, giving to the under surface of the wing a dusky appearance; the primaries are all dusky black; the feathers on the cheek have a bristly feel; in other parts of the head and neck the feathers have a velvety feel, a good deal resembling that of the Great Northern Diver.

Ventral aspect. A belt of white across the breast until it touches the wing, and separated from the white of the head by a ring of black about half an inch broad; remainder of breast black, quickly changing to blackish, which itself changes to brown on the abdomen and under wing coverts; the flanks, like the lower part, of the breast, are shining black.

Length, from tip of bill to apex of tail, 20½ inches; alar expanse 27½ inches; the two first primaries longest and subequal.

A specimen of this beautiful duck, the first which I have seen, was shot in the bay of Laprairie this spring (1862) by a *habitant*, and was purchased by Mr. Thompson of this city, who has kindly placed it at my disposal for examination, I believe it to be one of the rarest of our visitants of this species, and to demonstrate that an acquaintance with our Fauna must be a work of many years.

A. marila. Scaup duck.
Fuligula marila of Stephens and Bonaparte!!
Fulix marila. Baird!

V.S.P. Bill greyish blue; nail black; legs and feet blackish brown; irides yellow; eggs unknown.

Dorsal aspect. Frontlet black; all the other parts of head and upper part of neck glossy dark green; remainder of neck, commencement of back, shoulders, rump, and tail coverts, black; interscapulary region and scapulars finely waved with zigzag lines of clove brown on a white ground; long scapulars glossy blackish green; wing coverts hair brown, the inner ones finely waved with white; primaries hair brown, paler on the inner webs; speculum white, bounded superiorly, inferiorly, and internally by glossy blackish green.

Ventral aspect. Chin and throat brownish black; lower half of the throat, breast, and sides of the rump, black; belly white; vent white, waved with clove brown; sides white; flank feathers waved with clove brown near the tips; tail coverts brown.

1st primary longest, the rest graduated; length 20½ inches; alar expanse 30 inches; length of bill from the frontal feathers 1 inch 10 lines. The female has the head and neck blackish brown; lower part of the neck, breast, and rump, dark brown. The young males resemble the female.

A. rufitorquis. Ring-necked duck.
Fuligula rufitorquis of Bonaparte!
Anas fuligula of Wilson!
Fulix collaris. Baird!

V.S.P. Bill black, except a line round the base, a belt near the tip, and the rictus, which are light blue; legs and feet blackish brown; irides yellow; eggs unknown.

Dorsal aspect. Frontlet blackish brown; crown, cheeks, upper part of neck, and nuchal region, black, with a violet purple iridescence; collar round the neck dark chesnut; remainder of the neck, shoulders, interscapulary region, rump, and tail coverts brownish black, with a minute sprinkling of white on the scapulars; wing coverts and tail brown; primaries blackish brown, paler on the inner webs; long scapulars blackish green; speculum blueish ash, bounded superiorly and internally by blackish green.

Ventral aspect. Chin white; throat to the collar blackish brown; breast black; belly white; vent, sides, and flanks, white, waved with zigzag lines of clove brown; sides of the rump and tail coverts brownish black.

1st primary longest; length 18¼ inches; alar expanse 26 inches; length of bill from the frontal feathers 2 inches 2 lines. In the female the dorsal plumage is dark brown edged, as also on the breast, with chesnut.

Genus Mergus.

Gen. Char. Bill moderately long, slender, and straight, suddenly narrowing from a broad base, the edges serrated, and with subulate and sharp teeth inclining backwards; nostrils lateral and subcentral; tongue short and subulate, with recurved papillæ; legs short, placed far back on the abdomen, with full webs; hind toe touching the ground at its tip, and furnished with a membrane.

M. serrator. Red-breasted Merganser.
M. serrator. Baird!

V.S.P. Bill brownish on the ridge, orange at the sides, and on the lower mandible; legs and feet red; irides red; eggs 8 to 13, bluish white.

Dorsal aspect. Head and neck jet black, with dark green iridescence; occipital crest black, composed of long slender feathers; collar round the throat white, with a black mesial nuchal line; remainder of the throat chesnut brown, the feathers bordered with black; interscapulary region, short, and inner long scapulars, jet black; rump grey, waved with irregular lines of white; tail coverts cinereous, with pale edgings; tail hoary greyish brown; shoulders white, the feathers broadly edged with jet black; outer short scapulars, inner wing coverts, and outer long scapulars, white, the latter bordered with black on the outer vanes; speculum white, crossed with black; primaries blackish brown.

Ventral aspect. Chin and upper part of the throat to the white collar, velvet black; breast chesnut brown, the feathers margined with black; belly, vent, and tail coverts, white; sides, flanks, and sides of the rump, white, elegantly waved with zigzag lines of black.

1st primary longest; length 25½ inches; alar expanse 32 inches; length of bill from the frontal feathers 2 inches 4 lines. The female differs very little from the male.

M. cucullatus. Hooded Merganser.
Lophodytes cucullatus. Baird!

V.S.P. Bill, legs and feet, blackish red; irides red; eggs 6, white.

Dorsal aspect. Frontlet, crown of the head, blackish brown; occipital crest large, white tipped with blackish green, the white coming behind the orbit, and forming a triangular space, the apex of which is the eye; sides of the neck, nuchal region, and short scapulars, black, with a deep sea green iridescence; long scapulars sea green black, with a stripe of white; rump and interscapulary region brownish black; tail coverts blackish brown, edged with brown; tail long, brownish black; shoulders with two broad bars of black and white; primaries clove brown, paler on the inner webs; small wing coverts cinereous; great wing coverts grey; speculum white, with two black bars.

Ventral aspect. Chin and throat blackish green; breast, belly, and vent, white; sides and flanks chesnut brown, waved with black; sides of rump brown; tail coverts greyish-white, sprinkled with brown.

2nd primary longest; 1st longer than the 3rd; length 21½ inches; alar expanse 28 inches; length of bill from the frontal feathers 1 inch 11 lines.

M. Merganser. Gooseander.
M. castor of Gmelin, Latham, and Finch ! ! !
Mergus Americanus. Baird !

V.S.P. Bill black on the ridge, vermillion on the sides, and horn colour on the tip; legs vermillion colour; irides red; eggs, 10 to 14, white.

Dorsal aspect. Head and upper part of the neck blackish green, with a purplish green on the cheeks and a verditer green on the neck; lower part of neck white; anterior part of the back and inner short scapulars jet black; interscapulary region, rump, and tail coverts, bluish ash, the rump feathers tipped with white; tail hoary cinereous; primaries blackish brown, paler on the inner webs; secondaries white; great and small wing coverts white, the latter tipped with black.

Ventral aspect. Chin black, with a purple iridescence; upper part of neck blackish green; lower part of neck, breast, belly, vent, central tail coverts, and sides, white, glossed with flesh colour; flanks and sides of the rump cinereous, speckled and barred with white; lateral tail coverts white, sprinkled with crimson on the outer vanes.

1st primary longest; length 27 inches; alar expanse 34 inches; length of bill from the frontal feathers 2 inches 3 lines; length of middle toe, tarsus, and nail, 5 inches 9 lines.

A bird before me in the act of moulting, presents brown feathers, appearing through the blackish green ones of the crown and sides of neck; and white ones through the purplish black of cheeks and chin; and the outer scapulars cinereous. Ashy feathers through the white ones of the neck; but in all other respects resembling the perfect specimen described.

In the female the head and neck is rufous brown, with the exception of the belly and vent, which are white tinged with flesh colour; all the other parts which are white in the male are ashy, and the dorsal aspect generally is ashy, tipped with white. The young birds precisely resemble the female.

ARTICLE XL.—*Notes on some of the habits of the pine-boring beetles of the genus Monohammus.* By E. BILLINGS, F.G.S.

(Read before the Natural History Society of Montreal, 24th Nov., 1862.)

The number of insects inflicting injuries upon forest trees by feeding upon the roots, bark, wood, or leaves, is much greater than is generally supposed. Entomologists have ascertained that nearly two hundred species prey upon the English oak alone. In Canada, where there are such vast forests of so many different kinds of trees, there must be quite a multitude of the wood-destroying tribes to occupy the attention of the naturalist. To work out the history of these, is, to us Canadians, a labor of something more than mere scientific importance; for there are few countries whose commercial prosperity depends so largely upon the growth of native woods. Full one fourth of the total value of our export trade is derived from the forests, and there is usually about one tenth of the whole province under license from the government to the lumberers for the purpose of making timber.* Besides this there are great tracts of land covered with wood of commercial value, in which, the sound of the lumberer's axe has never yet been heard. How long this great source of national wealth is to remain unexhausted, and what are the causes which may some day put an end to so important a branch of our commerce, are subjects well worthy of serious consideration. It belongs to Canadian Entomologists to give an answer to one of the several questions that must be discussed during the investigation. I do not profess to know enough of the science to class myself in that body of observers; but having lived many years in the valley of the Ottawa where there are extensive forests of pine, I have paid some attention to the habits of several of the most prominent of the wood-destroying beetles. I shall this evening give a short account of some of the species, although I do not feel quite sure that Entomoligists will think my remarks of much value.

It appears that in Canada we have four species of beetles belonging to the longicorn genus *Monohammus*.

The largest, and apparently the most abundant of these is *Monohammus confusor*, a magnificent insect, and very destructive to the several kinds of pine timber of this country. The length, exclusive of the antennæ, varies from three fourths of an inch to one inch and a half, the majority of the individuals being about thirteen lines. The antennæ of the males vary in length from one and a half to three inches; the female is about the same length as the male, but her antennæ are always shorter and her body broader. When very perfect, these insects are of a light ash-grey color, with a few dark brown spots. The grey colour is due to a coat of very

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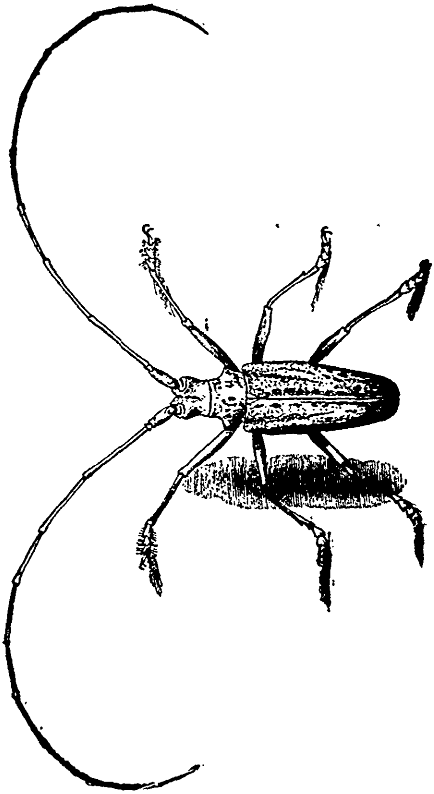
*By a reference to the trade returns for the year 1861, it will be seen that our total exports during that year, amounted to $36,614,195, and of this sum the products of the forest made up $9572,645, or somewhat more than one fourth of the whole. Mr. Langton, (Auditor General) says that in 1860 the quantity of land licensed by the government to lumberers, was "27,413 square miles, or 17,544,320 acres." See an interesting article by JOHN LANGTON Esq., (Auditor General) "*On the age of timber trees and the prospects of a continuous supply of timber in Canada.*" Trans. Lit. and Hist. Soc. of Quebec, vol. 5, page 61, May 1862.

fine short light hairs. When these are rubbed off, the head and thorax are seen to be nearly black and smooth and shining, the thorax being scarcely at all punctured. The elytra, when deprived of the hairs becomes of a horn colour, darkest near the thorax, and covered with small punctures. Some specimens are almost entirely destitute of the dark brown spots. and in general the number and size of these marks vary a good deal. On each side of the thorax there is a short broad-based spine. The antennæ consist of eleven joints, the second of which is very short, and the first much thicker than any of the others. This species is found in all parts of Canada where there are pine trees, and Dr. LeConte says it is abundant at Saratoga in New York.* A specimen has lately been caught flying in the streets of Philadelphia.†



Monohammus confusor, male (the first joint of all the *tarsi* is too short in the figure.)

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* Le Conte, Jour. Acad. Nat. Sci. Philadelphia, 2d Sec. Vol. 2, p. 148.
† Trans. Entomlogical Society of Philadelphia, Vol. 1, p. 98.

