SYNOPSIS OF THE AIR-BREATHING ANIMALS OF THE PALÆOZOIC IN CANADA, UP TO 1894.

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V. — *Synopsis of the Air-breathing Animals of the Palæozoic in Canada, up to* 1894.

By Sir William Dawson, C.M.G., LL.D., F.R.S.

(Read May 23rd, 1894.)

Our knowledge of the animal inhabitants of the land in Palæozoic time is very meagre in comparison with what is known of marine creatures. There was probably less land in early Palæozoic ages than later. Atmospheric conditions may have been less favourable to breathers in air. Life on the land requires a higher nervous and muscular system than those necessary in water, and different means of respiration. If, therefore, as seems probable, animal life originated in the waters, it may have required a long time before, in the great creative plan, these higher and more complex structures took their origin; and the introduction of the more elevated forms of land life may have been a slow and gradual process.

It is also to be observed that, as the greater part of our fossiliferous deposits are of aqueous origin, the chances of preservation of aquatic organisms are much greater than are those of terrestrial species.

These causes are alone sufficient to account for the paucity of fossil remains of land animals in the older rocks. But besides this, their rarity and their occurrence in special and exceptional places, make them less likely to attract the attention of collectors. We are apt to find what we expect, less likely to find what we do not expect or think very unlikely to occur. This last circumstance is perhaps connected with the fact that when a single species of a new type is discovered in a particular locality, it is likely to be followed by other discoveries elsewhere.

It is of interest to us, that in several of these discoveries, the Eastern Provinces of Canada have taken a leading part. The finding of Batrachian footprints by Logan at Horton Bluff in 1841, was the first indication of the existence of air-breathing vertebrates in the Carboniferous rocks.[1] The fact was published in 1842, and in 1844 Dr. King announced the discovery of footprints in the Carboniferous of Pennsylvania, and Von Decken the finding of skeletons of Batrachians in the coalfield of Saarbruck. The first discovery of the osseous remains of any Palæozoic land vertebrate in America was that of *Baphetes planiceps*, found by the author in the Pictou coalfield in 1850.[2]

The first announcement of insects in the Devonian (Erian) was that by Hartt of the finding of four species of insect wings in the "Fern Ledges" of the Little River group at St. John, New Brunswick, in 1862.[3] Insects had previously been found in the Carboniferous of Europe, and have since been traced back to the Silurian.

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[1] Proceedings Geol. Society of London, 1842.

[2] Not published till 1855. Owen, Journal Geol. Society of London, Vol. X., p. 207.

[3] Canadian Naturalist, N.S., III., 205, 1867.

The earliest known Carboniferous Millipede was *Xylobius Sigillariæ*, discovered by the author in Nova Scotia in 1858, and described in the Journal of the Geological Society in 1859. Since that time numerous species of these animals have been found in the Carboniferous and Devonian of Europe and America, and, in so far as Canadian species are concerned, have been described by Scudder and Matthew.

The first known Palæozoic land snail was that found by Lyell and myself at the South Joggins, in Nova Scotia, in 1851.[1] This form of land life has since been recognized in other coal regions in America, and in the Devonian plant beds of St. John, but not as yet in Europe.[2]

In the group of Arachnidans, both spiders and scorpions were found in Palæozoic beds in Europe before they were recognized in America

The circumstance that Canada has been so fortunate in these discoveries, along with the dispersed condition of the descriptions of our Palæozoic air-breathers, renders it appropriate that a list of them should appear in our Transactions, with references to the publications in which they have been described, and to their localities, discoverers, and dates of discovery and description.

The known land animals of the Palæozoic in Canada may be summed up as follows :—

Vertebrata, 26 species; all Amphibia.

Arthropoda, 33 species; viz., Insects, Scorpions, Myriapods.

Mollusca, 5 species, Pulmonate Snails.

Four of the vertebrate species are named for the first time in this paper—two from osseous remains and two from footprints.

The bibliography given on the following pages refers only to original descriptions and figures, and to later papers supplementary thereto. More full lists of references for the Arthropod species will be found in Scudder's Index to Fossil Insects, Bulletin Geol. Survey United States, No. 71, 1891. The type specimens of most of the vertebrates, and several of the other species, have been placed in the Peter Redpath Museum, of McGill University.

I. VERTEBRATA.

Up to the present time no evidence of the existence of air-breathing vertebrates has been recognized older than the base of the Carboniferous system, though it is not impossible that some of the fishes of the Devonian may have been endowed with a swimming-bladder capable of being used as an imperfect lung, in the manner observed in modern Dipnoi and Ganoids. Independently of the inference from general structure, the conditions of life in inland waters abounding in vegetable debris would render this probable. The pectoral fins of some Erian and Carboniferous fishes also show points of advance in their bony structure which may have been connected with the habit of creeping in shallow water. No animals, however, endowed with limbs capable of locomotion on land and with the correlated structures of trunk and skull have as yet been recognized in beds older than the Carboniferous. We may, however, hope yet to find land vertebrates in the Devonian, as the conditions seem to have been suitable to them.

All the air-breathing vertebrates known in the Carboniferous proper are referred to the

[1] Journal of Geological Society of London, Vol. IX., p. 58, 1853.

[2] Dawson, Revision of Palæozoic Land Snails, American Journal of Science, Vol. XX., 1880, p. 405.

class Amphibia; but some of them approach in certain important characters, as in the development of the ribs and chest, and therefore of the respiratory and circulatory power, to the true reptiles. In the Permian, the newest system of the Palæozoic, true reptiles have been found in Europe and in the United States; but not as yet in Canada, though footprints of reptiles or amphibia occur in the upper member of the Carboniferous.

