4. EURYPTERUS BREWSTERI. (Powrie MS.) Sp. nov.
Pl. X. fig. 3.

This new species of *Eurypterus* was obtained by the Rev. Henry Brewster, of Farnell, near Brechin, from the Old Red Sandstone of Kelly Den, near Arbroath, and it has been named after its discoverer by Mr. Powrie.

It consists of a carapace and a portion of the 1st thoracic segment, slightly displaced; close to which is seen an ovisac, in which are more than 20 ova, more or less compressed (fig. 3, a).

The carapace measures 2 inches 2 lines in breadth at its posterior border, and $\frac{3}{4}$ of an inch in length. The sides curve rapidly inwards, leaving the front border only 8 lines broad. The eyes, which are 1 line in length, are reniform, and within the anterior half of the carapace; they are 4 lines apart, and have their convex surfaces directed outwards. The margin of the carapace is slightly striated; and there is an inner elevated border in front, 1 line in breadth, which thins out and disappears on the lateral border. The surface of the carapace is slightly wrinkled, but not ornamented in any way.

This species agrees most nearly in general form with *Eurypterus lacustris* of Harlan,* from the Upper Silurian of New York; but the relative proportions differ considerably.

Interesting as this carapace is, it is rendered still more so by the ovisac associated with it. The so-called *Parka decipiens* may include many widely-different organisms; but I fully believe that the oviform bodies from the Old Red Sandstone are chiefly the eggs of Crustacea.

EXPLANATION OF PLATE X.

Fig. 1. *Stylonurus Loganii*, sp. nov. From Logan-Water, Lanarkshire.

Fig. 2. *Pterygotus minor*, sp. nov. From Farnell, Forfarshire.

Fig. 3. *Eurypterus Brewsteri*, Powrie MS. sp. nov.; a, Egg-bag. From Kelly Den, near Arbroath, Forfarshire.

All three specimens are in the collection of Mr. James Powrie, F.G.S., and are figured of the natural size.

III. ON THE LAURENTIAN FORMATION.† By J. J. BIGSBY, M.D.,
F.G.S.—PART II. THE RESIDUARY ELEMENTS OF LIFE IN THE
LAURENTIAN GROUP.

THE Laurentian Group is as complex in its composition as the younger fossiliferous metamorphic rocks; silica, alumina, lime, and carbon compose its beds, together with phosphorus, fluor, barytes, &c.; and it develops the same accidental minerals—staurotide, garnet, pyroxene, metallic compounds, &c. Why then should there not be in it the buried forms of life? It is found that, as we descend in the great sedimentary column, the organic remains gradually lose

* See Hall's 'Palæontology of New York,' p. 407, pl. 81, fig. 3.

† Continued from p. 158.

C. West lith. and nat.

PALÆOZOIC CRUSTACEA. (nat. size)

W & N Hartman. imp.

substance and form, until they wholly disappear, so that in the group with which we are now concerned (the very earliest we know of) not only has the original substance of the animal and its habitation vanished, but, for the most part, the very form also: and we have the residuary elements of the organisms—lime, phosphorus, &c., in masses sometimes extraordinarily large, corresponding with the extent and thickness of this great group, at least 30,000 feet in Canada (Logan), and 30,000 feet in Norway (Durocher).

The principal of these residuary elements, such as lime, silica, alumina, carbon, phosphorus, sulphur, fluor, iron, azote, exist in many forms and combinations in these rocks—as beds, seams, and veins, or minutely diffused in streaks, bars, or clouds, or altogether invisible, throughout certain mineral masses. According to Delesse,* a chief authority on this subject, all these elements are *essentially original*; although sometimes they may be contemporaneous with, or posterior to, the rocks containing them.

Lime.—The aggregate thickness of the great limestones of the Laurentian series of Canada and the northern parts of the adjacent State of New York is about 5000 feet, in bands of from 400 to 2500 feet, coarsely crystalline, rarely saccharoid, and slightly magnesian. In Scotland it is in considerable quantities; and in Norway and Finland Durocher† found it in beds and lenticular masses 1000 feet thick (often more), and traceable along the strike for many miles. This rock occasionally can only be distinguished from the newer fossiliferous marble (Silurian or Devonian) by its being more largely crystallized.