Next in order is *Monohammus scutellatus* (Say), which is about one fourth smaller than *M. confusor*, and can always be readily recognized by its dark, nearly black, shining bronze colour; some of the individuals having a few irregular spots of yellowish white scattered over the surface. The thorax and elytra are rugose, with large transverse punctures, or rather short confluent wrinkles distinctly visible to the naked eye. The scutellum is white, the thorax armed with a short spine on each side. The length of this species is usually eight or ten lines, but individuals of from five to eight lines are occasionally met with. The antennæ are from three fourths of an inch to two inches in length.

This species, although not so abundant as *M. confusor*, appears to have a more extensive geographical distribution. It occurs in all parts of Canada, and it is found also in Nova Scotia, and in the Hudson Bay territories, northward to the Arctic regions. Mr. Couper says it was taken by Sir John Richardson at Fort Simpson on the Mackenzie River, in lat. 62° N*. Mr. D'Urban says it was procured by Mr. Barnston, from Great Slave Lake, in lat. 54 N.†

The third species is *Monohammus marmoratus*, (Randall). It is described by Le Conte as being very much like *M. confusor*; the principal difference consisting in the markings of the thorax, which is closely covered with large rugose punctures, while in *M. confusor* this part is not punctured. The antennæ are black, and in the female annulated with ash-grey. The elytra are quite scabrous at the base from elevated points." Le Conte now unites with it *M. maculosus*, (Haldimand) and his own two species, *M. mutator*, and *M. futuor*; the first of the latter two described in Agassiz's Lake Superior, and the last in the Jour. Acad. Nat. Sci. Phi.2d Ser. Vol. 2, p. 148. It is abundant at Lake Superior. I have never seen it; and if it occurs in the valley of the Ottawa, it must be very rare.

The fourth species is *Monohammus titillator*,‡ (Fabricius), Mr. Couper cites it as occuring at Toronto, (Canadian Journal, 1st Ser. Vol. 3. p. 212.) It is also given in Mr. Ibbetson's list of Canadian Coleoptera, at page 326 of the same volume. As neither of these two entomologists mention *M. confusor*, and as the original spe-

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* Couper in Canadian Journal, 1st Ser. Vol. 3, p. 212.

† D'Urban in Canadian Naturalist Vol. 5, p. 227.

‡ In the new edition of Harriss' Insects this species is figured with thirteen joints in the antennæ.

cimen on which the species *M. titillator* was founded is an insect from the Southern States, it may be that they have applied the name to our most common and largest species. This question however, remains to be decided by further observations.

There are in the collection of McGill College three specimens from Toronto, of the size of the smaller individuals of *M. confusor*, which have a light reddish tinge different from the usual colour of that species. I have also seen several specimens from Lake Simcoe, in the collection of Capt. Rooke of the Scots Fusilier Guards, which seem to be of the same colour as those of McGill College. I have never seen this variety in the valley of the Ottawa, and it may be peculiar to the western part of the province. Whether or not it will constitute a distinct species, remains for our entomologists to determine.

The first two of these species, *M. confusor*, and *M. scutellatus*, attack and destroy great quantities of pine timber. No doubt the other two species do also prey upon the pines, but I have never yet observed them; and, in fact, they appear to be either rare or of a limited geographical distribution. The trees attacked by them are the white or Weymouth pine, (*Pinus strobus*) and the red pine, (*P. resinosa*) the two most valuable timber trees of Canada. The female *Monohammus* during the summer and autumn lays her eggs in crevices in the bark both of the standing trees, and of those which are dead and lying on the ground. The larva, after being hatched, soon acquires strength of mouth sufficient to enable it to work its way deeply into the wood. There it remains about a year, boring a long winding gallery nearly half an inch in diameter, sometimes into the very heart of the tree. As the time approaches for its final transformation, it turns, and works outwards towards the surface; just before reaching which it enters the chrysalis state. When the perfect beetle is developed, it soon, with its powerful mandibles, gnaws a passage for itself to the open air. I am of opinion that the insect does not come out as soon as the opening is made, for I have often seen them lying quite motionless in their burrows, with the head just peeping through. In this position the antennæ are not visible, as they are laid back on the sides of the body. On the 20th of July, 1860, while crossing Mount Royal, I noticed in a fallen pine tree, on the top of the mountain, several burrows in the bark, which had been lately opened, and were empty. On examining further, I found three others, with the head of a *M. confusor* filling each; on being touched they withdrew a short distance, but not out of sight. With the point of my geological hammer I soon stripped off the bark, and extracted all three. It seems improbable (although it is possible) that they all arrived at the surface at the same time. It is more probable that after the opening is made, the insect remains for a while, perhaps for a couple of days, in its burrow, until its elytra become consolidated. Although I have often found large white or yellowish larva, deep in the body of pine trees, I have never been able to ascertain to what species they belonged. This and many other questions relating to the natural history of these insects, remain to be decided by the researches of our entomologists.

These insects attack dead timber, and also trees which have received some injury, and are in an unhealthy condition. I have never seen the female laying her eggs on a perfectly healthy and sound pine tree. Timber newly fallen is always attacked by them. The first dwellings constructed in the new settlements are generally made of logs with either the whole or a portion of the bark remaining on them. The inside is not plastered, except in the crevices between the logs; if these latter happen to be pine, the *Monohammus* lays her eggs in the bark, on the outside of the house, and for months afterwards the larva may be heard in the stillness of night, making a noise like the boring of a small augur. The perfect insect sometimes comes out on the inside of the wall, and suddenly drops down upon the floor, the table, or the bed, to the great consternation of the inmates, who imagine that an insect with such great horns must bite or sting with proportionate severity.

For the manufacture of boards or planks, the pine trees are cut up into lengths of from 12 to 18 feet, and are either drawn or floated to the mill. The logs are got out during the winter, and if they remain in the mill-yard one season, they are invariably found to be bored through in all directions by larva of these beetles, and the boards greatly deteriorated in value. Where extensive operations are carried on, a single lumberman will sometimes have a license giving him possession of over a hundred square miles of pine forest. In the months of May and June it often happens that great fires sweep through the woods, burning up all the fallen trees and dry branches strewn over the ground, and so scorching the living pines that most of them wither at the top and die during the season. Trees thus injured are soon after attacked by both *M. confusor* and *M. scutellatus*, and within one year are so greatly bored that they are unfit for the manufacture of timber. Those experienced in the business, however, well understand the habits of the insect in this respect, and hasten to make the timber before it is destroyed. Pines scorched by the spring fires must be cut down and made into timber the next autumn. After one of these fires it generally happens there is a regular race between the lumberers and the beetles, the prize being a grove of white or red pine. I was told that Messrs. Egan & Co. lost £40,000 worth of timber by some unavoidable delay of a few months. Pine trees, when scorched, would be sound enough for timber five years afterwards, if it were not for the attacks of these formidable destroyers.

Where there are only a few pines, as in the neighborhood of this city, it is rare to meet with more than one or two of these beetles together. But in the great forests of the Ottawa it is not unusual to find 15 or 20 on a single tree. On one occasion I saw an extraordinary number, and entered an account of the circumstances in my note book on the spot. It was on the 11th day of September, 1857. I was at that time making some geological observations in the neighbourhood of Lake Clear, in the county of Renfrew. Following an old lumber road through the woods, I came to a place which had been burned over some time during the preceding spring. There was one large white pine standing on the sunny side of a small gently sloping hill. The height of this tree was about 120 feet, and its diameter nearly 3 feet. About 30 feet at the base was scorched. It was 60 feet to the lowest branch, and as nearly as I could judge, the foliage for 20 feet at the very top, had turned yellow. The remainder was green and apparently healthy. This tree was swarming with *M. confusor*, and many of the females were occupied in laying their eggs. I think there were at least 300 of both sexes, and I saw several flying from other trees 30 or 40 yards distant. In flying, the body is not horizontal, but inclined at an angle of only 15° or 20° from the perpendicular. The insects were on all parts of the tree, and they did not appear to take a firm hold of the bark, for a heavy blow with the hammer, at the base, would bring down a dozen at a time, some of them falling from near the top. While falling, they did not attempt to fly. I had 50 or 60 crawling around me at once, and had a fine opportunity to observe the very considerable variations in the size of the individuals, and length of the antennæ. When two of them going in opposite directions, met face to face, a clumsy kind of a fight took place, in which they reared up and pushed against each other, until one or the other fell over backwards. They bit each other with their mandibles, but with no effect that I could perceive. The females fought with each other, or with the males, indifferently. There can be little doubt but that this tree was, during the next twelve months, totally destroyed. If there were 150 females, and if each laid 200 eggs, and half of these produced a healthy larva, then in one year this tree must have been perforated by 15,000 galleries. I examined other trees in the neighbourhood, and on a few only did I see any of the beetles, usually from one to four or five on each. I can only account for the preference given to this particular tree, by supposing that it was in a better condition for the nourishment of the larva than the others, and that the instinct of the females directed them to it. It is probable that nearly all the females for a considerable distance around were thus brought together on one tree, and were followed by the males.

I cannot say whether or not these insects ever attack a perfectly healthy and sound tree. I think they do not; and yet their ravages are certainly highly injurious to the commerce of this country, as they destroy a vast deal of the fallen or scorched timber, which otherwise might be brought to market at any time during several years after the trees have received their death-blow by fire or storm. I think also that thousands of the trees, only sufficiently injured by fire to throw them for a while into a weakly or unhealthy condition, would recover were it not for the attacks of these formidable creatures.

The beetles of the genus *Monohammus* are, as is well known to entomologists, assisted by many species of other genera in the work of destroying pine trees. Canadian naturalists who have selected the wonders of the insect world for their study, have before them a vast and little-wrought field. In an interesting paper on the trees of Canada, by our colleague, Mr. Robb, it is said that Canada produces " about seventy kinds of timber trees, of which, at present, we make profitable use of not more than eight or ten, the rest being left to absolute decay. Her forests extend over about 360,000 square miles; and are unrivalled throughout the world for the variety of species, and more particularly for the size of the timber of full growth. Of sixty-four samples sent to the Paris Exhibition of 1855, by Mr. Andrew

Dickson, of Kingston, one half were collected from an area of one hundred acres. The trees which we find most generally in our woods are the oak, beech, maple, iron-wood, elm, birch, ash, pine, hemlock, tamarack, cedar, poplar, and bass-wood. All these trees attain to a considerable size, and grow to a greater or less extent, in all parts of Canada, except on the coast of Labrador, where the only trees that thrive are the white birch, the fir, spruce, beech, and one of the varieties of pine. The trees of smaller growth common to all the country are the hickory, willow, alder, wild-cherry, dog-wood, sassafras, and a few others. The black-walnut, tulip-tree, and chesnut are confined exclusively to the western peninsula. Oak and elm are more abundant and of better quality in Canada West than in the eastern part of the province; but all the other woods attain greater perfection in Canada East."* Now all these trees have their own species of insect persecutors. How many species prey upon each tree? When does each species deposit its eggs, and in what part of the tree? when is the larva produced, what is its form, and upon what part of the tree does it feed? how long does it remain in the larval state? what is the form of the chrysalis,and when does the imago appear? and lastly,is there any method of protecting the tree? When all these questions shall have been answered, our entomologists, of which we have now a few good men and true, will have performed a great work. It seems almost impossible to protect a forest against an insect foe, but who knows what may be achieved by patient study? By accumulating facts, sooner or later, a means of protection may be discovered. At all events, when our interests are threatened by an enemy, it is well to know all about him, his numerical strength and the plan of his operations; without knowing these we can never hope to discover his weak points.

ARTICLE XLI.—*Zoological Classification; or Coelenterata and Protozoa, versus Radiata.*

The recent appearance of the fourth volume of Agassiz's magnificent contributions to the natural history of North America, and of various manuals, text-books, and articles, on the sub-divisions of the *Radiata* of Cuvier, have forcibly attracted our atten-

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**Descriptive list of the principal Canadian Timber Trees.* By CHARLES ROBB, C. E. Canadian Journal, 2nd Ser., Vol. 6, p. 29.

tion to the state of the classification of these creatures, and the changes recently proposed in it.

We are not *specially* zoologists, but have devoted some attention to the subject in its relations to geology, and as interesting in itself, as well as in connection with the teaching of its elements to students. We speak, therefore, as addressing zoological specialists from without their own circle, and desire to do so with all the humility becoming this exoteric position.

A number of zoologists have lately added to the Cuvierian fourfold division of the animal kingdom, two new types of *Protozoa* and *Coelenterata*, the former being probably more widely accepted than the latter, though it also is supported by some high names. We have not been able to convince ourselves of the necessity of either of these groups, in the rank assigned to them; and, on the contrary, fear that their establishment will tend to confuse our conceptions of the natural subdivisions of animals.