The Canadian species have all been grouped for the present in the order *Stegocephala*. In general form, those hitherto found in Canada are lizard-like, with four limbs, often well developed, and usually with five toes. The arrangement and division of the cranial bones resemble those in modern batrachians. The ribs are usually long and curved. The vertebræ are often only imperfectly ossified, but their processes are well developed. The body is protected below by bony plates and overlapping bony scales, and in some species the back has spines, tubercles and horny scales. The order has been divided into sub-orders, based on the more or less perfect ossification of the vertebræ, viz., (1) *Leptospondyli*, or those having the vertebræ merely crusted with bone; (2) *Lemnospondyli*, or those with the vertebræ in separate bony pieces; (3) *Stereospondyli*, or those with perfectly ossified vertebræ. There is, however, good reason to believe that this arrangement is somewhat arbitrary and provisional, and a number of imperfectly known species cannot be placed with certainty in either group. The Canadian genera may all be arranged in two families, *Microsauria* and *Dendrerpetonidæ*.[1] It may be remarked, however, that the former may prove to be entitled to the rank of an order; and that in the case of the latter, the species included in it approach so nearly to the Labyrinthodonts that they have hitherto been included by me in that family, into which, indeed, they appear to graduate.

Class—AMPHIBIA.

Order—STEGOCEPHALA.

Family—*Microsauria*,[2] Dawson.

The Microsauria are lizard-like in form, with limbs usually well developed and five toes, and a long but not flattened tail. Cranial bones smooth. Maxillary and mandibular teeth numerous, simple. In some many small vomerine or palatal teeth. Vertebræ ossified externally, bi-concave, with well developed articular, spinous, and in the trunk, lateral processes, ribs long and curved, generally with two heads, chest and abdomen protected by a sternal plate and by bony scales or rods. Skin above with horny scales sometimes developed into tubercles, spines or lateral lappets.

Genus HYLONOMUS, Dawson.

Teeth numerous, small, conical, sharply pointed, vomerine teeth small and numerous, skull ovate, smooth; hind limbs and pelvis remarkably well developed; tail long, abdominal scales oval. In some species an ornate arrangement of tubercles and spines on the back and lappets on the sides.

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[1] Zittel, Palæontologie, 1893, uses the term *Gastrolepidoti*; but as the Microsauria also have abdominal bony scales, this is not distinctive.

[2] *Order* Microsauria of my "Air-breathers of the Coal Period," 1863. I still think these animals ordinally distinct.

1. Hylonomus Lyelli, Dawson.

[Journal of Geological Society of London, vol. xvi., 1859, p. 268. Air-breathers of the Coal Period, 1863, p. 45 Acadian Geology, 3rd edition, 1880, p. 870. Transactions Royal Society of London, Pt. II., 1882, p. 635.[1] London Geological Magazine, June, 1891.]

Coal Formation, S. Joggins, Nova Scotia, collected by Sir C. Lyell and J. Wm. Dawson, 1851.

2. Hylonomus Wymani, Dawson.

[J. G. S., *l.c.* Air-breathers, p. 52. Acadian Geology, p. 378. Trans. R. S., Pt. II., 1882, p. 637.]

Coal Formation, S. Joggins, N. Scotia, collected by Lyell and J. W. D., 1851.

3. Hylonomus multidens, Dawson.

[Trans. R. S., II.. 1882, p. 637.]

Coal Formation, S. Joggins, N. Scotia, collected by J. W. D., 1878-9.

4. Hylonomus latidens, Dawson.

[Trans. R. S., II., 1882, p. 637.]

Coal Formation, S. Joggins, N. Scotia, collected by J. W. D., 1878-9.

Genus Smilerpeton, Dawson.

Form somewhat elongated and limbs short. Mandibular and maxillary teeth wedge-shaped, with cutting edges. Palatal teeth numerous, some of them large. Abdominal scales oval.

5. Smilerpeton aciedentatum, Dawson.

[*Hylonomus aciedentatus*, Dn., J. G. S., *l.c.* Air-breathers, p. 49. Acadian Geology, p. 376. Trans. R. S., Pt. II., 1882, p. 638.]

Coal Formation, S. Joggins, collected by J. W. D., 1859.

Genus Hylerpeton, Owen.

Body stout with strong limbs. Mandibular and maxillary teeth strong, not numerous, grooved at apex. Palatal teeth numerous and some of them large. Thoracic plate broad. Abdominal scales pointed or oat-shaped.

6. Hylerpeton Dawsoni, Owen.

[Owen, J. G. S., vol. xviii., p. 241. Dawson, Air-breathers, p. 55. Acadian Geology, p. 380. Trans. R. S., II., 1882, p. 639.]

Coal Formation, S. Joggins, N. Scotia, collected by J. W. D., 1879.

7. Hylerpeton longidentatum, Dawson.

[Preliminary Notice, American Journal of Science, December, 1870. Trans. R. S., II., 1882, p. 640.]

Coal Formation, S. Joggins, N. Scotia, collected by J. W. D., 1879.

[1] These names and those of collectors will be abbreviated in the subsequent titles, or after the first reference.

8. HYLERPETON INTERMEDIUM, s. n.

This species is known as yet only by the mandibles and portions of the skull, which are rather shorter than those of adult individuals of the last species. The extremity of the mandible and the cranial bones have the same slightly waved surface as in the other species. Mandibles three centimeters long and the teeth which are about fifteen in each ramus of the lower jaw are simple, with large pulp cavities. Those of the maxillary bone slightly enlarging upwards, and intermediate in form between the long slender teeth of *H. longidentatum* and the thick obtuse teeth of *H. Dawsoni*.