On the north side of the Lower Ottawa Valley Sir W. E. Logan finds the marble to emit, on being struck, an overpowering smell of carburetted hydrogen;—a fact taken to prove the presence of life at the time of deposit.‡

Almost all, if not all, the Laurentian beds, granite, gneiss, hornblende, anorthosite, &c., have lime in their composition. Bischoff§ and Hunt|| agree with Delesse that lime had taken its place in the crust of the earth before the creation of animals and vegetables; and we infer the same from the observations of Sir C. Lyell (Princip. p. 797). So there always has been a rich provision of this element for organic purposes.

Silica and alumina are most abundant in the rocks of all ages. The important chemical services which these substances are now known to perform in some geological operations are clearly laid down by Dr. Percy in the Lectures already referred to. The subject is too manifold for present discussion.

* Annales des Mines, 5 sér. vol. xxiii. p. 165.

† Mém. Soc. Géol. France, 2^{me} sér. vol. vi. p. 34–38; and Bullet. Soc. Géol. Fr., n. s. vol. iii. p. 619, &c.

‡ Dr. Percy, in his 'Swinian Lectures' of 1863 (Dec. 19), mentions a similar occurrence in the manufacture, by the humid way, of carbonate of magnesia from pure dolomite (so determined by chemical analysis)—so strong and unpleasant an odour arose in the process that it had to be abandoned, as a commercial failure.

§ Geological Chemistry, Engl. edit. vol. ii. p. 183.

|| Observations on some points in American Geology. 1861.

Carbon.—This substance is indispensable to organic structure, and is in very great quantity in the Canadas, almost always near to, or imbedded in, marble, which is often at the same time rich in phosphate of lime, and contiguous to deposits of magnetic oxide of iron (forming small hills). Four of the principal constituents of animals and plants are thus brought together in the Laurentian group; and with every probability that they have been employed as such. The presence of carbon in the state of graphite, *unoxidized*, in metamorphic rocks, was first urged by Sterry Hunt on the attention of geologists as showing that a temperature of ignition was not required for metamorphism. Sir W. Logan* found carbon so largely disseminated in the marbles of the Lower Ottawa (Grenville, Chatham, and Gore Counties) that he proposes to call them ‘plumbaginous marbles.’ Durocher mentions four places in Sweden and Norway in which graphite is collected for economical purposes.† Carbon in all its forms is derived from vegetables, and usually by aqueous means. Therefore there must have been vegetation before the Laurentian rocks assumed their present condition.

Phosphorus is found in many shapes, and in great quantities in the Laurentian rocks, in union with lime, alumina, silica, fluor, lithia, soda, iron, copper, and zinc. This element presents an aggregate of combinations which must have taken much time to produce, if we are to apply to mineral processes the same reasoning that we do to the vital, inferring from the number and variety of organic remains in any given bed that it had endured long as a stage. Phosphorus is plentiful in almost every geological formation, excepting, perhaps, the Mid-silurian, the so-called Cambrian, and the Huronian. It seems to be a ubiquitous element, being found in iron, coal, granite, lava, most sedimentary rocks, soils, and all waters. (In the Appendix is given a list of its principal formations and localities.) Phosphorus generally occurs as a phosphate of lime, minutely disseminated through nearly all rocks, and in a vast quantity, viewed in the large. Chemical tests may be required for its detection; but sometimes the rock-surfaces are roughened with crystals of apatite. It is in the marbles of Canada‡ that this phosphate particularly abounds. In the coarse red marble of Burgess Township (River Ottawa) it forms (diffused as apatite) one third of the whole deposit, being intermixed with other common minerals. Beds similarly charged with phosphates are in the vicinity. The low country about the River St. Lawrence, south of these Laurentian deposits, as well as that between the Ottawa and Lake Erie, is strewn with blocks of phosphatic marbles. Near Prescott, I broke up one, weighing a ton, full of beautiful druses of apatite. Phosphate of lime occurs in the white marble of St. Paul’s Bay and Malbay in Lower Canada. This mineral§ is found in the marbles of Norway;

* Geol. Survey, 1853–56, p. 641.

† *Loc. cit.* p. 39.

‡ Report, 1863, p. 26.