The group of *Protozoa* is confessedly distinguished from the others merely by negative characters,—by deficiency of important systems of organs, as of nervous system and organs of sense. It cannot, therefore, be regarded as embodying a type of structure distinct from those of the *Radiates*, *Mollusks*, and *Articulates*, but rather as embracing all the creatures which are so simple that we cannot recognise in them any distinct type. It is obvious that such a group, however convenient, cannot be recognised as coordinate with the others above named, and that it must be merely provisional, containing animals whose affinities have not yet been ascertained, and which may be humbler members of one or all of the other recognised types. The real question as to the position of these creatures is this.—Can we ascertain their affinities? If we can, let us place them in their true relations. If not, let us admit that they do not consitute a veritable sub-kingdom, but merely a residuum which we are unable to classify.

Regarding, with Carpenter, the *Protozoa* as consisting of *Rhizopoda*, *Porifera*, *Infusoria*, and *Gregarinida*,* it is at once apparent: (1.) That all these creatures, in point of simplicity of structure, are as low as, or lower than the humblest members of the other invertebrate kingdoms. (2.) That they do not present, in any distinct form, the types of structure characteristic of these sub-kingdoms. (3.) That many of them strongly resemble the

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* These latter may possibly be humble *Entozoa*.

embryonic or immature stages of certain *Radiates*, *Mollusks*, and *Articulates*. These statements being admitted, it remains to enquire whether the balance of affinities inclines to one rather than to the others of these provinces or sub-kingdoms.

The great difficulty here is to find any distinct type of structure in these humble creatures, and some of the naturalists best acquainted with them hold that no such affinities are to be discovered, while others appear to think that their affinities would place them at the base of more than one province. In these circumstances, we are more likely to be guided aright by a consideration of the general principles of classification, than by that minute search for distinctions with which zoologists are more familiar.

To any philosophical student of animals, it must be apparent that our primary divisions or types are based on considerations of general form, and of the arrangements of the nervous system, and organs of support. On the first of these grounds alone, we must of necessity divide animals into but two groups of *Radiata* and *Bilaterata;* on the second, it is equally apparent that we must have two groups of *Vertebrata* and *Invertebrata*.

There has been of late a tendency among many naturalists to deny or overlook the fact that many of the lower animals present, in the words of Agassiz, "a vertical axis, around which the primary elements of their structure are symmetrically arranged," while the main axis of the body cannot, as in the other animals, be regarded as a horizontal one, with corresponding parts on its two sides. But nothing can be more illogical than to overlook this general radiated arrangement, because some subordinate parts present traces of bilateral symmetry. It is a mere forcing of nature within the bonds of an arbitrary system. It would be quite as reasonable to deny the prevalence of radiation from an axis or centre in plants, because a is bilateral; or to maintain that a cuttle fish has no bilateral symmetry because its arms spread from a centre; or that a man is a radiated animal, because the iris of hiseye is radiated. The *Radiata* constitute a division of animals asnatural on one ground, as the *Vertebrata* do on another.

Vertebrates, again, differ from *Invertebrates*, in the grand distinguishing point of the separation of the principal masses of the nervous system from the general viscera, in a distinct chamber above the centres of the system of support.

If we separate the *Vertebrates* on the one hand, and the *Radiates* on the other, there remain the *Mollusks* and *Articulates*, groups as markedly distinct from each other, as from the other provinces. We may thus obtain by a somewhat different process from that usually employed, the fourfold Cuvierian classification into sub-kingdoms, and this without leaving any distinct place for the *Protozoa* as a group of this rank.

Let us next inquire if the *Protozoa* may rank as a class. Agassiz has well shown that our classes, orders, &c., in zoology are not arbitrary or accidental, but based on the relations of our own minds to the actual order of nature. Classes, he maintains, are formed on the manner in which the plan or type embodied in the province is carried out, so far as ways and means are concerned; and we may add, of course, with a reference to uses or objects. It seems to have occurred to him that this implies a certain and definite number of classes to each province, for he has but three in each of his invertebrate provinces; though he subdivides more minutely in the vertebrates, deviating in this, as it appears to us, from the large general view which he has himself expressed.

In the *Vertebrates* four classes have commended themselves to the common sense of mankind,—the mammals, birds, reptiles, and fishes; and while it is easy, for example, to subdivide the reptiles into two groups, or the fishes into several, these have obviously respectively a less value than the mammals and birds, and consequently cannot be classes. What, then, are the *ways*, *means*, and *ends* involved in the vertebrate sub-classes? They are as follows: 1st. The mammal implies reproduction without metamorphosis, and the highest development of the sensorium and of intelligence. 2ndly. The bird implies the highest development of the locomotive apparatus, and parts subsidiary to this. 3rdly. The reptiles imply development of the merely vegetative life. 4thly. Fishes embody the lowest condition of the external members and respiratory process, and of the nervous system.

A little thought may satisfy us that we cannot suppose a fifth class co-ordinate with these four, however much we may subdivide any one of them. The question remains, do the other provinces admit of more divisions, or of fewer? If truly co-ordinate with the first, they should admit of the same number, because each type is placed in the same circumstances, in respect to ways, means, and ends.

In the *Articulates* we can readily distinguish four classes, corresponding to those of the *Vertebrates:* 1st. The arachnidans, with high sensorium and intelligence, and no metamorphosis, and representing the mammalia; 2nd. The insects, corresponding to the birds; 3rd. The crustaceans, corresponding to the reptiles; 4th. The worms, corresponding to the fishes.

In the *Mollusks,* we have: 1st. Cephalopods, corresponding to arachnidans and mammals; 2nd. Pteropods and gasteropods, corresponding to birds and insects; 3rd. Lamellibranchiates, corresponding to reptiles and crustaceans; and lastly, the tunicates, brachiopods, and bryozoa present an enlarged representation of the fishes.

If the *Radiates* really constitute a natural group, they should conform to this general plan. Here we have: 1st. Echinoderms, which constitute a class, and the highest of the province; 2nd. Acalephs, the specially locomotive class; 3rd. Anthozoa, or actinozoa, or polyps, the vegetative class; and lastly, protozoa, with the lowest endowments in respect to internal parts and sensorium.

Our *Protozoa* are thus required in order to bring the *Radiates* into harmony with the other provinces; and it seems plain that the group is much nearer its true place as a class, than as a province. The question still remains, whether some of the *Protozoa* might not be more naturally placed at the base of other sub-kingdoms than those of the *Radiates*, as, for instance, the *Vorticellæ* with the *Bryozoa; Gregarinida* and some *Infusoria* with the worms. It seems likely that this may eventually be done; and that just as the *Bryozoa, Entozoa,* and *Rotifers* are now generally separated from *Radiates*, a more nice analysis of the characters of the more aberrant *Protozoa,* may enable some of them to be separated from that group.

As an additional evidence of the correctness of the view above stated, I may remark that the divisions of *Protozoa* proposed by Carpenter have much more of the character of orders than of classes, in this respect that they imply rather *gradations of rank* than different ways and means of execution. Another proof is offered by the strong resemblance of many *Protozoa* to the embryonic states of true members of the province *Radiata.*

With respect to the *Coelenterata*, the case is still more clear. The structural and embryonic evidence given by Agassiz, in his last and the preceding volume, amply prove the affinity of these creatures to *Echinoderms*, their radiated structure, and their place in the system as two of the classes of the *Radiata*.

It may be objected that these views savour of the arbitrary methods proposed by MacLeay and Swainson. If, however, there is system in nature, it must admit of some general statement; and the time must come when naturalists will be obliged, by the necessities of the case, to search for and apply such general views.

Specialists' will object that they must have more subdivisions of animals than those above admitted; but they have full scope for this in the formation of families, orders, and genera, without attempting to disintegrate our higher groups. The family, in particular, as distinct from the order, is a group of great value, and to the cultivation of which their attention might be very properly directed, more especially since the genus is fast losing its importance, from the tendency to erect every little group of species, distinguished by some minute structural peculiarity, into a new genus. Since, however, the greater part of these are clearly nothing but sub-genera, it might be well to have some arrangement which might enable them to be recognized for purposes of determination, while the grand generic unity should be maintained by retaining the name of the genus proper, in the nomenclature, with a mark or number to indicate the sub-genus.

The views thus slightly outlined are not of yesterday; but have resulted from much thought on the subject. They are, however, thrown out merely as suggestions for the consideration and criticism of naturalists, and in the hope that they may, at least in part, be found to harmonize with the true order of animal nature in its lower forms, as the progress of discovery brings this more distinctly into view.

J. W. D.

ARTICLE XLII.—*On a new Crustacean from the Potsdam sandstone.* By Prof. JAMES HALL. *A Letter addressed to Principal Dawson, dated Albany,* 31*st October,* 1862.

I have been much interested in reading your observations upon the tracks of *Limulus* in sand, and comparisons with the tracks in the Potsdam sandstone;* more especially as these observations connect themselves in a remarkable manner with a recent discovery of my own; and a question may arise as to whether you have

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* Canadian Naturalist for August, 1862.

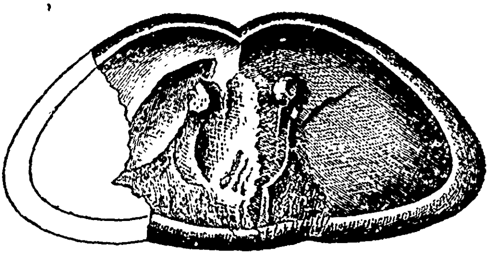
described an animal which I have found, or I have found the animal corresponding to your description. I will leave you and the scientific world to judge of the facts. However, after what you have written, I cannot now publish what I communicated to the Albany Institute last winter, without referring to your paper, and in the mean time you may lay this note before the Montreal Natural History Society, and publish it, or such parts of it, as you please.

In February last, I communicated to the Albany Institute a notice of a new crustacean from the Potsdam sandstone of Wisconsin, and subsequently I sent a drawing of the same to M. Barrande. In 1855, I obtained from the Potsdam sandstone of the upper Mississippi River, a fragment of what appeared to be a spine of a crustacean, of very remarkable and peculiar structure, reminding one of that of bone; and which might at one time, before we had accustomed ourselves to limit the geological range of fishes, have been taken for an ichthyic remain.

This fragment remained in my collection a subject of much interest, for I was aware from its structure that it could belong to no genus of Trilobites, but at the same time I did not think it worth while to publish any notice of it from its incompleteness.

In 1857, Mr. Daniels, of the Geological Survey of Wisconsin, discovered in the Potsdam sandstone of Black River, in that State, tracks similar to those described by Sir W. E. Logan, in the sandstone of Canada. This added a new interest to the unknown crustacean fragment; and in 1860 I visited the Black River region, to procure if possible some of these impressions. I failed however in finding the precise locality; and in 1862 sent my assistant in the Wisconsin survey, Mr. Hale, to make farther explorations, but he did not succeed in finding anything of interest. At another locality however, he obtained some fragments of the crustacean before mentioned, among which are two cephalic shields sufficiently perfect to be characterized. I inclose you a drawing of one of these.

The relations to *Limulus* are at once suggested by the form and expression of these carapaces, while the large prominent eye-tubercles hold relatively the same position as the small approximate oculiform tubercles or spots on the anterior part of the shield in *Limulus*, (and also in *Eurypterus*). The carapace is proportionally flatter than in *Limulus*; and has, like that, a strong thickened border; the posterior angles rounded. The margin is impressed or sinuate in front, and there are slight indications of longitudinal grooves on each side of the central, leaving a median lobe proportionally wider than in *Limulus.* The eyes, though imperfect, remind one somewhat of the eyes of Trilobites, and are remarkably prominent.