Coal Formation, S. Joggins, N. Scotia, in erect tree, discovered by P. W. McNaughton, 1893.

Genus FRITSCHIA, Dawson.

Body lizard-like. Limbs large and well ossified. Mandibular and maxillary teeth conical, grooved at apex. Abdominal scales slender and rod-like.

9. FRITSCHIA CURTIDENTATA, Dawson.

[*Hylerpeton curtidentatum*, Preliminary Notice, Am. J. Sci., *l.c.* Trans. R. S., II., 1882, p. 641.]

Coal Formation, S. Joggins, Nova Scotia, col. J. W. D., 1879.

Genus AMBLYODON, Dawson.

A genus characterized by stout cylindrical teeth, blunt at the apices; but otherwise imperfectly known.

10. AMBLYODON PROBLEMATICUM, Dawson.[1]

[Trans. R. S., II., 1882, p. 644.]

Coal Formation, S. Joggins, Nova Scotia, col. J. W. D., 1878.

Genus SPARODUS, Fritsch.

11. SPARODUS, sp.[1]

[Trans. R. S., II., 1882, p. 643.]

Coal Formation, S. Joggins, Nova Scotia, col. J. W. D., 1878.

All of the above species of Microsauria have been found in the interior of erect trees at the South Joggins, in Nova Scotia, a mode of occurrence which indicates that they were eminently terrestrial in their habitat. See note appended.

Family *Dendrerpetonidæ*, Fritsch.

(*Gastrolepidoti*, Zittel.)

In general form, and in the arrangement of the bony and horny scales, these animals resemble the Microsauria, but the teeth are furrowed and have the enamel plicated at the base, and the surface of the cranial bones is strongly sculptured. They are on the whole

[1] These species are uncertain as to their classification.

larger and more formidable creatures than the Mierosauria, but less so than the Labyrinthodontia. I have formerly regarded them as Labyrinthodonts, and as the name Gastrolepidoti fails to distinguish them from the Microsaurians, am disposed to prefer Fritsch's name, based on the typical genus, despite its length and want of euphony.

Genus DENDRERPETON, Owen.

Teeth numerous, plicated at the base and chiefly on the inner side; large detached teeth in palate, also small vomerine teeth. Bones of skull corrugated; body protected below with thoracic plate and ovate bony scales; above, horny and imbricated scales, also scaly lappets or pendants. Form elongated; fore limbs largest; vertebræ somewhat biconcave; neural arches and bodies ossified.

12. DENDRERPETON ACADIANUM, Owen.

[J. G. S., vol. ix. Air-breathers, p. 17. Acadian Geology, p. 362. Trans. R. S., II., 1882, p. 642. Geol. Maga. Apl., 1891.]

Coal Formation, S. Joggins, Nova Scotia, col. Lyell and J. W. D., 1851.

13. DENDRERPETON OWENI, Dawson.

[J. G. S., vol. xviii., p. 469. Air-breathers, p. 32. Acadian Geology, p. 368. Trans. R. S., II., 1882, p. 643.]

Coal Formation, S. Joggins, col. J. W. D., 1860.

The remains of the above species of Dendrerpeton were found in erect trees at the South Joggins; sometimes several individuals in one tree.

Genus BAPHETES.

Teeth conical, hooked, striated longitudinally, and with inflected and convoluted cement; in two series; the inner of larger size. Cranial bones much corrugated. Head broad. Probably a dermal covering of corrugated bony scales.

14. BAPHETES PLANICEPS, Owen.

[Journal Geol. Society, vols. x. and xi. Air-breathers, p. 10. Acadian Geology, pp. 328, 359.]

Coal Formation, Albion Mines, Pictou, col. J. W. D., 1850.

Genus PLATYSTEGOS, Dawson.

Head broad and short; orbits very large; cranial bones deeply sculptured; teeth strongly plicated and curved, with sharp edges at apices, especially the inner palatal teeth, which are very large; many minute teeth on the vomerine bones; vertebræ ossified, biconcave; limb bones imperfectly ossified, short; lower surface protected with a thoracic plate and thick, densely imbricated bony scales in transverse rows; body above with thin, rounded scales, concentrically marked.

15. PLATYSTEGOS LORICATUM, s. n.

Characters as above. Head about 8 centimetres long; when flattened, 9 c.m. broad across parietal foramen; squamosal and temporal bones projecting backward in points much

behind the condyles; parietal foramen small; orbits large; length of longest tooth seen 7 m.m.; cranial bones closely and deeply pitted; humerus with very thin bony walls, cartilaginous within, 3·5 c.m. long.

Erect tree, Coal Formation, South Joggins, col. P. W. McNaughton.

(Incertæ Sedis.)

Genus Eosaurus, Marsh.[1]

Eosaurus Acadianus, Marsh.—Known by two biconcave vertebræ 2·4 inches in diameter and much resembling the caudal vertebræ of *Ichthyosaurus*—see paper by Prof. Marsh, Silliman's Journal, vol. xxxiv.

16. Eosaurus Acadianus, Marsh.

[Am. Jour. Sci., vol. xxxiv. Air-breathers. p. 58. 1861, Acadian Geology, p. 382.]

Coal Formation, S. Joggins, Nova Scotia, col. Prof. O. C. Marsh, 1855.

(Species known by footprints only.)

Some of these may be identical with species known by osseous remains; but it is impossible to be certain as to this.

Genus Sauropus, Lea.

Large plantigrade animals, probably Labyrinthodonts or allied. Hind foot usually the larger, five toes.

