extravagant allowance for the additional depth gained on this account, still there could not possibly be water sufficiently deep to float a glacier of one or two thousand feet in thickness. The North Sea would have required to be nearly ten times deeper than it is at present to have floated the ice of the Glacial period. The mass under which, as we have seen, the Ochils were then buried, if placed in the centre of that sea, would still have its upper surface as high above the sea level as the tops of our Pentlands. We may conclude, with the most perfect certainty, that the ice entering the North Sea from the east of Scotland must have continued its course in one unbroken mass till it reached the deep water of the Atlantic, to the west of the Orkney and Shetland Islands. It is hardly necessary to remark that the waters of the North Sea would have but little effect in melting the ice. A shallow sea like this, into which large masses of ice were entering, would be kept constantly about the freezing point, and ice-cold water has but little melting power. It takes 142lbs. of water, at 33° of temperature, to melt one pound of ice. In fact, an icy sea tends rather to protect the ice entering it from being melted than otherwise. And besides, owing to fresh acquisitions of snow, the ice-sheet would be accumulating more rapidly upon its upper surface than it would be melting at its lower surface, supposing there were sea-water under that surface. The ice of Scotland during the glacial period must, of necessity, have found its way into warmer water than that of the North Sea before it could have been melted. But this it could not do without reaching the Atlantic, and in getting there it would have to pass round by the Orkney Islands, along the bed of the North Sea, as land-ice.

This will explain how the Orkney Islands may have been glaciated by land-ice; but it does not, however, explain how Caithness should have been glaciated by that means. These islands lay in the very track of the ice on its way to the Atlantic, and could hardly escape being overridden; but Caithness lay considerably to the left of the path which we would expect the ice to have taken. The ice would not leave its channel, turn to the left, and ascend ever upon Caithness unless it were forced to do so. What, then, compelled the ice to pass over Caithness?

(To be concluded in the June Number.)

VI.—ON SOME BIVALVED ENTOMOSTRACA FROM THE COAL-MEASURES OF SOUTH WALES.

By Prof. T. RUPERT JONES, F.G.S.

(PLATE IX.)

IN the spring of 1869 Mr. William Adams, F.G.S., of Cardiff, sent to me for examination several pieces of Coal-shale, bearing some minute organisms which had been recognized as Entomostraca by Mr. Charles Moore, F.G.S. The shale, in some of its layers, which are more or less bituminous, is full of *Anthracomya Phillipsii*,

Williamson, sp.; and amongst these shells are a few others, differing very slightly in shape, but characterized by their minutely reticulate surface, therein resembling *Estheria*. There are also a few specimens of *Estheria tenella*, and numerous small Cytheroid forms, which cannot belong to either *Cythere* or the allied genera, as far as the carapaces show. In some pieces of the bituminous shale another Entomostracan Bivalve, namely, *Leaia*, occurs in abundance on some slabs, but without associates. This genus is now for the first time found so far south in Britain; the hitherto known specimens have come from different parts of North America (Pennsylvania, Illinois, and Nova Scotia), from Scotland, Lancashire, and Germany. A layer of what at first sight appear to be small Seeds or Spore-cases coats one face of a slab rich with *Anthracomya* and *Estheria*, but these little bodies are possibly small Daphnia-like Entomostraca, as suggested by Mr. Carruthers, F.G.S. A single larger Spore-case (?) occurs on another piece, and a Lepidodendroid leaf on another. In some of these shales there occur black shining circular spots, with irregularly concentric wrinkles, that at first sight look like compressed fruits; but Mr. Carruthers has explained (Brit. Assoc. Meeting, 1869) their nature and origin, as spots where gases, disengaged from decomposing organic matter, formed bubbles, imprisoned in the mud; and, whilst gradually diminishing, their successive walls were again and again squeezed and slickensided by the double action of pressure and expansion. The less bituminous shale contains fragments of *Neuropteris* and *Cyclopteris* (?). Fish (?) bones also occur on some of the slabs.