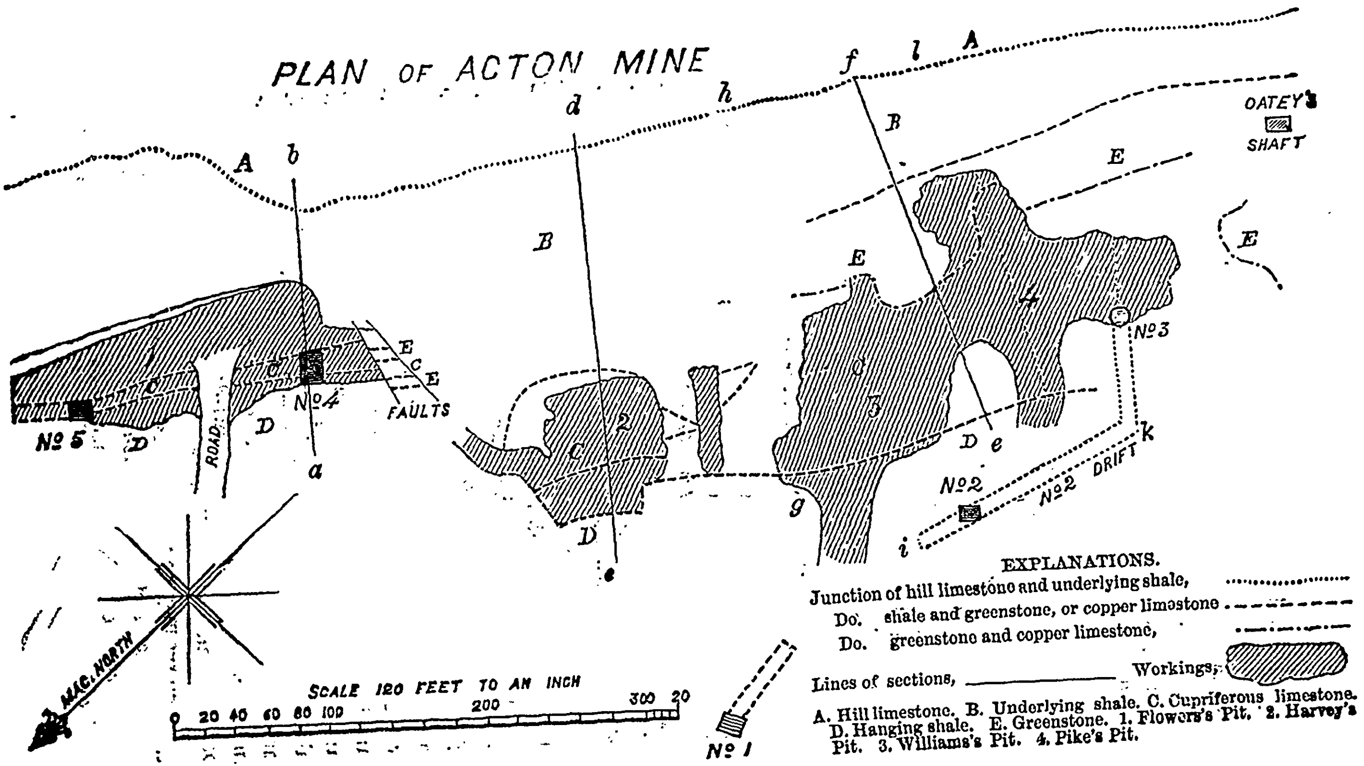
Carapace of *Aglaspis* from Wisconsin.

There is a single fragment of what appears to have been an articulation of the thorax, or a portion of some appendage analogous to the branchial feet of *Limulus*; it has a flattened, curving, pointed extremity. Another fragment I infer may have been the caudal extremity; it is comparatively thick and strong; but the specimen is too imperfect to be determined. The first specimen I obtained is a straight spine-like body, and I infer that the animal may have been provided with a caudal spine, as in *Limulus.*

Such, in general, are the characters of this crustacean. Whether this may have been the animal which made the peculiar tracks in the sandstone, I cannot say, but I have so inferred. The first specimen was found at a distance of thirty miles or more in a northwesterly direction from the locality of the tracks of Black River, and in higher beds of the sandstone. The last found specimens are from a more distant locality, in a southeasterly direction, and also from beds above those of the tracks. All this, however, cannot furnish matter for argument against the origin of the tracks, in the present state of our knowledge of a country which has been comparatively but little explored.

Whatever may be proved hereafter in this respect, it does not diminish the great interest attaching to so new and remarkable a form of crustacean from the unequivocal primordial zone of the northwest.

PLAN OF ACTON MINE



EXPLANATIONS.

Junction of hill limestone and underlying shale, ………………

Do. shale and greenstone, or copper limestone - - - - - -

Do. greenstone and copper limestone, — · — · —

Lines of sections, ———— Workings, ▨

A. Hill limestone. B. Underlying shale. C. Cupriferous limestone. D. Hanging shale. E. Greenstone. 1. Flowers's Pit. 2. Harvey's Pit. 3. Williams's Pit. 4. Pike's Pit.

ARTICLE XLIII.—*Contributions to the History of the Acton Copper Mine.* By THOMAS MACFARLANE.

(Read before the Natural History Society of Montreal.)

Three years have elapsed since the opening of the Acton Copper Mine, and probably few mines have in such a short time gained a greater or more merited celebrity. It has been my good fortune to be connected with it since September, 1861, in such a capacity as enabled me to gain much experience as to the nature and value of the deposits of copper ore, which are here the objects of mining enterprise. Had it not been for this circumstance I should not have ventured upon another description of the Acton Mine, seeing that so many valuable papers on the subject are already in our possession. As it is, the few observations which I have made, and which I now proceed to record, are only to be regarded as supplementary to former descriptions, especially to those of Sir W. E. Logan, and the Rev. A. F. Kemp; and as embracing a sketch of the progress of the mine from September, 1861, when Messrs. Davies and Dunkin, the proprietors, received the mine back from the lessees who had previously worked it, until the first of October, 1862, when the mine was purchased by the Southeastern Mining Company of Canada.

In the month of September, 1861, mining operations were being carried on in the following workings: Flowers's pit, Williams's pit, Harvey's pit, and No. 2 shaft. It is to be observed with regard to these names, that the word pit is applied to an open working of irregular and very considerable dimensions, while the name of shaft is given only to regular sinkings of the usual and smaller dimensions. The position of the above named workings, and the character of the rocks in which they occur, and by which they are bounded, will be seen from the accompanying map.

The whole of the open workings occur upon a bed of what has been called in former descriptions "copper limestone," the general strike of which is N.E. and S.W., with a dip more or less inclined to the N. W. Immediately underlying this cupriferous limestone, which is dolomitic, there occur from twenty to eighty feet of dark colored shales, in which, especially near the cupriferous limestone, copper pyrites is frequently found disseminated in thin strings and layers. Beneath this, occurs another bed of limestone, of very considerable thickness, the outcrop of which forms the hill running along the south-east side of the mine. Between the cupriferous limestone and the underlying shale, there is often intruded a fine-grained greenstone, which sometimes forms very considerable and irregular masses, sometimes intersects the limestone strata, and often presents a peculiar banded structure, resembling more that produced by igneous flow, than that due to deposition from water. This greenstone, although intruded most frequently between the underlying shale and the cupriferous limestone, is sometimes observed occurring between the latter and the hanging shale. This hanging shale, of a black color, which overlies the cupriferous limestone, is also often impregnated with copper pyrites, and has a very considerable thickness. It has not yet been ascertained what rock overlies the hanging shale in the immediate neighborhood of the mine, but from observations elsewhere, it appears to be followed by lighter colored shales, containing small interstratified quartz veins. Upon these shales is superposed a finely and evenly foliated clay-slate, with transversal cleavage. At greater distances from the mine there is found a considerable development of clay-slates and sandstones; some of the latter possessing the characters of the greywacke sandstone of German geologists. The whole of these rocks are apparently destitute of organic remains. According to Sir William E. Logan, they constitute a part of the Quebec group, of the Lower Silurian series Referred to the systems of continental geologists, they would appear to occupy a place between the primitive slate formation and the Silurian, in a formation corresponding to Barrande's Azoic formation in Bohemia, or to the Cambrian system, as this is understood to be constituted by Cotta; viz., of less crystalline clay-slates and silicious slate, of non-fossiliferous greywacke sandstone and conglomerate.*

Having thus referred to the geological character and age of the rocks in the neighborhood of the mine, I proceed to describe the various workings above named. Flowers's pit, the most north-easterly of the open workings, has a triangular shape, an average width of forty-five feet, and had in September, 1861, a depth of twenty feet. The bottom of the excavation consisted, on the south-easterly side, of shale, while the outcrop of the cupriferous limestone, having a thickness of four feet, ran along the north-west side. The original thickness of forty-five feet of limestone, had thus, on account of a fold in the underlying shale, decreased to four feet, as shown in the following section at No. 4 shaft.

The excavation of the limestone at *a* was continued, (the point

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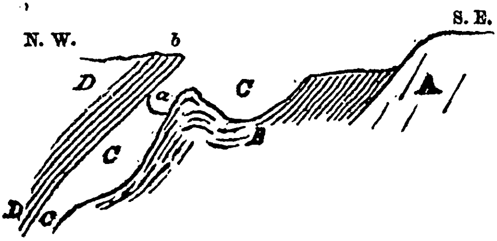
*Cotta: Die Flötz Formationen, p. 204.

of shale *b* having been previously taken down) in the south-westerly half of the opening, along a distance of about sixty feet and to an additional depth of seven feet.* The limestone was more, or less charged with ore along the whole of this distance; but having in view the disadvantages which attend such large excavations in depth, it was resolved to sink a shaft, in order to examine the ground before hand. Accordingly shaft No. 4 was commenced in the south-west end of the working, and sunk, at intervals, to a depth of seventy-five feet on the inclination of the bed. The first twenty-five feet sunk below the open working was in rock containing very good ore, of which rock eighteen and a half cubic fathoms were excavated, and yielded—

Section along the line a—b of the general plan.



A, Hill limestone; B, underlying shale; C, cupriferous limestone; D, hanging shale.

$1\frac{2}{2}\frac{0}{3}\frac{1}{5}\frac{1}{2}$ tons of first quality ore of 24.0 per cent of copper.
$133\frac{2}{2}\frac{1}{4}$ " crush " 2.0 " "

These quantities correspond, after deducting the loss in dressing the crush ore (one-third of the copper contents), to 18.6 tons of 12 per cent ore, or about one ton per cubic fathom. The cost of sinking these twenty-five feet, and bringing the rock to the surface, amounted to $482.94; or to $26.10 per cubic fathom of rock, and $25.96 per ton of 12 per cent ore. Below the twenty-five feet the ground was poor; and in June, 1862, the sinking was discontinued, in order to the stoping of the ore ground on each side of the shaft. Up to the end of July, 45.62 cubic fathoms

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* It is to be remarked with regard to this and other sections in this paper, that unless when otherwise mentioned, they are not drawn to a scale, and are merely intended to give an idea of the succession of the various rocks, without reference to their thickness.

were stoped out in the north-east side of the shaft, and yielded—

$10\frac{2}{2}\frac{6}{3}\frac{8}{5}\frac{}{2}$	tons	first	quality	ore of	22.0	per cent.
$43\frac{1}{2}\frac{4}{3}\frac{8}{5}\frac{7}{2}$	“	“	“	“	18.4	“
$1\frac{3}{2}\frac{6}{3}\frac{5}{5}\frac{}{2}$	“	second	“	“	9.0	“
154	“	crush		“	4.06	“

These quantities, after deducting loss in dressing, correspond to $119\frac{8}{2}\frac{5}{3}\frac{0}{5}\frac{}{2}$ tons of 12 per cent ore, or 2.62 tons per cubic fathom. The total expenses of excavation and bringing to surface, amounted to $574.10; equal to $12.59 per cubic fathom, and to $4.80 per ton of 12 per cent ore. The average thickness of the bed was here 19½ feet, = 3¼ fathoms. Consequently one square fathom of the bed yielded 8.51 tons of 12 per cent ore, at an expense of $40.92. During the following months of August and September the stoping was continued, accompanied by drifting under the old road leading into Flowers's pit (see map). Here were excavated 63.37 cubic fathoms of ground, which yielded—

49147	lbs.	first	quality	ore of	21.2	per cent.
23850	“	“	“	“	19.8	“
7114	“	second	“	“	13.5	“
17600	“	“	“	“	11.5	“
40320	“	crush		“	5.2	“
134400	“	“		“	4.1	“
22400	“	smalls		“	3.5	“
128427	“	“		“	2.6	“

These quantities, after deducting one-fourth of the copper contents of the crush ore, correspond to $95\frac{2}{2}\frac{2}{3}\frac{2}{5}\frac{}{7}$ tons of 12 per cent ore, or 1.5 tons per cubic fathom. The total expense of mining and raising this quantity was $873; equal to $13.77 per cubic fathom, or to $9.19 per ton of ore. The average thickness of the bed was at this place 2½ fathoms. Consequently a square fathom of the bed yielded 3.75 tons of 12 per cent ore, at an expense of $34.32.