17. Sauropus unguifer, Dawson.

[Geol. Maga, vol. ix., 1872, p. 251. Acadian Geology, 3rd ed., supplement, p. 62. Trans. R. S., II., 1882, p. 651.]

Millstone Grit, Fillimore's Quarry, R. Philip, col. Albert L. Hill.

On the same slabs with this species there are footprints of another animal of about half the size and with shorter feet.

18. Sauropus Sydnensis, Dawson.

[Acadian Geology, p. 358. Trans. R. S., II., p. 652.]

Coal Formation, Sydney, C. B., col. R. Brown.

19. Sauropus antiquior, Dawson.

[Trans. R. S., Pt. II., 1882, p. 652.]

Lower Carboniferous, Parrsboro', col. F. M. Jones.

Genus Hylopus, Dawson.

Smaller footprints, digitigrade, and made by animals having a long stride and hind and fore feet nearly equal. Five toes. Probably footprints of Microsauria and possibly of Dendrerpeton.

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[1] Systematic position uncertain. May be Amphibian or Enaliosaurian.

20. Hylopus Logani, Dawson.

[Air-breathers, p. 5. Acadian Geology, p. 353. Trans. R. S., Pt. II., 1852, p. 653.]

Lower Carboniferous, Horton, col. Sir W. E. Logan, 1841, M. Pineo, 1881.

21. Hylopus Hardingi, Dawson.

[Air-breathers, p. 8. Acadian Geology, p. 356. Trans. R. S., *l.c.*, p. 653.]

Lower Carboniferous, Parrsboro', col. Dr. Harding, 1846 ?

22. Hylopus caudifer, Dawson.

[Air-breathers, p. 8, Fig. 3. Trans. R. S., *l.c.*, p. 653.]

Coal Formation, S. Joggins, col. J. W. D.

23. Hylopus minor, s. n.

On a slab of sandstone in the Museum of the Geological Survey of Ottawa, collected by Mr. Weston, is a series of small footprints about two c.m. in diameter, with five toes, the fore foot being a little smaller than the hind. The length of the stride of the hind foot is eight c.m. The distance transversely from the outside of the tracks is about six c.m. There is a central tail-mark, and at the sides, when the animal has turned, it has left a few slight striæ probably representing the ends of the lateral lappets. These tracks are probably those of a Microsaurian. I have some small slabs with similar but less perfect impressions collected by Mr. Devine at the Joggins, a few years ago.

24. Hylopus, Sp.

Mr. Weston has also placed in the Survey collection a small slab with some footprints of a different character from the above. They are merely marks of five toes, about three centimetres broad, and somewhat close together longitudinally, the distance being less than five centimetres. There is no tail-mark. They may be footprints of a species of Dendrerpeton walking over a firm surface.

25. Hylopus ? trifidus, s. n.

Footprints small, trifid ; in some, traces of a fourth toe projecting outward ; footprints uniform in size and close together in two rows three-fourths of an inch apart—footprints an inch apart. It is just possible that this creature may have been biped. South Joggins, collected by Mr. Devine.

26. Hylopus ? Sp.

Trifid, or occasionally quadrifid, tracks, with slender toes about a quarter of an inch in length resembling those of modern sandpipers, but with occasional smaller tracks as if of smaller fore feet. They probably indicate some creature as yet unknown, otherwise than by its footprints. South Joggins, collected by Mr. Devine.

On the slabs containing these footprints, there are trails of small invertebrate animals, showing many punctate impressions. They may have been produced by worms, millipedes, insects or small crustaceans.

There are in our collections numerous indeterminate and imperfect footprints which have not been named or catalogued. They indicate the presence of land vertebrates from the base of the Lower Carboniferous up to the summit of the Upper Coal-formation; and it is highly probable that several of them belong to creatures not otherwise known. It is hoped that eventually means will be found to publish these, as well as many characteristic bones of batrachians in the above list, which have not been adequately figured.

II. ARTHROPODA.

Class—ARACHNIDA.

Order—PEDIPALPI.

Family—*Geralinuridæ.*

Genus—GRÆOPHONUS.

1. *Græophonus Carbonarius*, Scudder.

[Can. Nat. (2) VIII., 1876; Acadian Geology, Supt. 2nd edition, 56 (as *Libillula Carbonaria*); Mem. Boston Soc. Nat. Hist. IV., 454; Fossil Insects of N. America, I, 430.]

Coal Formation, Cossit's Pit, Cape Breton, col. Albert G. Hill, 1874.

Family—*Eoscorpoidæ.*

Genus—MAZONIA.

2. *Mazonia Acadica*, Scudd.

[Contributions to Canadian Palæontology; II., pp. 63, 64, Pl. 5, figs. 5, 6, 8, 9.]

Coal Formation, S. Joggins, col. J. W. D.

3. *Mazonia*, Sp.

[Ibid., 64, 65, pl. 5, fig. 4.]

Coal Formation, S. Joggins, col. J. W. D.

Genus—PALÆOPHONUS.

4. *Palæophonus arctus*, Matthew.

[Com. to Royal Society of Canada, 1893.]

Devonian,[1] Little River Group, St. John, N.B., col. W. J. Wilson.

(INCERTÆ SEDIS.)

Genus—EURYPTERELLA.

5. *Eurypterella ornata*, Matthew.

[Trans. R. S. Canada, VI., Sec. IV., p. 60, 1888.]

Devonian, Little River Group, St. John, N.B., col. W. J. Wilson.

[1] Mr. Matthew desires me to state that he has recently found some reason to suspect that these beds are as old as Silurian; but the fossil plants indicate rather a Middle Devonian age. J. W. D.