These shales, associated with "Black Band Ironstone" of the South-Welsh Coal-field, are regarded by Mr. Adams as the equivalent of the bed referred to as "Rider [Coal], 1 foot," in the Section of strata of the "Pennant" series, at page 172 of the Mem. Geol. Survey, Iron-ores, Part iii., 1861. Mr. Adams informs me that "about one and a half mile south-west of Bedwelly Church, and one and a quarter mile north-east of Gelligaer Church (on Sheet 36 of the Ordnance Survey Map), in Glamorganshire, on the west side of the River Rumney, a coal-level was opened on the crop of the Mynyddysllwyn Coal, on Cilfach-bargoed-fawr Farm. After driving westward in the coal, they struck a down-throw west fault (from 25 to 30 yards); and in place of the coal, or rather on the same level, came in the Black Band beds, and in these the fossil shells are found. (See Section.) The Black Band is apparently of limited area. This new bed of fossil shells is about 800 ft. higher in the South-Welsh Coal-measures than any hitherto met with. At Llancariach Colliery, the property of George Worthington, Esq., $1\frac{1}{4}$ miles nearly due west from Gelligaer Church, this Black Band again occurs, with the same fossil shells, some acres in extent, but of less thickness than at the works above mentioned; and here also it is between two faults."

A shale full of *Anthracomya* of the same species as that above noticed has also been found by Mr. Adams at Aberbeeg, in the Ebbw Valley, overlying a coal called the Troed-rhiw-Clawdd Coal, which

lies at the bottom of the Pennant rocks, about 226 yards below the Mynyddysllwyn Coal.

SECTION OF STRATA AT CILFACH BARGOED COLLIERY.

§ 1. *Anthracomya*.—The Molluscan shells referred to above are very numerous, flattened and compressed, in layers. The chief

form is similar to Prof. Williamson's *Unio Phillipsii*, from the Upper Coal-measures at Ardwick, near Manchester, described by him in the "Phil. Mag.," 1836, p. 241. It is the same also as Prof. Phillips's *Unio linguiformis*, "Sil. Syst.," p. 88, and Mr. Binney's *Modiola* (?), "Manchester Lit. Phil. Soc. Trans.," vol. xii. p. 221. Prof. Williamson has lately favoured me with a sketch of this shell, and with a piece of the Ardwick shale. The same form occurs plentifully in the Coal-shales of other places, and has been labelled *Anthracomya (Unio) Phillipsii* in the Museum of the Geological Survey. In 1861 Mr. Salter instituted the genus *Anthracomya* for such shells as these, of which there are several forms that "have oscillated between *Avicula* and *Modiola*, and even *Unio*" ("Iron-ores," etc., p. 230). Prof. King's *Anthracosia* had already taken in the *Unio*-like forms, and Mr. Salter afterwards proposed *Anthracoptera*¹ for the reception of the obliquely angular forms, somewhat like *Myalina* and *Dreissena*.

Fig. 1, Pl. IX., represents the *Anthracomya*, so abundant in the shales under notice; specimens like Fig. 18 are rare. The shell is concentrically wrinkled, somewhat irregularly, and the ridges are modified by pressure. The surface is marked with fine lines parallel to the ridges. Fig. 3, in plate 2 of the "Iron-ores, etc.," Part iii., may be a small *Anthracomya Phillipsii*, but it is rather too narrow.

§ 2. *Estheria Adamsii*.—Together with the above we find several very similar shells, concentrically ridged, but marked all over with microscopic pittings, like the pattern of a thimble-top on a very minute scale—an ornament very unusual in Molluscs, but common in *Estheria* (*E. Dunkeri* and *E. Hislopi*, Baird, for instance). The punctuation differs from that of the little Mollusc, *Lepton squamosum*, in being far smaller and very much more closely set. The best preserved specimen of this *Estheria*-like shell is more like *Anthracomya Adamsii* (Salter, "Iron-ores, etc.," Part iii., p. 230, pl. 2, fig. 7) in shape than *A. Phillipsii*, being less oblique than the latter, and having a longer hinge-line. The specimens, however, are all too much crushed to be taken as perfect types of form.

In some slabs of shale there are films of whitish minute network, which appear to have resulted from the decomposition of these punctate shells; whilst the common *Anthracomyæ* have become changed, sometimes into white calcareous shells, but are usually brownish, sometimes minutely granular, but not reticulate.

The outline of the reticulate valves, when perfect, or nearly so (Fig. 1), closely approaches that of *Estheria striata*, var. *Beinertiana* (Monog. Foss. Esth., p. 25, pl. 1, fig. 13). The superficial ornament, however, constitutes a specific difference. In other cases the valve is narrower, and has a shorter hinge-line (Fig. 2); but it is difficult to determine if this be an original shape, or if it be due to squeezing.