As regards the north-east extremity of Flowers's pit, a shaft had been sunk in the limestone there previous to September, 1861, to a depth of twenty feet on the incline, below the bottom of the open working, and forty-four feet below the floor, on the present collar of the shaft, now called No. 5. At the bottom, a considerable quantity of copper pyrites was observable, partly in veins permeating the limestone, and partly impregnating the same. In order to the examination of the ground here it was resolved to sink this shaft. The ground gradually improved, and at a depth of fifty-four feet presented an appearance exactly similar to the rich deposits previously excavated on the surface. This appearance has been most suitably and accurately described by Sir W. E. Logan as "*a breccia or conglomerate, with a paste com-*" posed of variegated and vitreous sulphurets of copper, mingled" with fine grained silicious matter, enclosing fragments of lime-" stone, some angular and some rounded, some of them almost" wholly calcareous and others largely silicious."* The average thickness of the bed in the ten feet thus sunk, was nine feet, the length of the shaft on the strike of the limestone, twelve feet. From the five cubic fathoms thus excavated, there were produced

$1\frac{6\,9\,8}{2\,3\,5\,2}$ tons first quality ore of 22.0 per cent.
$83\frac{5}{2\,4}$ " crush " 4.5 "

These quantities, after allowing for the loss, correspond to 23.1 tons of 12 per cent ore, or 4.6 tons to the cubic fathom. The costs of mining the above five cubic fathoms, and bringing them to the surface, amounted to $133.33, which is equal to $26.66 per cubic fathom, and to $6.03 per ton of 12 per cent ore. Calculated at the above mentioned thickness of 1½ fathoms, a square fathom of the bed yielded 6.9 tons of 12 per cent ore, and cost $40. The sinking of No. 5 shaft was discontinued during the winter, but resumed during the summer, and at the end of July attained a depth of seventy-six feet on the incline. From it, at a depth of sixty feet, a gallery was carried towards the west, 30⅝ feet; at which distance from the shaft the limestone was cut off by the hanging wall, every indication seeming to point out the presence here of a left-hand throw. This fault had a direction of N. 10° W. Some stoping was done both above and below this gallery. Up to the end of July there were excavated in shaft, drift and stopes, 65¼ cubic fathoms of ground. These yielded

$53\frac{9\,3\,1}{2\,3\,5\,2}$ tons first quality ore of 19.1 per cent.
$4\frac{2\,1\,5\,7}{2\,3\,5\,2}$ " second " " 9.0 "
$316\frac{4\,6\,6}{2\,2\,4\,0}$ " crush " 3.95 "

which quantities correspond to $155\frac{9\,1\,3}{2\,3\,5\,2}$ tons of 12 per cent. ore, or 2.38 tons per cubic fathom. The total expense of mining and raising this quantity was $1512.04; or $23.17 per cubic

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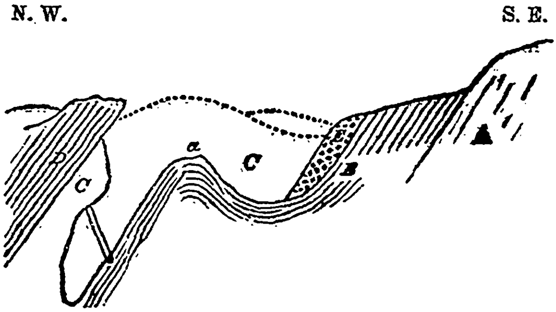
* Report of Progress for 1858, p. 59.

fathom, and $9.72 per ton of ore. The thickness of the bed at this point was 16¼ feet, = 2¾ fathoms. Consequently a square fathom of the bed contained 6.54 tons of 12 per cent ore, and cost $26.73. The limestone in No. 5 shaft generally maintained a dip of from 70° to 80°, and the character of the ore was principally that described by Sir W. E. Logan, as above quoted. The richest specimen assayed from this shaft contained 41.2 per cent copper, and 19.2 per cent of silicious matter. It was not altogether free from limestone. The strike of the bed of limestone from shaft No. 4. to No. 5. is N. 34°. E. Friction grooves have been observed at the junction of both the foot and the hanging shale with the limestone. These generally dip to the west at an angle of about 50°. In August and September, No. 5 shaft was further sunk fifeeen feet, thus reaching a depth of ninety-one feet. The ground between the shaft and the fault above noticed was also stoped out. It was poorer than that previously excavated, but the thickness of the bed increased to twenty-four feet.

Immediately to the west of Flowers's pit, there appears to exist one or more powerful faults, which have thrown the cupriferous limestone 140 feet to the right hand. These are indicated on the map, from which it will be seen that the principal one has a direction of about east and west, and comes in at the east end of Harvey's pit, where the evidences of the existence of this right hand throw are very striking. It is worthy of remark, that a great accumulation of rich ore was excavated from Flowers's pit, at the point where this fault intersected the one described as occurring in the drift to the west of No. 5; traces of this are also be found on the surface. These faults, the existence of which was, I believe, first pointed out by Principal Dawson, will doubtless be found to influence considerably the ore-bearing qualities of the limestone bed.

Harvey's pit is the next open working to the west of Flowers's pit. On the surface it has a length of one hundred, and a breath of eighty feet. A section of the working, at right angles to the direction of the strike, is given on the next page; from which it will be seen that the same relations exist here as in Flowers's pit, so far as the architecture of the limestone and the underlying shale is concerned. The same contraction in the thickness of the limestone is visible here, as at Flowers's pit. This rock, before its excavation, bent over the point *a*, and constituted the arch of limestone mentioned in a former description of the mine, by the Rev. A. F. Kemp.* It was on this arch that the first excavation was made in opening the mine. Harvey's pit was last worked in September, 1861. The previous mining had been done very irregularly, and the cupriferous limestone had not been wholly removed; but a considerable part of it was left against the hanging wall, as shewn in the following sketch. This limestone had, moreover, been supported by heavy timbering, which again had been loaded with waste rock. To have taken down the whole of this limestone would have been expensive, and to have cut through it to the hanging wall beneath the timbering would have left the pit in a very unsafe condition. To have sunk a shaft at one end of the pit would probably have bean the best plan, had it not been thought preferable to sink or drive from No. 1 shaft, 140 feet northwest of Harvey's pit. These considerations prevented any excavation from being made in this opening; and, since September, 1861, it has been used as a reservoir for water employed in dressing the ore. There is still ore visible in Harvey's pit, nearly in the middle at the deepest point, and on the stope at the west end.

Section along the line c—d of the general plan.



A, hill limestone; B, underlying shale; C, cupriferous limestone; D, hanging shale; E, greenstone.

The next open working of importance, to the west of Harvey's pit, is Williams's pit. In September, 1861, it was separated from Pike's pit by a piece of ground, since removed, under which a very large drift had been excavated. The east side of Williams's

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* See Canadian Naturalist, Vol. V. page 360.

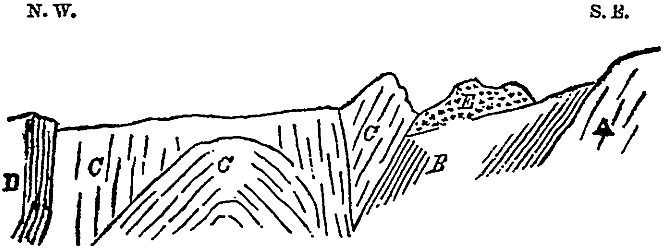
pit, was worked in September, 1861, and $161\frac{1}{2}$ cubic fathoms of rock excavated. These yielded:

$16\frac{13}{2532}$ tons, first quality ore of 24.0 per cent.
$211\frac{17}{24}$ " crush " 4.5 "

which, after deducting loss in dressing, correspond to 85 tons of 12 per cent ore. The eastern stope, consequently, contained 0.52 tons of 12 per cent ore per cubic fathom. The total expense of excavation was $1292.00; or $8 per cubic fathom, and $15.17 per ton of 12 per cent.

The distance from the underlying to the hanging wall, on the east slope of Williams's pit, is 135 feet; which extraordinary width is wholly filled up by limestone of slightly different varieties. Next to the foot wall may be observed a fine grained, light grey limestone, with which thin leaves of slate are intercalated, the slate being the more cupriferous. Further to the north-west, there follows a limestone of a coarser grain and slightly darker color, in which the richest copper deposits seem to occur. Portions of this are also slaty, but less regularly so than the variety just mentioned. Still further to the northwest, the first mentioned slaty limestone again appears; after which succeeds a cupriferous limestone, characterised by being impregnated with copper pyrites, and by containing here and there patches, consisting of silicious matter and copper pyrites, which project from the surface of the limestone, wherever it has been exposed to the influence of the atmosphere, in the form of moss-like efflorescenses. The extraordinary thickness which the limestone attains in Williams's pit, seems to be attributable to foldings in its strata. The stratification of the limestone is very obscure, and is rendered more so by innum-

Section from g to h on the general plan.



A, hill limestone; B, underlying shale; C, cupriferous limestone; D, hanging shale; E, greenstone.

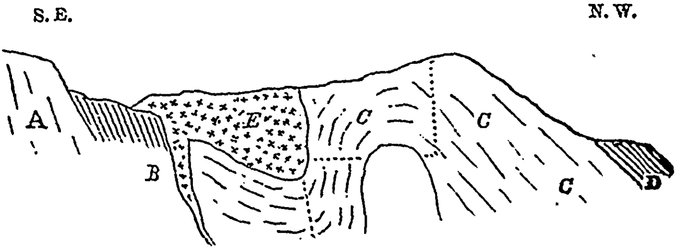
erable joints, and veins of calcspar, which ramify through the limestone in all directions. Judging however from the position which a certain narrow band of schistose limestone occupies, it appears as if the limestone of the east slope of Williams's pit was stratified as sketched in the preceding section.

Between Williams's pit and Pike's pit there existed, as already mentioned, previous to January, 1862, an arch of limestone; which was perhaps the most picturesque feature of the mine. During the winter, a large quantity of water having accumulated in Williams's pit, and become frozen over, it was judged advantageous to take down the arch, while the access to it by means of the ice was convenient. The piece of ground on the south side of the arch abutting against a huge mass of greenstone, together with the rock above the arch, contained 770 cubic yards = 96 cubic fathoms nearly. These produced:

4 $\frac{1419}{2354}$	tons	first quality	ore of	23.0	per cent.
67 $\frac{9}{24}$	"	crush	"	4.7	"
154 $\frac{5}{24}$	"	"	"	2.7	"

which quantities correspond to 69½ tons of 12 per cent ore. Consequently, a cubic fathom of this rock gave 0.72 tons of 12 per cent ore. The cost of mining and hauling was $539, or $5.61 per cubic fathom, and $7.75 per ton of 12 per cent ore. The following is a section of the limestone and the adjoining rocks, at this point, as seen from the north-east side, previous to the excavation:

Section along the line e—f of the general plan.



The letters denote the same rocks as in former sketches. The dotted lines show the piece of ground mentioned above. It will be observed that here also there exist evidences of foldings in the limestone strata, and that towards the west end of the mine, the greenstone becomes extensively developed.