Genus—AMPHIPELTIS.

6. *Amphipeltis paradoxus*, Salter.

[Published (as a crustacean) Journal Geol. Soc. of London, Feb., 1863; Acadian Geology, 2nd edition, p. 523.]

Devonian, Little River Group, St. John, N.B., collected by C. F. Hartt.

7. Spider-like animal, allied to *Anthracomartus*.

[Communicated to Royal Society of Canada, 1893, but not yet published.]

Devonian, Little River Group, St. John, N.B., collected by G. F. Matthew.

Class—INSECTA.

Order—PALÆODICTYOPTERA.

Family—*Palæoblattariæ*.

Genus—ARCHIMYLACRIS.

8. *Archimylacris Acadica*, Scudder.

[Acadian Geology, 2nd edition, 388; American Naturalist, I., 639.]

Coal Formation, Pictou, N. Scotia, collected by J. Barnes.

Genus—MYLACRIS.

Mylacris Bretonensis, Scudder.

[Can. Nat., VII., 271; Acadian Geology, Supt., p. 55, (as Blattina); Mem. Bost. Soc. Nat. Hist., III., 41.]

Coal Formation, Sydney, Cape Breton, collected by R. Brown.

9. *Mylacris Heeri*, Scudder.

[Can. Nat., VII., p. 272; Acadian Geology, Supt. 55, (as Blattina); Mem. Bost. Soc. Nat. Hist., III., 43.]

Coal Formation, Sydney, Cape Breton, collected by R. Brown.

Genus—PETRABLATTINA.

10. *Petrablattina sepulta*, Scudder.

[Proc. Am. Ass., Adv. Science, XXXIV., B. III.; Can. Naturalist, N. S., VIII., 89; Acadian Geology, Supt. 55, (as Blattina); Proc. Bost. Soc. Nat. Hist., III., 125.]

Coal Formation, Sydney, Cape Breton, collected by J. W. D.

Order—PALÆONEUROPTERIDA.

Family—*Platephemeridæ*.

Genus—PLATEPHEMERA.

11. *Platephemera antiqua*, Scudder.

[Devonian Insects of New Brunswick, 1865; Canadian Nat., N. S., III., 205; Acadian Geology, p. 524.]

Devonian, Fern Ledges, St. John, N.B., collected by J. W. and C. F. Hartt.

Family—*Hemeristina.*

Genus—LITHENTOMUM.

12. *Lithentomum Hartii*, Scudder.

[Devonian Insects of New Brunswick, 1865; Can. Nat. (2) III., 206.]

Devonian, Fern Ledges, St. John, N.B., collected by C. F. Hartt.

Family—*Homothetidæ.*

Genus—HOMOTHETUS.

13. *Homothetus fossilis*, Scudder.

[Devonian Insects, N. Brunswick, 1865; Can. Nat., N. S., II., p. 235; Acadian Geology, p. 524.]

Devonian, Fern Ledges, St. John, N. B., col. J. B. Hogan.

Family—*Xenoneuridæ.*

Genus—XENONEURA.

14. *Xenoneura antiquorum*, Scudder.

[Devonian Insects of New Brunswick, 1865; Canadian Naturalist, III., 206; Acadian Geology, p. 526.]

15. *Geroneura Wilsoni*, Matthew.

[Trans. Royal Society of Canada, IV., 1888, p. 57.]

Devonian, Little River Group, Lancaster, N. B., col. W. J. Wilson.

Family—*Protophasmida.*

Genus—HAPLOPHLEBIUM.

16. *Haplophlebium Barnesii*, Scudder.

[Mem. Bost. Socy, Nat. Hist., XI., 151; Acadian Geology, 386; Geol. Magazine, IV., p. 386; Canad. Nat., 2d series, III., 262.]

Synonym, Dictyoneura haplophlebium, Goldenburg, Fauna Sarep. Foss.

Coal Formation, Glace Bay, Cape Breton, col. J. Barnes.

Family—

Genus—GEREPHEMERA.

17. *Gerephemera simplex*, Scudder.

[Scudder, Devonian Insects of New Brunswick; Geol. Maga., V., 174.]

Devonian, Little River Group, St. John, N. B., col. J. W. Hartt.

(INCERTÆ SEDIS.)

18. *Dyscritus vetustus*, Scudder.

[Devonian Ins., N. Brunswick, 1865; Geol. Mag., V., 172.]

Devonian, Little River Group, St. John, N. B., col. C. F. Hartt.

19. *Archæoscolex corneus*, Matthew.

[Trans. R. S. Can., 1888, V., 39.]

Devonian, Little River Group, St. John, N. B., col. W. G. Wilson.

Class—MYRIAPODA.

Order—ARCHIPOLYPODA.

Family—*Archiulidæ*.

Genus—XYLOBIUS.

20. *Xylobius sigillariæ*, Dawson.

[Journal Geological Society, XVI., p. 271; Canad. Nat., VIII., 280; Acadian Geology, 2d edn, p. 49-496, supplement, p. 56; Air-breathers, p. 62; Geol. Maga., V., p. 216; J. G. S., XXV., p. 441; Mem. Bost. Socy., N. H., II., 232 and 361; also sup. note, foss. Myr., 1; Contributions to Can. Pal., Geol. Survey of Canada, II., p. 61.]

Coal Formation, S. Joggins, Nova Scotia, col. J. W. D. (1858, described in 1859).

21. *Xylobius Dawsoni*, Scudder.