§ I allude to the two following deposits of this phosphate only with the view of showing the great quantities in which it occurs almost pure. At Logrosan, near Costanzoza, in Spain, phosphorite (so called) occurs in vertical layers, 2–22 feet

but not in the same profusion as in Canada. In the Isle of Pargas, near Åbo, Gulf of Bothnia, it is sky-blue and green, disseminated in whitish marble.*

Sulphur.—Its existence prior to animal life is doubtful. It appears to be derived in a free state from the animal kingdom.† It is an after-formation, says Coquand.‡ We have it in the Laurentian rocks of Canada§ and Scandinavia in the sulphurets of copper, lead, and iron; while the Norwegian beds contain also the sulphuret of zinc, with the sulpharseniurets of iron and cobalt.¶

In Canada both marble and gneiss are largely charged with iron-pyrites, the presence of which in metamorphic rocks is inimical to their having been altered by great heat, unless we suppose it to have been brought in by subsequent infiltration.

Iron.—According to Sterry Hunt,¶ one of the most successful labourers in chemical geology, and as confirmed by Bischoff, Ebelmen, and others, the presence of iron indicates the existence of organic substances when the oldest metamorphic rocks were being deposited; and in them the quantity in Canada, the United States, Norway, &c., is known to be immense.

Azote.—The remarkable investigations of Delesse on the relations of azote, or nitrogen, to rock-formations and their contents have led to important results. It is shown by him that the proportions of this gas in any mineral substance indicate, within certain limits, the age of any fossil it contains, animal or vegetable. Delesse says that, all things being equal, rocks and minerals have so much less of azote and of organic matters according as they belong to a more and more ancient period. He proves that azote is nearly universal throughout nature, and highly influential, especially as affecting the stability of organic substances.** All rocks contain more or less,—among others,†† granite, gneiss, marble, basalt, obsidian (volcanic rocks usually having the least). In soils it is very plentiful. In two specimens of Laurentian rock,‡‡ one of mica, the other of black porphyry with crystals of labradorite, the proportion of azote was found to be low—0·07 and 0·10 in 1000; and a granite from the Vosges (probably Laurentian) gave 0·15 in 1000. This ratio is, as Delesse expected, from the antiquity of the rocks examined. A Triassic dolomite gave 0·26, and bitumen from the lake in Trinidad

thick, alternating with clay-slate (Silurian?) and a coarse quartz-rock. When pure it contains 81 per cent. of basic phosphate of lime. It is not worked. By far the most widely spread and continuous bed of this phosphate is that seen by Count Keyserling at the base of the White Chalk in Russia (Bull. Soc. Géol. Fr., n. s. vol. iv. p. 11); although only a few inches thick, it extends, with a varying breadth, to the distance of 550 miles.

* Durocher, *loc. cit.* p. 37.

† Bischoff, *Chemical Geology*, vol. ii. p. 344. ‡ *Traité des Roches*, p. 182.

§ Logan, *Geol. of Canada*, 1862, pp. 26, 37. ¶ Durocher, *loc. cit.* p. 41.

¶ Quart. Journ. Geol. Soc., vol. xv. p. 493; Bischoff, *Chem. Geol.*, vol. i. p. 42; Ebelmen, *Bull. Soc. Géol. Fr.*, n. s. vol. ix. p. 223.

** Delesse, *Mémoire de l'Azote*, p. 17.

†† *Annales des Mines*, 5^e sér. vol. xviii. pp. 196, 308, 309, 315.

‡‡ *Mémoire*, pp. 170, 171.

0.26 of azote. Delesse states, moreover, that this azote, generally speaking, is not the product of infiltration, but existed in the rocks at the time of their being laid down.*

Conclusion.—It appears, then, from the foregoing statements that there is in Laurentian rocks an abundance, both diffused and segregated, of the prime ingredients of organic structure,—lime, phosphorus, azote, carbon, and the like. How is it that no life-forms, no half-consumed relics of individual existences have been met with, or very few, and those obscure, in the greatly varied strata of Laurentian age? How is it that the *Lingula*-flags of Wales, the 'Primordial Zone' of Bohemia, the lowest beds of the Silurian of North America, are often full of remains of highly organized beings, while, if we descend the vertical scale only a few feet, there is little or no evidence of life? A little above us numerous groups, societies, and dynasties of living beings are represented, flesh-eaters and plant-eaters, that exercised the very functions of the present day; here, however, we meet a blank, sudden and almost perfect.