After blasting down the arch, Williams's pit was not worked until May, 1862. By that time, however, it was completely filled with water; and the quantity contained in it could not, considering the immense area of the excavation, have been much under a million of gallons. Previous to working the pit, it was emptied to within a few feet of the bottom, by means of a syphon made of a two-inch malleable iron pipe, 350 feet in length, leading into No. 1 shaft; from which the water was raised by the pump attached to the stationary engine there. Blasting was then commenced, and up to the end of July there were excavated 1104 cubic yards = 138 cubic fathoms of limestone, which yielded:

6 $\frac{2066}{2352}$	tons first	quality	ore of	20.0	per cent.
56 $\frac{2338}{2352}$	"	"	"	18.4	"
277 $\frac{461}{2240}$	" crush		"	5.2	"

These quantities correspond to 175 $\frac{134}{2352}$ tons of 12 per cent. ore or 1.27 tons per cubic fathom. The total expense of emptying the pit, excavating the rock, and bringing it to the surface, amounted to $1092.29, or $7.91 per cubic fathom, and to $6.24 per ton of 12 per cent ore. Mining was continued in Williams's pit during the months of August and September, and a considerable part of what constituted the floor of Pike's pit was removed. During these two months there were excavated in all 1468 cubic yards = 183½ cubic fathoms of rock; of which about one-third was in the rich ore-ground on the south-east side of Pike's pit, and the other two-thirds in the much poorer rock situated between the old face of the western stope of Williams's pit and No. 3 shaft. The following lots of ore were produced from the above quantity of rock:

236215	lbs. first	quality	ore of	19.3	per cent.
169200	" "	"	"	19.8	"
28456	" second	"	"	13.5	"
120000	" "	"	"	11.5	"
454720	" crush		"	5.0	"
680960	" "		"	3.5	"
143360	" smalls		"	2.8	"
327040	" "		"	3.5	"

These, after deducting one-fourth of the copper contents of the crush ore, are equal to 507 $\frac{1328}{2352}$ tons of 12 per cent ore. Consequently, a cubic fathom of this rock yielded 2.76 tons of 12 per cent ore. The total expense of mining and hauling to surface was $1777.12, or $9.68 per cubic fathom, and $3.50 per ton of 12 per cent ore. The width of the limestone horizontally across Williams's pit, at this point, is 150 feet; the width of the stope nine fathoms. If we assume the thickness of the limestone, at right angles to the underlying shale, to be twelve fathoms, which is evidently a moderate estimate, then a square fathom, along the plane of the bed at this point, contains 33.12 tons of 12 per cent ore. In the upper part of Williams's pit, the conglomerate character of the cupriferous limestone, referred to in describing No. 5 shaft, is beautifully developed. Masses of this character have frequently been blasted out, measuring at least eight cubic yards. A large mass of nearly the same dimensions was found loose on the surface of this deposit. On drilling a hole into it, preparatory to blasting it, the borings obtained were carefully collected and examined. They contained:

Silica,......................	36.98	
Carbonate of lime,............	4.64	
Alumina,.....................	0.84	
Iron,........................	7.01	
Copper,......................	34.20	by assay.
Sulphur,.....................	16.33	by difference.
	100.00	

The three last ingredients calculated to 100 parts give

Iron,........................	12.18
Copper,......................	59.44
Sulphur,.....................	28.38
	100.00

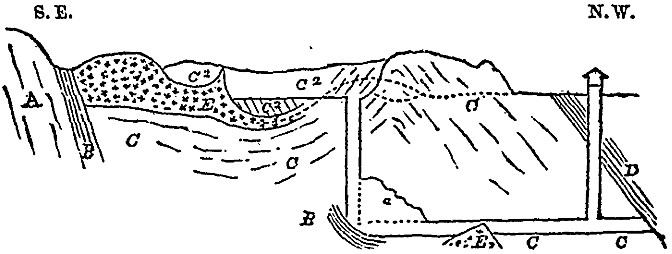
which figures approximate pretty closely to some analyses of purple copper. In the bottom of Williams's pit, about forty feet below where this mass was found, the ore is more solid, not so much diffused through the limestone, but concentrated in veins, which are pretty distinctly separated from the side rock. In one of these, of considerable thickness, I found the purest purple copper which I have yet observed on the mine. It contained neither lime nor silica, and assayed 61.9 per cent of copper. At no great distance from this vein, the limestone was destitute of copper, and had the following composition:

Silica,...........................	1.50
Alumina and peroxide of iron,......	2.85
Carbonate of lime,................	71.10
Carbonate of magnesia,............	24.12
	99.57

Previous to September, 1861, No. 2 shaft had been sunk through shale, and into the limestone to a depth of seventy-eight feet; and a drift carried from it, at this depth, both towards the hanging wall, and towards the foot wall. The direction of this drift was N. 10° E.; consequently not at all at right angles to the direction of the strike, (which in this part of the mine appears to be N. 20° E.); but rather parallel with it. The length of the drift from the shaft to the hanging wall was forty-two feet, to the foot wall sixty feet. This latter, which was partially cut through, was found to be of greenstone, or rather a shaly greenstone, composed of alternate layers of that rock, and of shale with copper pyrites. This constituted at least the lower part of the face of the drift. The upper part was of limestone. In view of these circumstances, and although a gallery had been driven twenty-seven feet along this foot wall to the west, it was deemed proper to continue the main drift. This was done for a distance of sixty feet in the same direction of N. 10° E., always in limestone; the bottom of the drift consisting almost the whole distance of the same shaly greenstone. Some good patches of purple copper were met with, and also some veins of calcspar with purple copper and copper pyrites, dropping down from above; these veins led to the belief that the drift was being carried along underneath the ore. At the distance of 120 feet from the shaft, the direction of the drift was altered to N. 63° W. (in order to meet No. 3 shaft); the drift was then carried sixty-three feet further, always on the foot wall, which gradually rose, until the driving was discontinued; when it was found to have an inclination to the N. W. of 40°. In driving this sixty-three feet, some little copper was discovered, principally in veins of calcspar from one to three inches thick. Shortly after the driving here was discontinued, No. 3 shaft, which was meanwhile being sunk, was carried down to the drift, and made to communicate with it. No. 3 shaft had, previous to September, 1861, a depth under the floor of Pike's pit, of twenty-six and a half feet. In March and April it was further sunk twenty-seven and a half feet, and at the depth of fifty-four feet it broke through into No. 2 drift. The last six feet sunk was in poor rock, but, previous to this, twelve feet had been sunk through cupriferous limestone, permeated by veins of calcspar and quartz, containing purple copper. One of these veins seemed, in the southeast corner of the shaft, to have a dip of about 45° to the N.,W., but on the opposite side it became very much flatter

This circumstance seemed to confirm the opinion that No. 2. drift had been carried along underneath the copper, so that it was determined to stope back from No. 3 shaft, overhead in the drift. In a short time the few feet of poor rock constituting the roof of the drift were removed, and a bed of limestone exposed, containing numerous veins consisting of purple copper and silicious matter, and presenting an appearance similar to that described as occurring in the bottom of Williams's pit. The following sketch is a section along a line running from No. 2 shaft to No. 3, and thence across Williams's pit:

Section from i to k, and thence to l, on the general plan.



A, hill limestone; B, underlying shale; C, cupriferous limestone; D, hanging shale; E, greenstone; C2, dark coloured silicious limestone, distinctly stratified, with impregnating copper pyrites.

It will be observed that a jog or bend of the footwall occurs in No. 2 drift, similar to those occurring at the surface in Harvey's pit and Flowers's pit; and that it was in the basin thus formed, and a little from the bottom of the same, that the rich ore at *a* was discovered. The excavation of ore at this point, by widening the drift and stoping overhead, commenced on the 1st of June. From that date until the 8th of August, 573 cubic yards = 71.6 cubic fathoms were excavated. These produced:

$7\frac{1391}{2352}$	tons first	quality	ore of		22.0	per cent.
$13\frac{167}{2352}$	" "	"	"		18.4	"
$4\frac{1032}{2352}$	" "	"	"		24.0	"
$2\frac{505}{2352}$	" second	"	"		9.0	"
269	" crush		"		4.2	"

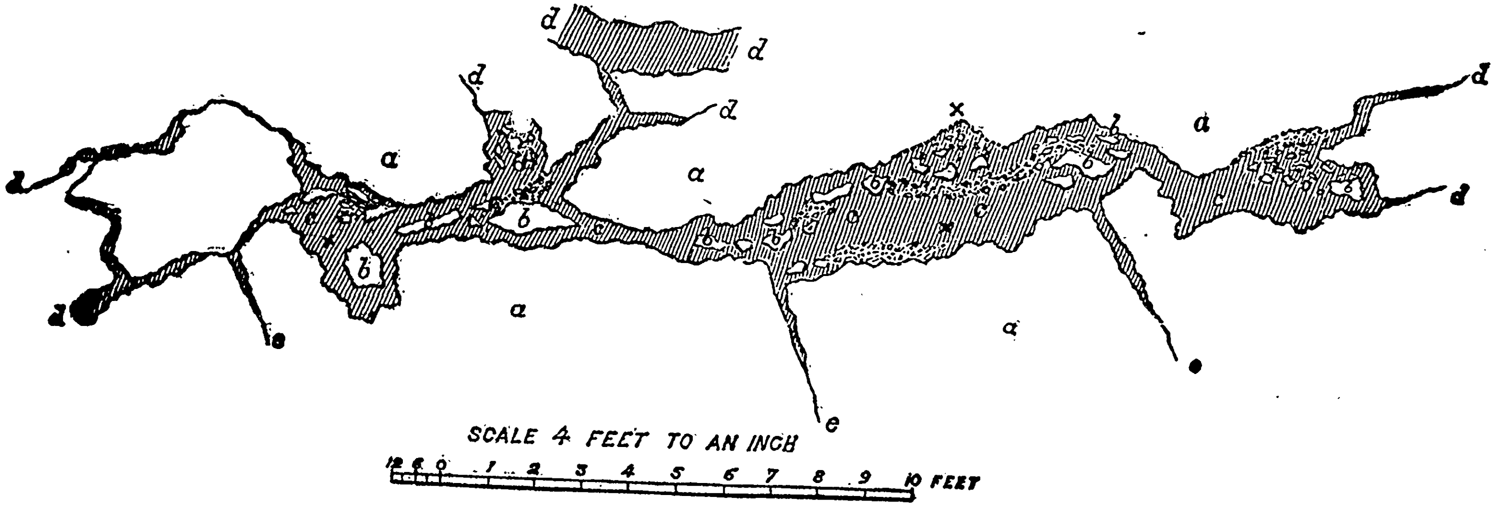
corresponding to $101\frac{808}{2352}$ tons of 12 per cent ore, or 1.41 tons per cubic fathom.

The total expense of mining and bringing to surface was $1288, or $18 per cubic fathom, and $12.71 per ton of 12 per cent ore. Mining was continued here after the above date, but up to the end of September no further measurement had taken place. Probably nowhere else on the mine are such beautiful and distinct specimens of the copper conglomerate, or rather breccia, observable, as in the excavation above No. 2 drift. In many cases the line of division between the cupreous matrix and calcareous fragments is sharp and distinct; and it not unfrequently happens that there may be found in close proximity to each other, pieces of matrix almost free from lime, and fragments of limestone containing not a trace of copper. To judge from the appearances in No. 2 drift, the cupriferous limestone there does not contain a definite bed of conglomerate running irregularly through, and subordinate to it. It seems rather that the limestone has been cracked in all directions, and is now filled with a network of veins from an inch to two and a half feet thick, and containing purple copper, copper pyrites, silicious matter, and fragments of limestone. The matter of these veins has so often a brecciated character, from the presence of angular fragments of the adjoining limestone, as frequently to entitle it to the old German name of "Gang brockengestein," a term sometimes used for characterising this brecciated structure in veins. The accompanying sketch shews a section of one of these veins cut through in stoping upwards from No. 2 drift.

The following analysis was made of a piece of veinstone, from the same vein which enclosed a well defined angular fragment of limestone:

Silica......................	38.65	
Carbonate of lime,............	0.95	
Iron......................	7.31	
Copper......................	37.20	
Sulphur,......................	15.89	by difference.
	100.00	

SECTION ACROSS A VEIN IN DRIFT No. 2.



EXPLANATIONS.

a. Limestone.
b. Fragments of limestone
c. Purple copper and silicious matter.
d. Leaders connecting with other veins.
e. Offshoots similar to those cut in the drift before the discovery of the copper.
× Points at which specimens were taken for examination.

The angular fragment contained no copper, but gave:

Silicious matter,..............	8.25
Alumina and peroxide of iron...	2.75
Carbonate of lime.............	73.20
Carbonate of magnesia.........	15.50
	99.7

Other specimens of veinstone examined, contained as follows:—

	1.	2.	3.
Silica	18.3	30.5	36.9
Copper	47.4	42.6	33.4

From the various analyses made of the purple copper, it does not seem to differ essentially from the variety of this mineral to which the formula $Fe\ Cu^5\ S^4$ has been given.

I have thus described the progress of the mine, and the results obtained in the various productive workings during the thirteen months ending 30th September, 1862. If we take the average of these results, we find that the average produce per cubic fathom has been 1.6 tons of 12 per cent ore; the average cost of mining and bringing to surface, $11.28 per cubic fathom, and $7.03 per ton of 12 per cent ore. These, it will be observed, are the results of mining in the productive part of the cupriferous bed, exclusive altogether of the cost of explorative work, of which latter it was only in No. 2 drift that any considerable amount was done. Probably the cost of prospective work did not exceed $1.50 on each ton of ore produced; so that we may assume that the cost of searching for ore, mining and bringing it to the surface, was $8.50 per ton of 12 per cent.