[Acadian Geology, p. 406; J. G. S., XXV., p. 441; Mem. Bost. Socy., N. H., II., 235 and 561, and sup. note Myr. 1; Ac. Geol. Supplement, p. 56; Contrib. Can. Pal., II., 61.]

Coal Formation, S. Joggins, Nova Scotia, col. J. W. D.

22. *Xylobius fractus*, Scudder.

[Acadian Geology, 2d ed., p. 496; Ib. Supt., p. 56; J. G. S., XXV., p. 441; Mem. Bost. Socy., N. H., II., 234 and 361, and III., 148; Contrib. Can. Pal., II., p. 61.]

Coal Formation, S. Joggins, N. Scotia, col. J. W. D.

23. *Xylobius similis*, Scudder.

[Acadian Geology, 2d ed., p. 496; J. G. S., XXV., p. 441; Mem. Bost. Socy., N. H., II., 233 and 551, and supt. note 1; Ac. Geol. Sup., p. 56; Contrib. Can. Pal., II., 61.]

Coal Formation, S. Joggins, N. Scotia, col. J. W. D.

Genus, ARCHILIUS.

24. *Archiulus xylobioides*, Scudder.

[Acadian Geology, 2nd ed., 496. J. G. S., xxv., p. 441. Mem. Boston Soc. of Nat. Hist., II., 236 and 561, and Sup. Note 1. Ac. Geol. Supt., p. 56.]

Coal Formation, S. Joggins, Nova Scotia, col. J. W. D.

25. *Archiulus euphoberioides*, Scudder.

[Contributions to Can. Pal., II., p. 59.]

Coal Formation, S. Joggins, Nova Scotia, col. J. W. D.

26. *Archiulus Lyelli*, Scudder.

[Ibid., II., p. 60.]

Coal Formation, S. Joggins, Nova Scotia, col. J. W. D.

Family, *Euphoberidæ*.

Genus, AMYNILYSPES.

27. *Amynilyspes*, sp., Scudder.

[Contrib. Can. Pal. II., 59.]

Coal Formation, S. Joggins, Nova Scotia, col. J. W. D.

Genus, EUPHOBERIA.

28. *Euphoberia atava*, Matthew.

[Com. to Royal Society of Canada, May, 1894.]

Devonian, Little R. Group, St. John, N.B., col. G. F. Matthew.

29. *Euphoberia*, sp., Matthew.

[Ibid.]

(INCERTÆ SEDIS.)

Genus, PALÆOCAMPA.

30. *Palæocampa obscura*, Matthew.

[Ibid.]

Order, CHILOPODA.

Genus, EILETICUS, Scudder.

31. *Eileticus? antiquus*, Matthew.

[Com. to R. S. Canada, May, 1894.]

Devonian, Little R. group, St. John, N.B., col. G. F. Matthew.

Genus, ILYODES, Scudder.

32. *Ilyodes? attenuata*, Matthew.

[Ibid.]

33. *Chilopod*, not named.

[Ibid.]

III. MOLLUSCA.

Class—GASTROPODA.

Order—PULMONATA.

Family—*Helicidæ*.

1. *Pupa* (*Dendropupa*) *vetusta*, Dawson.

[Sir C. Lyell and Dr. Dawson on Remains of Reptiles and a Land shell from the South Joggins in Nova Scotia, Journal of Geological Society of London. vol. IX., 1852 (figured but not named); Acadian Geology, 1855, p. 160; Air-breathers of the Coal Period, 1863; Acadian Geology, 2d and 3d editions, p. 384, 1868 and 1879; Revision of Palæozoic Land Snails, American Journal of Science, vol. XX., Nov. 1880, p. 405.]

Coal Formation, S. Joggins, Nova Scotia, col. Sir C. Lyell and J. W. D., 1851.

2. *Pupa Bigsbii*, Dawson.

[Am. Jl. of Science, vol. XX., 1880, p. 410; Revision of Pal. Land Snails, Am. Jl. Sci., 1880, p. 410.]

Coal Formation, S. Joggins, N. Scotia, col. J. W. D.

3. *Pupa pervetus*, Matthew.

[Trans. Royal Society of Canada, 1893.]

Devonian, Little R. Group, St. John, N. B., col. G. F. Matthew.

4. *Strophia* (*Strophella*) *grandæva*, Dawson.

[American Jl. of Science, vol. XX., p. 413; Salient Points in the Science of the Earth, p. 288.]

Devonian, L. River Group, St. John, N. B., col. G. F. Matthew.

5. *Zonites* (*Conulus*) *priscus*, Carpenter.

[Quarterly Journal of Geological Society of London, Nov., 1867; Acadian Geology, 2d edition, 1868, p. 385.]

Coal Formation, S. Joggins, Nova Scotia, col. J. W. D.

Note on Erect Trees Recently Discovered.

These remarkable repositories of animal remains, occurring in the section of coal-formation rocks so beautifully exposed at the South Joggins in Nova Scotia, were discovered by Sir Charles Lyell and the writer in 1851, and were first described in a joint paper published in the Journal of the Geological Society of London in 1853.[1] Subsequently they have been more fully noticed in "Acadian Geology," in the "Air-breathers of the Coal Period,"[2] and in a paper published in the Transactions of the Royal Society of London[3] in 1882. Shorter notices will be found in my "Salient Points in the Science of the Earth" and in the Transactions of this Society for 1891.

The singular combination of accidents necessary to secure the preservation of remains of land animals in the interior of erect trees was, of course, of very rare occurrence, and in point of fact until the year 1893 these conditions were known to occur in only one set of beds: under the thick-bedded sandstone in Division 4, Section XV., Coal-group 15, of my section of the South Joggins in "Acadian Geology."