It is difficult to account for this: mere metamorphic action does not explain it; for abundance of instances are known where strong indications of past life are seen in the midst of intense metamorphism; † and although in general the Laurentian metamorphism is powerful, in parts it is weaker, necessarily so in a process dependent for its effects on the composition of the rock it attacks. An active search among the beds near the conglomerates may possibly be successful. Those who have hitherto been looking for traces of fossil life in rocks of this epoch may have been faint-hearted and unexpecting. Some have been ill-informed and unskilful; and it is as true in field-geology as in other pursuits, that a man will bring home with him according to what he takes out.

It now remains to add that in the Laurentians of Canada marks of life are supposed to have been met with in three separate places. The one is from a crystalline limestone of the Carrying Place of the Grand Calumet (River Ottawa), found by Mr. J. M'Mullen (Canada Geological Commission). The specimens from this place 'present parallel or apparently concentric layers resembling those of *Stromatopora rugosa*, except that they anastomose at several points. The layers are composed of crystalline pyroxene, while the interstices are filled with crystalline carbonate of lime.‡

Secondly, Dr. James Wilson, of Perth, some years ago found loose masses of limestone in the vicinity of that town (65–67 miles SSE. from the Grand Calumet), which contain similar forms to those just described. They are 'composed of dark-green concretionary serpentine, while the interstices are filled with crystalline dolomite.' 'If both are to be regarded as the results,' says Sir W. Logan, 'of unaided mineral arrangement, it would seem strange that identical forms should be derived from minerals of such different

* Mémoire, p. 162.

† See a paper on Metamorphic Rocks in the Edinb. New Phil. Journ. n. s. April, 1863.

‡ Report Geol. Canada, 1862, p. 48.

composition. If the specimens had been obtained from the altered rocks of the Lower Silurian series, there would have been little hesitation in pronouncing them to be fossils.

The third instance I found in the course of a geological excursion on the north shore of the St. Lawrence, at the base of Cape Tourment, a massive headland, 2000 feet high, and 36–40 miles below Quebec. Within 200 yards of a cascade, 400 feet high or more, and the only one for many miles in any direction, is a vertical face of a close-grained quartzose gneiss, which, in the body of the rugged headland, sometimes becomes granitoid. At 3 or 4 feet above high-water-mark is a circular, cup-like, organic (?) body, two or three inches in diameter, with much of the look, as well as the size, of a *Maclurea*, not, however, with gyrations, but with concentric rings, one within another; the summits are rounded and not sharp-ridged; no radiating striæ nor reticulations were observed in it, but they may exist. It might be very loosely compared to *Spongarium interlineatum*, or to a *Chatetes*. At first we took it for the effect of friction by pebbles; but its position forbids the idea. It is probably organic; and Sir W. Logan intends to examine the locality carefully. Near this fossil (?), and for some hundred yards around, the gneiss contains many small wandering veins of calcespar (tested); and here and there ragged scraps of dark blue limestone, of Lower Silurian age, adhere loosely to the Laurentian rock. Whatever may be the importance to which these appearances on the south base of Cape Tourment are entitled, they seem well worthy of some notice.

NOTE.—Since the above was written, the hope of recovering some traces of organic life has been realized in Canada, that geologically ancient and instructive land. Practised observers announce that a fossil has been detected, beyond all doubt, far down in the great Laurentian series. This is a discovery which concerns the deepest recesses of time, and points to extensive assemblages of life in primeval ages, instead of the blank desolation hitherto supposed. Principal Dawson's determination of this newly discovered, but most ancient fossil (*Eozoön Canadense*) as a Foraminifer has been already alluded to in the GEOLOGICAL MAGAZINE, No. 1, p. 47; and I will only add the few following remarks, which are of great interest to naturalists, who know that somewhat similar changes in the structure of recent Foraminifera have been shown by Ehrenberg and Bailey to be taking place in the ocean in the present day. 'The calcareous septa,' says Sterry Hunt, 'which form the skeleton of this Foraminifer are unchanged, while the sarcode has been replaced by certain silicates, which have not only filled up the chambers, cells, and septal orifices, but have been injected into the minute tubuli, which are thus perfectly preserved. The replacing silicates are a white pyroxene, serpentine, and a dark-green aluminomagnesian silicate, near chlorite and loganite.'