Before leaving this part of the subject, I may be permitted to make some remarks as to the nature of the deposit and the source of the ore. It will probably be admitted on all hands, that the bed of limestone in which the ore occurs, is of sedimentary origin, and originally possessed a horizontal position. Nor will it probably be denied, that a part at least of the copper; viz., that part which occurs in the form of copper pyrites, finely disseminated through some parts of the rock, was deposited, in some state or other, simultaneously with the limestone. That the limestone and the rocks adjoining it have, by certain powerful agencies, been raised from their horizontal position, and in this process been rent, broken, bent and twisted in the most violent manner, is evident from the various phenomena presented in every part of the mine. Whether this upheaval was caused by the greenstones being thrown up from beneath, seems to be uncertain, but it is probably not unreasonable to suppose that this protrusion of the greenstone occurred simultaneously with the upheaval of the strata; and that both may have been caused by certain more general and wide spread movements of the earth's crust. Whatever may have caused the upheaval, it seems sufficiently evident that the upheaval caused the rending of the limestone, the formation of the fissures and crevices, in which the copper ore was subsequently deposited, and the partial filling up of these by detached fragments of limestone of all possible dimensions. With regard to the filling up of the fissures by the copper ores, we may conceive three different modes in which this may have been effected: 1. The ores may have been injected into these fissures in a fused state. 2. They may have been removed from the impregnated side rock by certain solvents, and re-deposited in the fissures. 3. They may have been brought up from beneath by springs. With regard to the first of these theories, it must be remarked that the general appearance of the veins, coupled with the presence of greenstone in the neighborhood, would seem to be in its favor. But when it is considered that the ore is intimately associated with quartz, or rather with chert, this view of the origin of the ore does not appear admissible. It is difficult to conceive of a fused material so homogeneous as the substance which forms the matrix of the breccia, consisting exclusively of metallic sulphurets and silica. And even although it were possible to imagine a fused mass of this composition, the degree of heat required for its fusion would have been such as to exert an action on the adjoining limestone, similar to that produced by certain igneous rocks, viz., a conversion of the greyish colored limestone into white crystalline marble. With regard to the second theory, the presence of sillica does not present any difficulty, because it is a well-known fact that that substance is deposited in large quantities from hot springs. It is not unreasonable to suppose that the water percolating through the rocks possessed a high temperature, because it is not unlikely that a higher temperature than the present prevailed after the Lower Silurian strata had been deposited. With regard to the manner in which the copper may have been dissolved, and held in solution by the water, it seems evident that it could not have existed in the water in the state of sulphate of copper, from the oxydation of impregnated copper pyrites; because such a solution on coming in contact with limestone would have formed with it sulphate of lime and carbonate of copper. Nor is it possible to ignore the physical properties of copper pyrites, and suppose it to have been, to however slight an extent, soluble in water. The only solvents known for heavy metallic sulphurets, are the alkaline sulphurets. Many heavy metallic sulphurets when fused with sulphuret of potassium or sodium, yield when treated with water, solutions containing considerable quantities of the heavy metals; and I have found that on fusing a regulus containing iron, copper, cobalt and nickel, with sulphate of soda and charcoal, and treating the result with water, a dark green solution was obtained, containing, after careful filtration, all four of these metals. This solution, on exposure to the air, gradually oxydized, became colorless, and deposited the metallic sulphurets as a black powder. I am not quite prepared to assert that the copper in the veins above referred to was deposited in this manner; but I am of opinion that if we are to adopt the theory of secretion from the side rock, this is the only explanation which is admissible. The third theory of the source of the copper is probably the correct one, and it is the one which is most in accordance with generally received opinions. Cotta, for instance, regards it as certain that mineral veins proper have been filled up by infiltration, and that the material thus deposited came from beneath.* If we however attempt to go a step beyond this general explanation, we must enquire as to the nature of the solvent, and in doing so can scarcely arrive at other results than those mentioned in connection with the second theory. We must regard the alkaline sulphurets as the most probable solvents under the circumstances; and when we reflect that the sulphurets of platinum, gold, mercury, tin, tellurium, antimony, arsenic, vanadium, molybdenum, tungsten, nickel and iron, are all soluble in alkaline sulphurets, it will appear that the latter may have played a more important part in the formation of ore veins than has been hitherto supposed. When moreover it is remembered, how numerous and diverse the double sulphur salts are, and how many of these, especially arsenic and antimonious sulphurets

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* Cotta: Erzlagerstätten, p. 127.

occur in ore veins, the importance of the agency of the alkaline sulphurets in the filling up of such can scarcely be over-rated.*

This sketch of the recent results of mining at Acton, would scarcely be complete without a description of the processes employed for concentrating the ore, and a reference to certain experiments instituted for the purpose of ascertaining the amount of copper lost in the processes of crushing and jigging.

As soon as the ore has been brought to the surface it undergoes the process of coarse spalling; that is, it is separated from the waste rock, and broken into pieces having a diameter of from four to six inches. These pieces are sorted, according to the quantity of copper they contain, into first quality ore, second quality ore, crush ore and fourths. The first three sorts then undergo the process of fine spalling. The first quality ore is broken into pieces of the size of an egg, and any poor rock which these may contain is picked out. It thus yields marketable first quality ore, containing from eighteen to twenty-four per cent. The second quality pieces, treated in the same way, yield marketable second quality ore, containing from ten to thirteen per cent. The

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Editor's note, by T. Sterry Hunt. F. R. S.

De Senarmont, in his researches on the artificial formation of the minerals of metalliferous veins by the moist way, has shown that by the aid of heated solutions of alkaline sulphurets and bicarbonates, at temperatures of 200° and 300° Centigrade, it is possible to obtain in a crystalline form many of the native metals metallic sulphurets, and sulpharseniates, besides quartz, fluor spar and sulphate of barytes. These observations, and those of Daubrée are cited by me in a paper in the *Naturalist* for December 1859, p. 500, with the remark that, in them, "we have, beyond a doubt, a key to the true theory of metalliferous veins." Heated alkaline solutions (sulphurets and carbonates,) which are at the same time the agents of metamorphism, dissolve from the sediments the metallic elements which these contain disseminated, and subsequently deposit them, with quartz and the various spars, in the fissures of the rock." Mr. Macfarlane's view seems to be in perfect accordance with the theory which I have advanced. The notion that the contents of the vein have been deposited from springs coming from below, is in no way inconsistent with that of their secretion from the wall-rock, inasmuch as we conceive that metalliferous and other mineral waters, in all cases, derive their soluble matters from certain permeable strata, and may afterwards either deposit these dissolved matters in the same strata, or more frequently rise to higher formations, where a lower temperature is more favorable to the precipitation of the dissolved elements.

crush ore, after having been spalled down, and separated from the waste rock, assays from three to five per cent. It is further treated by crushing and jigging. The so-called fourths consist of limestone containing copper pyrites in coarse grains, small strings and finely disseminated particles. This quality is not worked up at present. It is piled in separate heaps, in order to be treated by stamping and washing, so soon as the apparatus for that purpose is procured. Besides the coarser rock, there is produced, in the various workings, smalls, which consist of pieces of ore and rock whose diameter does not exceed three or four inches, and which are usually so coated with mud as not to be easily separable from each other. These smalls are first thrown upon a screen, the bars of which are one and a quarter inches apart; the larger pieces which remain upon it are sorted and spalled in the same way as the coarser rock; while the smaller pieces, which pass through, and assay from two to three per cent, are at once subjected to crushing and jigging.

The crush ore, and the finer part of the smalls, are reduced, by passing between cast iron rollers, to such a size as to pass through a sieve of twelve holes to a square inch. The crushed product is then brought into a jigging sieve, having sixty-four holes to a square inch. This sieve is wholly immersed in water, where it receives a succession of jerks, each of which causes it to descend, and suspends its contents in the water. These then arrange themselves according to their relative specific gravities; the richest and largest particles at the bottom of the sieve, the poorest and smallest at the top. After the sieve has received a sufficient number of jerks, it is raised out of the water, and the upper layer, or skimmings, scraped off. These contain from one and a-half to two per cent copper, and are thrown aside. That part which collects at the bottom of the sieve, and contains twelve to fourteen per cent of copper, is called ragging, and is a marketable product. There is sometimes produced an intermediate sort called seconds, occupying a position on the sieve between the skimmings and the ragging. This is laid apart, and afterwards re-jigged, the same products being produced as those above mentioned. In this process of jigging a considerable portion, the finest part of the crush work, falls through the sieve into the box below, which contains the water, and is called hutch-work. This, on being washed in a streak from the slime which it contains, assays from eight to eleven per cent. and is then in a marketable state. The costs of these various dressing operations were as follows :—Coarse spalling costs from fifteen to twenty-five cents per cubic yard of rock, according as the same contains less or more ore ; fine spalling from fifty to eighty cents per ton of the resulting ore, according to the quality of the rock operated on. The processes of crushing and jigging cost during January, February and March, 1682, $5.60 per ton of products, and $1.15 per ton of crush ore. The total expense of coarse and fine spalling, and crushing and jigging, per ton, of all the products is at present $5.25.

The crushing and jigging processes are almost the same as those adopted in Cornwall for the dressing of crush ore, yet they are attended with the loss of much of the copper contained in the original crush ore. Having for a long time estimated the quantities, and assayed the samples of the crush ore put through the rollers; and ascertained the weight and contents of the resulting products, I have found that the loss of copper is much more than might at first sight be imagined. I subjoin a few of the results obtained: From the 17th of November to the 12th of December, 1861, there were crushed 956,760 lbs. of ore, containing 4.6 per cent, or 44,010 lbs. copper. From this there were produced 283,451 lbs. of products, averaging 10.95 per cent, and containing 31,052 lbs. copper. There were consequently lost 673,309 lbs. of skimmings and slimes of 1.92 per cent, containing 12,958 lbs. copper. Thus 29.5 per cent of the copper contained in the crush ore was lost in the skimmings and slimes. Further, during January, February and March, 1862, there were crushed 2,881,160 lbs. of ore averaging 3.4 per cent, and containing 100,303 lbs. of copper; from which there were roduced 615,520 lbs. of products averaging 9.5 per cent, and containing 58,711 lbs. of copper. There were consequently 2,265,580 lbs. of skimmings and slimes of 1.83 per cent, containing 41,592 lbs. of copper. Thus 41.5 per cent. of the copper contained in the crush ore was lost. It is to be remarked, however, with regard to the foregoing results, that much of the copper contained in these skimmings and slimes is with proper appliances recoverable. Subsequent to the first of July, 1862, arrangements were made for dressing the ore by contract, and for working up a part of the slimes as these were being produced. Under this system the following result was obtained :—During the months of July, August and September, 1862, there were crushed 3,348,887 lbs. of crush ore and smalls, of from 2.0 to 5.9 per cent, averaging 4.1, and containing in all 137,969 lbs. of copper. From this there were produced 1,073,644 lbs. of products of from 8.0 to 12.6 per cent., averaging 9.9 per cent, and containing 106,625 lbs. of copper. There were consequently cast aside 2,275,243 lbs. of skimmings and slimes, averaging 1.38 per cent, and containing 31,344 lbs. of copper; which is equal to 22.7 per cent of the copper contained in the original ore.

From the results here narrated, it would appear that at least one-fourth of the copper contained in the crush ore is lost in the process of dressing it. The actual value thus wasted goes far to counterbalance the saving of freight which results from concentrating the ore. It would not certainly be attended with greater advantage to send the crush ore of four or five per cent to market instead of dressing it; but it admits of plain proof, that it would be better at once to sell an ore of seven per cent, and pay freight on it to Boston or New York, rather than to submit it to further concentration by crushing and jigging, and sustain the great loss of copper which occurs in these operations. The following calculations will be found to confirm this statement:

100 tons of 7.0 per cent ore would bring in Boston $4.00 per unit; which for 6.5 per cent, (½ per cent being deducted for the difference between dry and humid assay) is equal to $26.00 per ton,..........		$2600.00
From this deduct freight, barrels, &c., at $9.00 per ton,		$900.00
There remains,..................		$1700.00
On the other hand, 100 tons of 7.0 per cent ore would yield, by crushing and jigging, about 43¾ tons of 12.0 per cent products; which would bring, say at $4.30 per unit, for 11.5 per cent, $49.50 per ton,...		$2163.43
From this deduct:		
Cost of crushing, &c., at $5.50 per ton,.....	$240.70	
Freight and barrels, at $9.00 "	393.75	634.45
There remains,..................		$1528.98

or $1.71 per ton less than when at once sent to market. It is thus evident that an advantageous concentration of a seven per cent ore by means of crushing and jigging, is not possible. The question next arises, as to whether such an ore could not be smelted at the mines, and a large part of the cost for freight and barrels saved :—

100 tons of this ore might, by smelting, be made to yield 16⅔ tons of regulus of 36.0 per cent (even supposing that one-seventh of the copper were lost in the operation). This would be worth, at $4.50 per unit, or $162 per ton,		$2700.00
From which deduct:		
Cost of smelting, at $5.00 per ton,	$500.00	
Barrels and freight, $9.00 "	150.00	650.00
There remains,		$2050.00
The 100 tons of 7.0 per cent ore sent to market, would have yielded, according to the previous calculation,		1700.00
Consequent profit by smelting		$350.00

or $3.50 per ton of seven per cent ore. It would thus appear that the best mode of treating the crush ore would be to separate from it as much seven per cent ore as possible, and to treat the refuse from this, which might assay two per cent, by stamping and washing. Of this two per cent ore, the fourths (now set aside) would, on being worked up, yield a large quantity; and although they might be unable to bear much of the mining expenses, would considerably more than pay the cost of their own concentration.