I propose to register this large *Estheria* (more than an inch in length), obliquely ovate in outline, with a long straight hinge, and with numerous concentric irregular ridges, and a general ornament

¹ Quart. Journ. Geol. Soc., 1863, vol. xix., p. 80.

of very minute hexagonal punctation, as *E. Adamsii*. In ornament it resembles *E. punctatella*, Jones, as well as the recent forms mentioned above, but differs from them materially in shape.

In the piece of Anthracomyan shale from Ardwick, given me by Prof. W. C. Williamson (see above, p. 217), I also recognize, under the microscope, a morsel of a similar reticulate valve. This *Estheria* will therefore be found elsewhere.

In a piece of the shale from Mr. Adams's collection, I observe two specimens of *Estheria tenella* (Monog. Foss. Esth., p. 31, pl. 1, fig. 26, 27, &c.).

§ 3. *Cytheroid Entomostraca*.—There are at least three Cytheroid forms in the shales under notice; although often crushed, or occurring as mere casts, yet in some instances the valves are well preserved. They differ from known *Cythera*, *Cyprides*, &c., not only in the patterns of the "muscle-spot," but in having the inner face of that spot excavated at its margin, and in having the inner surface of the valves reticulated with vascular impressions, especially near the centre. In such points these old Cytheroids have Leperditian and Beyrichian characters; but their valves resemble those of *Cythere* and other *Ostracoda*. The very common Carboniferous species, *Cythere* (?) *fabulina*, Jones and Kirkby, MS. (Trans. Glasgow Geol. Soc., vol. ii., p. 217, 1867), is an allied form, and probably belongs to the same generic group, which I designate *Carbonia*.

1. *Carbonia Evelina*, nov. (Pl. IX., Fig. 4).—Subovate; dorsal line divided in unequal thirds by the front and back slopes and the straight hinge-line between. Anterior end sharper than the posterior. Ventral border well curved. Surface wrinkled by numerous small, smooth, rounded ridges, longitudinal, interrupted, sinuous, tapering away amongst themselves, and converging towards the ends of the valves. In the centre of each valve a small circular area or "muscle-spot" is visible, consisting of three or four minute subtranslucent spots crowded together within a darkish circle. The wrinkling of the general surface is continued faintly over these muscle-spots. This species is rare.

2. *Carbonia Agnes*, nov. (Pl. IX., Figs. 6 and 7).—Ovate-oblong; dorsal edge gently arched, ventral line straight or slightly incurved; anterior third of the valve rather larger than the posterior. The surface is quite smooth in some specimens, and shows a small central muscle-spot, consisting of a narrow darkish circle, enclosing a light (translucent) area, in which a dark, irregular, four-bodied spot is set, with a few black specks along one of its edges.

The casts have a faintly reticulated surface, due to the structure of the shell; and on the casts the place of the "muscle-spot" is indicated by a small round area with a raised ledge, higher on one side than the other. There is also a slight transverse hollow behind and below the central spot on the cast.

a. Var. *subrugulosa* (Fig. 10).—Here the shell has its smoothness partially interfered with by faint longitudinal striae.

β. Var. *rugulosa* (Figs. 8 and 9).—The shell is strongly striated by longitudinal interrupted wrinkles, converging towards the ends of the valves.

The casts also show some faint signs of the wrinkles, together with reticulation around the raised circle of their "muscle-spots." On the outside shell the "muscle-spot" appears only as a small obscure patch of darkish tint.

§ 4. *Carbonia* (?), sp. (Pl. IX., Fig. 5).—There are at least two specimens of a large Cytheroid species, not well preserved, casts only remaining, which deserve notice. The larger one, which is best preserved, is here figured; but it is hazardous to fix its generic relationship. The cast is faintly reticulate.