APPENDIX.—*The presence of Phosphoric Acid and Phosphates in Rocks.*

Igneous Rocks.—Phosphoric acid abundant in augite-rock, porphyry, and vesicular lava (Rhine); white trachyte (Drachenfels); dark-red scoriaceous

lava (abundantly) and an ancient lava (Vesuvius); nepheline rock; toadstone (Derbyshire); Rowley-rag (Dudley): Bischoff, Geol. Chem., Engl. edit. vol. ii. p. 25. Phosphate of lime in basalt and dolerite (Vogelsberg): M. Bromeis, Ann. Mines, 5^e sér. vol. iii.

Laurentian.—Apatite in granite, zircon-syenite, hornblende-rock, marble, talcose, micaceous, and chloritic schists, dolerite, metalliferous veins traversing granite, in gneiss, diorite, porphyry, clay-slate, and beds of magnetic iron-ore; in various parts of Europe: Bischoff, *ibid.* vol. ii. p. 23. Also in marble in Westmeath and other townships on the Ottawa, Canada, and in St. Paul's Bay and Murray Bay, N.E. of Quebec, and in Laurence County, State of New York: Rep. Geol. Surv. Canada, 1848–49, 62.

Silurian: Primordial.—Phosphatic shells of *Lingule*; Canada, Minnesota, &c. (Logan, D.D. Owen, and J. Hall). Black phosphatic nodules at R. Onelle, Lower Canada, in a calcareous conglomerate: Can. Geol. Rep. 1851, ii. p. 106. —*Calceiferous Sandrock*. Dark phosphatic nodules (coprolites) in a conglomerate, resting transversely on gneiss, Lake Allumettes: Geol. Rep. Canada, 1851, ii. p. 110. —*Chazy Limestone*. Black phosphatic nodules; Lochiel, Hawksbury, R. Ottawa: *ibid.* —*Trenton Limestone*. Phosphatic fossils in blue shell-limestone of Kentucky: D. D. Owen, Geol. Rep. Kentucky, p. 98.

Lower Silurian (?).—Immense deposits of Phosphorite in Spain (Logrosan, Estremadura): Bullet. Soc. Géol. Fr., n. s. vol. xvii. p. 15.

Carboniferous.—Phosphate of lime in clay-slate, Fins (Allier, France): Meugy, Ann. Mines, 5^e sér. vol. xi. p. 150. In the many and large beds of iron-ores and of clay-iron-stone of Kentucky, 29·5 per cent. of phosphate in one of the latter (at Crittenden): D. D. Owen, Geol. Rep. p. 378.

Mesozoic.—Phosphoric acid very distinct in ten different Jurassic and Triassic limestones, none of it in others: Fehling, Quart. Journ. Geol. Soc., vol. vii. Misc. p. 90. Phosphate of lime in the marl-beds of the Lias (Calvados, &c.), in Jurassic, St. Thibault (Côté d'Or): Meugy, Ann. Mines, 5^e sér. vol. xi. p. 150. Phosphate of lime, in a thin bed 550 miles long, under Chalk, Russia: Count Keyserling, Bullet. Soc. Géol. Fr., n. s. vol. iv. p. 11. In Lower Chalk, Greensand, and other rocks of nearly the same age; Wissant, Havre, Rethal near the Ardennes: Meugy, Comptes Rendus, vol. xliii. p. 755. The phosphatic beds of the Lower Greensand, Gault, and Upper Greensand of England.

Tertiary.—Phosphate of lime in the Lower Tertiary beds of the Paris Basin, particularly in the Plastic Clay of Auteuil: Meugy, Ann. Mines, 5^e sér. vol. xi.

Recent.—Phosphate of lime exists in all waters running into the sea. The springs of Carlsbad, Bohemia, would, if it were collected, yield 55·6 pounds a year. Phosphoric acid in the sea-water of Copenhagen (Forchhammer). In the incrustations from steamboat-boilers (Volcher), Bischoff, vol. i. p. 109; ii. p. 27. Common in the soils of Kentucky (D. D. Owen).

ABSTRACTS OF FOREIGN MEMOIRS.

ON THE BACULITE-BEDS OF BÖHMISCH-KAMNITZ, NORTH-WESTERN BOHEMIA. By Dr. LAUBE. (Proceed. Imp. Geol. Instit. Vienna, Feb. 16, 1864.)

THESE strata, the youngest of the Cretaceous Period, are rather extensively spread East of the Elbe, until above Böhmisches-Leipa and Reichenberg, overlying the Quader-Sandstone, without the interposition of the Pläner beds except at three localities, where