In order to ascertain the fitness of some of the products for metallurgical treatment, the following examinations were made towards the close of last year. A sample of first quality ore from No. 4 shaft gave,

Silica	25.12	
Carbonate of lime	33.10	
Iron	5.81	
Copper	24.75	
Sulphur,	11.22	by difference.
	100.00	

A sample of ragging gave:—

Silicious matter	16.92
Carbonate of lime	53.07
Carbonate of magnesia	trace
Iron	4.06
Copper	13.07
Sulphur	11.62 by difference
	100.00.

A sample of hutch-work gave:—

Silicious matter	24.32
Carbonate of lime	53.10
Carbonate of magnesia	2.10
Iron	3.36
Copper	9.95
Sulphur	7.17 by difference.
	100.00

From these results, and from others previously given, it will appear that silica and lime are almost the only slag-producing materials contained in these ores. Iron is present in small quantity, but without previous calcining, which in this case is inadmissible, it would go to the formation of the regulus. The compounds of silica with lime are all but infusible; but these substances form with iron oxide, easily fusible slags, which are frequently produced in copper-smelting works. In smelting the Acton ores, therefore, a flux containing iron oxide, such as puddling slag, or roasted iron pyrites, is indispensable. The cost of these would not add very materially to the expense of smelting; but it would of course be better, if such could be had in the neighborhood, to use in place of these fluxes, poor pyritous copper ores, previously calcined.

The total product of the Acton Mine during the period to which this paper has reference, viz., from September 1st, 1861, to September 30th, 1862, was 2336 tons of 2,352 lbs.; or 2,747 tons of 2,000 lbs, the average copper contents of which amounted to 12.0 per cent. This is equal to an average monthly production of 179 tons of ore of 2,352 lbs., or 211 tons of 2,000 lbs. In reality, however, the production was much greater in the summer than the winter months. For instance, the total produce during July, August and September last, was;—

$366\frac{1868}{2352}$	tons	first quality ore.
$80\frac{1012}{2352}$	"	second " "
$150\frac{922}{2352}$	"	ragging
$312\frac{2075}{2352}$	"	hutch-work
$84\frac{882}{2352}$	"	buddle-work
$994\frac{2062}{2352}$	tons	in all, or 331 tons monthly.

With regard to the future of the mine, I see no reason to doubt that it will be as successful as its past; provided always that a due amount of prospective work is done, and that arrangements are made for saving freight, and increasing the value of the poorer ores, by smelting the products of the mine on the spot. To this must of course be added prudent and economical management, without which even the richest mines yield little profit.

In conclusion, I have to remark, that it may seem to some, that in the foregoing, I have been unnecessarily minute. I have, however, thought myself justified in going into detail, by the altogether exceptional character of the deposit. As far as I am aware, there is no instance known of a mineral deposit bearing even a moderate resemblance, in its various relations and characters, to that of the Acton Mine; and, consequently, it is impossible to draw on any stock of experience gained elsewhere, for guidance in exploring it. That the future of the mine may be successful, and its permanency established, no fact, however seemingly trivial, observed in its earlier working ought to be regarded as unimportant. That other deposits of a similar nature may yet be discovered in the district is not impossible; and in the working of such, the experience gained at Acton may not be altogether valueless. For these reasons I have, in the foregoing paper, mentioned details and minutiæ, which few may find useful; but at the same time I trust there will be found in it matter of more general interest.

Actonvale, Canada East, 28th October, 1862.

MISCELLANEOUS.

ON THE AGE OF THE PYRAMIDS OF EGYPT.

Mahmoud Bey, astronomer to the Vice-roy of Egypt, has just published the results of his investigations of the pyramids, undertaken at the request of the Vice-roy. The measures of the great pyramid he finds to be 231 meters for the sides of the square base, and 146.5 meters for the height; so that the faces form an angle of 54° 45′ with the horizon. This agrees with the known inclinations of the six other pyramids of Memphis; which vary between 51° and 53°, and average 52° 30′. This common inclination; and the fact that the pyramids, and the other funereal monuments which surround them, are, as Mahmoud has satisfied himself, always placed exactly facing the four cardinal points, suggests that these pyramids had some relation to a celestial phenomenon, and to the divinity which presided over that in the Egyptian mythology. Now he has found that Sirius, when it passes the meridian of Gizeh, shines vertically upon the southern face of the pyramids; and in calculating the change in the position of this star for a series of centuries, shows that 3,300 years before the Christian era, the rays of this star, at its culmination, must have been directly perpendicular to the southern face of the pyramids, inclined at an angle of 52° 45′ with the northern horizon. According to the principles of astrology the influences of a star are greatest when its rays fall perpendicularly upon an object. If now we suppose that these pyramids were constructed a little more than 5,000 years ago, it would appear evident that their faces received the angle of 52 degrees, in order to be perpendicular to the rays of Sirius, the brightest star of our northern heaven; which was consecrated to the god Sothis, the celestial dog, and the judge of the dead, and was also said to be the soul of this deity.

This opinion is confirmed in an unexpected manner by the following considerations. The pyramids, being tombs or funereal monuments, would naturally be under the patronage of that divinity who presides more particularly over the dead, that is to say with Sothis, who is no other than the thrice-great Hermes, Cynocephalus, Thoth or Anubis. Now the hieroglyphic designation of Sothis is a pyramid by the side of a star and a crescent. Nothing is therefore more natural than this relation thus discovered by Mahmoud Bey between Sirius and the pyramids. The date of

3,300 B. C., thus assigned to these structures, accords with Bunsen's determination, according to which king Cheops reigned in the thirty-fourth century before our era. It also agrees with the tradition of the Arabs, according to which they were constructed three or four centuries before the deluge; which they assign to the year 3,716 before the Hegira.—(*Le Cosmos*, *Nov.21st*, 1862.)

T. .S .H.

ON THE CAUSE OF ATTRACTION.

The Rev. Father Secchi, the learned director of the Roman Astronomical Observatory, has just published an essay, in which he discusses from an advanced point of view the theory of attraction After having shown, in accordance with the views so ably expounded by Mr. Tyndal in his paper on Force, published in the *Naturalist*, (p. 241,) that all the physical forces or movements of which we are cognizant come to us from the solar centre, the learned Jesuit inquires, "But how does this movement or series of movements return to the sun? Who knows but what that part of the heat thus emanating from the sun, which is not lost by radiation into space, is converted into an impulsion of the mass of the earth towards the sun? I do not pretend to give a theory, but only to propose a conjecture, which it will be sufficient for me to show not to be absurd."

"We see that the intensity of heat, like that of gravity, diminishes inversely as the square of the distance. We know also that a prodigious quantity of molecular movements come from the sun by luminous and calorific radiation, and under the form of vibratory disturbances, remain, apparently destroyed, at the earth's surface, instead of being lost by radiation towards the planetary spaces. In fact, heat coming from sources of a very high temperature (that is to say, heat of short undulations,) when brought to a lower temperature, (or to long undulations,) can no longer traverse the terrestrial atmosphere and radiate into space. A certain quantity of motion coming from the sun must thus rest imprisoned in terrestrial bodies, by the chemical force to which it gives rise. So that in reality the *vis viva*, and the *quantity of movement* in the terrestrial globe, and its surrounding mass of ether, must increase indefinitely, if there were not some way of escape or discharge. Why may not this discharge be the incessant fall of the earth towards the sun, a fall expressed by the linear distance which the earth deviates from the tangent of its orbit; which tangent the earth would follow, in virtue of its inertia, did not some cause draw it towards the solar centre?"

Of this brilliant and novel conjecture, the learned editor of *Le Cosmos*, from whom we extract the above, remarks, that it seems to be one of those happy inspirations which belong to truth alone; and he adds, "there is great merit in having originated an idea which has never before presented itself to the human intelligence and which, in time to come, may bring forth fruitful results."—*Le Cosmos, Nov.* 21, 1862. T. S. H.

REVIEW.

DANA'S MANUAL OF GEOLOGY.*

In no part of the world has the science of geology been more successfully cultivated than in North America. But the results that have been arrived at, are scattered through a multitude of reports of the different surveys, and papers of greater or less length in the scientific journals. Up to the present time he who has endeavored to get a clear idea of the geology of the whole North American continent has found it necessary to devote more time and means to the object, than most students can well afford. In the important work, just issued by Professor Dana, this great difficulty is removed. We have now in one compact and beautifully illustrated book, not only a comprehensive and well-balanced account of the elementary principles of the science, but also the general results of what has been ascertained of the geology of this continent, down to the present moment. We have not, just now, leisure to give a full review of this excellent publication, and must therefore content ourselves with a mere glance at its contents. Prof. Dana has divided his subject into four parts, as follows.—

1. Physiographic Geology.—In this part of the work, are described the forms of the earth's surface, as exhibited in the

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*Manual of Geology: treating of the principles of the science with special reference to American Geological History, for the use of Colleges, Academies, and Schools of Science. By James D. Dana, M. A., LL. D., Silliman Professor of Geology and Natural History in Yale College, &c., &c. Illustrated by a chart of the world, and over one thousand figures, mostly from American sources. Philadelphia: published by Theodore Bliss & Co. London: Trübner & Co. 1863. Small 8vo, pp. 812.

distribution of the land and water; the directions of certain physiographic lines, in conformity with which the boundaries of the continents, the ranges of islands and chains of mountains are arranged; the system in the reliefs or surface-forms of the continental lands; the system of oceanic and atmospheric currents, and the general laws of the distribution of forests, prairies and deserts. All these phenomena are within the domain of physical geography, but they can never be well understood unless investigated through geology, as their origin dates far back in time.

2. Lithological Geology.—Relating to the composition and different kinds of rocks.

3. Historical Geology.—Under this title is discussed the main portion of the subject; the description in their order, of all the formations from the most ancient up to the most recent. Here we have, for the first time, the science of geology elucidated by special reference to the series of American rocks; thus removing the great difficulty we have pointed out in the first lines of this notice. Full details of all the deposits, their lithological composition, their characteristic organic remains and geographical distribution are given. There appear to be about 700 figures of fossils, nearly all of which were drawn on wood by Mr. F. B. Meek, an accomplished artist, and one of the best palæontologists of the continent. Most of the species figured are American, and several of them are from the Decades of the Canadian Survey, representing peculiar forms only possessed by the Provincial Collection of Canada. It is not uncommon to find works on general geology illustrated by figures, which, for all natural-history purposes, are perfectly worthless. This must happen when neither the artist nor the author is a naturalist. In the book before us, the illustrations are first-class, for the reason that all the parties engaged in their production, perfectly understood how to prepare them.

4. Dynamical Geology.—This division treats of the causes of events in the earth's geological progress. "These events include the formation of all rocks, stratified and unstratified, with whatever they contain, from the earliest Azoic to the modern beds of gravel, sand, clays, and lavas; the oscillations of the earth's crust; the increase of dry land, elevation of mountains, and elimination of the surface features of the globe; the changes of climate; the changes of life."

The work concludes with an appendix and a copious index.

Geology is a science of such vast extent, and so largely composed of all others, that few men possess the almost universal knowledge required to produce a good manual of its elementary principles. The author of this work being a profound geologist mineralogist, zoologist, and physicist, is one of the best qualified for the task. His book is a great one, and its publication will mark the commencement of a new era in the progress of the science. In conclusion we would strongly recommend it to the Canadian student. With the General Report on the Geology of Canada, soon to be published by Sir W. E. Logan, the Decades of the Survey, and Dana's Manual, he can enter the field unimpeded by the crowd of difficulties to which observers in this province, have heretofore found themselves opposed at the very outset.

E. B.

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The next number of this Magazine will be published in February, 1863.