In the spring of 1893, however, Mr. P. W. McNaughton, of the Joggins Coal Mine, who had been so kind as to watch the exposures of trees in the cliff at my request, found two productive trees in beds considerably below that which had afforded the previous discoveries. According to Mr. McNaughton's observations, the lowest of these trees is in Division 4, Section XII., Coal-group 26, of my section, or 414 feet lower in the series than the original bed, and about 1,617 feet distant from it along the shore. The intervening beds, besides sandstones, shales and underclays, include fifteen small seams of coal, and five beds of bituminous limestone and calcareo-bituminous shale, so that they must represent a considerable lapse of time. This tree, from the imperfect marking preserved on its surface, was evidently a ribbed Sigillaria. It was rooted in a shaly underclay, with coaly streaks and stigmaria roots. It was 1 foot 11 inches in diameter near the base. Below this, as is often the

[1] Vol. IX., p. 58.

[2] Montreal, 1863.

[3] Volume of 1882, p. 621 et seq.

case with erect sigillariæ, there was a slight swelling or bulb. The lower part is imbedded in gray sandstone and shale for 5 feet 2 inches. Above this are 2 feet 6 inches of gray shale. Above this is a sandstone 12 feet thick, but the tree penetrates this only about 8 inches, when it is broken off. Thus the total remaining height is 8 feet 4 inches.

Five feet of the lower part of this tree are filled with matter which must have been introduced into it while it remained an open pit, accessible to land animals. This material, while all probably introduced by rain-wash or accidental falling from the surface, is of varied character. At the bottom there is a layer of mineral charcoal about an inch in thickness, probably representing the wood or inner bark fallen in, and immediately above this is a black shaly layer, with bones of small batrachians, remains of millipedes and coprolitic matter. Above this is a hard material, composed partly of indurated calcareous clay and partly of vegetable fragments arranged in very irregular layers, which have usually a shallow basin-shape, being hollowed toward the centre. This is partly an effect of compression of the vegetable matter, and is partly caused by the greater thickness of the earthy beds toward the sides, a consequence of rain-wash from the surface. Here and there, throughout this part of the stem, there are thin, black, coaly or shaly bands marking surfaces of some duration. Toward the upper part of the productive five feet, sandstone predominates, but there are still occasional dark beds. Throughout all these layers there are animal remains, which are, however, more abundant in the dark and laminated beds. There is, more especially in the lower part of the tree, much coprolitic matter, sometimes in distinct layers, and rich in phosphate of calcium. Under the lens it is seen to contain fragments of bones of small reptiles and of chitinous matter of millipedes or insects. It is in short in some places a very fine bone-breccia and in others an indurated guano.

This tree is remarkable for the number of vertebrates which have left their remains in it, and which belong to nine species, represented by portions of about 30 individuals. *Pupa vetusta* also occurs, though rarely, and there are numerous fragmentary specimens of millipedes of the genera *Xylobias* and *Archiulus*. This tree is further remarkable above all others hitherto found for the great thickness of the productive layers and the abundance of coprolitic matter, which probably indicate that it remained open a long time, and that some of the animals continued to live and subsist on their feebler companions for some time after they fell into it. It results, however, from this that the bones of the smaller species are much scattered. The devourers of these smaller animals would seem to have been the species of Dendrerpeton whose bones are least scattered, and in some cases associated with carbonised cuticle. One specimen of *Dendrerpeton Acadianum* is the largest yet found, the skull being 4 inches in length. It may have been nearly 3 feet long, and could not therefore extend itself within its prison.

The second tree found by Mr. McNaughton is in Division 4, Section XIII., Group 20, of the section. It is thus 203 feet 7 inches below the original bed at Coal Mine Point, and is about half way between this and the new tree in Group 26. It is remarkable as standing on a bituminous shale, one of the few beds of this kind which have been elevated to constitute forest soils. It is 22 inches in diameter, and is about seven in height; but only about 18 inches of the lower part are productive, and are largely composed of a dark-coloured laminated material, much damaged by the percolation of ferruginous water. The inclosing beds are, in ascending order, coarse shale and sandstone 3 feet, sandstone 4 feet, and beds of coal with shaly partings 2 feet. This tree seems to have contained remains of 13 individuals of four or five species.

Note on Devonian Plant-Beds at St. John, New Brunswick.

It may seem remarkable that these beds of shale, occupying a limited area in the vicinity of St. John, New Brunswick, should have yielded so rich a flora and fauna, and at first sight they seem to be altogether exceptional in this respect—so much so, indeed, as to have occasioned doubts in some quarters as to their Devonian age. Remarkable though they are, however, a little consideration will serve to remove their apparently anomalous character. Though the beds of the Middle and Upper Devonian are largely marine, and, therefore, not likely to be rich in plant remains, we find even in some marine limestones of the Middle Devonian of Ohio, trunks of trees of the genus Dadoxylon, trunks of tree-ferns, stipes of fronds, indicating imperfectly many other species of ferns, and the vast masses of Macrospores and Sporocarps of Protosalvinia in the Devonian shales of Ohio and Ontario ; and these associated with Calamitean and Lepidodendroid plants, which also occur in the Devonian of Pennsylvania. In the Chemung group of Gilboa, New York, Prof. Hall has even discovered erect stumps of large tree-ferns surrounded with their aerial roots. Fresh water bivalves also occur in the Catskill group of New York, and in the Kiltorcan beds of Ireland and the Devonian of Europe, and even the Upper Silurian has afforded remains of scorpions and insects. It follows from these facts that if we can anywhere find a true fresh-water accumulation of this period favourably constituted for the preservation of the more delicate fossils, we may expect to find a land flora and fauna comparing in richness with that of the Coal-formation. This is what we seem to have in the fern ledges of St. John. Besides this, these beds are favourably exposed in the vicinity of a large city, possessing a zealous society of naturalists and geologists, eminent among whom have been the late Prof. Hartt, and Mr. Matthew, who is still spared to us. The labours of these gentlemen and their colleagues have undoubtedly been the leading cause which has enabled this peculiar deposit to yield up its treasures. It is rarely that such exceptionally rich beds as those of the Cambrian and Devonian of the vicinity of St. John have been so specially and thoroughly worked. Hence we need not be surprised that they have contributed so much to remedy the imperfections of our geological record.

Suggestions to Collectors.

My attention was first called to Palæozoic land animals by the discovery of *Baphetes planiceps* in 1851 ; and since that time I have in all my explorations in the Carboniferous rocks kept constantly in view, the possibility of the occurrence of such remains; and when I have employed others to collect for me, have instructed them to be constantly on the watch for specimens of this kind. I have indeed not been without hope that we might some day be rewarded by a true reptile, or a bird or even a prototypal mammal among the debris of the Carboniferous forests. In any case we may expect to find many more species of the types of life on the land already known in the Palæozoic.

The most promising repositories are undoubtedly those erect trees which have already yielded so many remains, and the recent discovery in the Joggins section of such trees at two new horizons in the Joggins section in Nova Scotia [1] should stimulate to further search. From the summer of 1851, when the writer in company with Sir Charles Lyell, found remains

[1] See preliminary notice, Canadian Record of Science, May, 1894.

of Dendrerpeton, Hylonomus and a land shell in a tree at Coal-Mine Point, down to 1893, such discoveries were limited to this one bed, and it was supposed to be unique in this respect. I had revisited the Joggins many times in the interval, had extracted about thirty trees at different times from the bed in question, and had made trials of all the trees exposed in other beds. Yet in 1893 there appeared in the cliff two productive trees in different beds, one of them 203 feet below the original productive bed, the other 414 feet below it; and thanks to the watchfulness of Mr. P. W. McNaughton, who had kindly promised to attend to this matter in my behalf, they were secured and have proved fruitful of interesting remains, of which in so far as the species are new, preliminary notices are inserted in the foregoing synopsis.

Erect trees occur in all our coal-fields, and are not infrequent in the roofs of coal-beds from which they are apt to fall when the supporting coal is removed. All such stumps, and especially their lower parts, should be carefully examined. Were this attended to, I have no doubt that discoveries similar to those made at the South Joggins would result in other coal-fields.

The next most likely places in which to find land animals are the roof-shales of the coals, especially where these are rich in remains of leaves. Such beds have yielded many fossil insects, and *Baphetes planiceps* was found in the roof shale of the Pictou main seam. It is to be observed that in these beds remains of arachnidans, insects and millipedes are often very faint and obscure, and so require careful examination of the surfaces in a good light. It is also to be noted that remains of land animals are apt to occur in special limited localities, where local circumstances have caused them to accumulate; and where one specimen is found others should be looked for in the same place, and in the continuation of the same surface. Nodules of clay-ironstone, contained in bands of shale or clay, have also proved productive, and should be carefully examined. In many beds the nodules will be found to be barren, but where nodules are found to contain plant remains they will repay search for animal remains as well.

Beds deposited near the margin of the upland country are also the most promising. In Nova Scotia the older rocks seem to have constituted islands in the waters or swamps of the Carboniferous period, and even of the Erian, and in the vicinity of such old margins of lagoons and swamps, discoveries of land animals may be expected. From this point of view the base of the Cobequid Hills, at Apple River and elsewhere on the Cumberland side, and from Advocate Harbour eastward on the south side, have yielded interesting facts in the way of footprints, and may be expected to afford more. So, also, on the south side of Minas Basin the Lower Carboniferous rocks of Horton Bluff and Lower Horton deserve careful and repeated search. The thick shale beds over the South Pictou coal seams are also very promising, and the roof-shales of Cape Breton have afforded some of our best insects, and only require search to afford many more. It is interesting also to note that the higher fauna of batrachian life has been traced back, though as yet only by footprints, to the basal beds of the Carboniferous. The skeletons of these older creatures are yet a desideratum, and may at any time be found in these beds.

As to the Erian or Devonian, the shales of the Little River group in Southern New Brunswick, which have afforded so many land invertebrates, are a peculiar and exceptional group of beds, unrivalled as yet in the preservation of the more delicate forms of Devonian vegetation. Similar exceptional spots may exist elsewhere, and the riches of the St. John

beds are perhaps not yet exhausted. I have elsewhere remarked that in the middle and later Erian the surface of the land seems to have been more varied than in the Coal-formation age. This would afford hope for a rich land fauna, more especially when taken in connection with the known abundance of plants and of insect life in some localities at least. There is thus good reason to hope for unexpected discoveries in Erian deposits which contain vegetable remains, and those of shallow water and estuarine fishes.

Such prizes will likely fall to the lot of local collectors, who can watch new exposures and visit productive localities again and again. Had we more of such observers scattered over the fossiliferous districts of Canada, we might hope for a more rapid progress in discovery. My own time for field work is, I fear, mainly in the past. I must be content to work at the material I have already collected, of which much remains to be studied, or to attend to specimens brought to me by others. Nothing, however, will give me greater pleasure than to aid in an entirely unselfish spirit any of our younger observers. It is one of the highest privileges of the aged to aid those who are to continue the work of scientific exploration in the future; and it is with this view that I have added the above suggestions to the present paper.