§ 5. *Leaia Leidyi*, Jones, Monograph of the Fossil *Estheria*, 1862, Appendix, p. 115, &c. (Pl. IX., Figs. 11-14). Messrs. Meek and Worthen have shown that in some specimens of *Leaia* (*L. tricarinata*, M. and W., Report Geol. Survey Illinois, 1869, p. 540, &c.) there is evidently a third (dorsal) carina on each valve, bounding a dorsal depression (their "lanceolate false area"), along the bottom of which is the hinge-line. In compressed specimens this is not distinguishable, and whether or no it is present in all (as it well may be) they leave an open question (p. 543). We may add that, thanks to our artist, Mr. George West, we can now point out that *Leaia* had the usual Crustacean ornament of reticulation, so common in Entomostraca, especially in *Estheria*. As this character may have been present in other *Leaia*, but destroyed by pressure and change, we cannot use it as a specific character in this case; and as to outline and proportions, the many individuals on the shales found by Mr. W. Adams, in South Wales, comprise all the forms yet figured by Lea, Dawson ("Acadian Geol.," 1868, p. 256), Meek and Worthen, and myself, and may be due to differences in age or sex, or conditions of preservation. Perhaps we may say the same of Geinitz's *L. Bentschiana*, from the Lower Permian beds near Neunkirchen, "N. Jahrb.," 1864, p. 657. It is, of course, probable that different "species" did exist, and are represented among the several forms found in distant countries; but we still wait for further and decided evidences of specific characterization.

§ 6. *Daphnioid* (?) Entomostraca.—On one of the slabs of bituminous shale from South Wales is a layer of small black bodies, acute-ovate and wrinkled, that were at first thought to be spore-cases, but Mr. Carruthers cannot discern any plant character in them, and suggests that they may be small thin Entomostracan valves, analogous to those of the modern *Daphnia* and their allies. They show indications of being bivalved, and have one end more pointed than the other. They are also boldly marked with longitudinal and inosculating wrinkles (probably lines of breakage from compression), which distantly imitate the wrinkles on a collapsed seed-vessel, or even the ornament on some seeds; but the eminent Botanist just mentioned cannot find in them sufficient evidence for a place among vegetable organisms. Mr. Carruthers has reminded me that the woodcuts (figs. 10 and 11) at pages 39 and 40 of Emmons's "American Geology," Part vi., 1859, closely resemble these crushed organisms, and are there referred to Entomostraca.

APPENDIX.—1. We are enabled, thanks to Principal Dawson, to offer a good drawing (Pl. IX., Fig. 15) of a specimen of the Nova-Scotian *Estheria*, roughly figured in a woodcut at p. 256 of "Acadian Geology," 1868. Not being well preserved, this specimen shows no reticulate or other ornament besides the concentric ridges. These are bold and distant, as in *E. Portlocki*, *E. Mangaliensis*, &c.; but as the form before us differs in outline from the broad-ridged species, we may regard it as distinct, and catalogue it as *E. Dawsoni*. It occurs in the Lower Carboniferous rocks at Horton.

2. Another species of *Estheria* has lately come into my hands, through the kindness of Mr. C. Peach. Several specimens have been found in argillaceous concretions in the Carboniferous Shales of the Camstone quarry, at Salisbury Craigs, Edinburgh, by Mr. B. N. Peach. It is a subquadrate form, boldly ridged. Its sculpture is not preserved, and, indeed, only mere films of the shell itself. The form, however, is sufficiently distinct to authorize us to regard it as a new species—*E. Peachii*.

EXPLANATION OF PLATE IX.

- FIG. 1. *Estheria Adamsii*, sp. nov. *a*, Left valve shown; natural size. *b* and *c*. Ornament (*c*, near the margin); magnified 40 diameters.
 2. *Estheria Adamsii*, (?). Right valve shown; 2 diam.
 3. *Anthracomya Phillipsii*, Williamson, sp. Nat. size.
 4. *Carbonia Euelina*, sp. nov. *a*, Left valve shown; magn. 25 diam. *b*, Muscle-spot; 70 diam. *c*, Dorsal view of the two valves; 25 diam.
 5. *Carbonia* ? sp. A cast; 25 diam.
 6 & 7. *Carbonia Agnes*, sp. nov. 6*a*, Left valve shown; 25 diam. 6*b*, Reticulation on the cast, and 6*c*, the muscle-spot; 70 diam. Fig. 7. Dorsal edge of the left valve, and outline of the other; 25 diam.
 8 & 9. *Carbonia Agnes*, var. *rugulosa*, nov. 8. Left valve shown; 25 diam., 9. Muscle-spot and reticulation of the cast; 70 diam.
 10. *Carbonia Agnes*, var. *subrugulosa*, nov. Left valve shown; 25 diam.
 11–14. *Leaia Leidyi*, Jones. Various forms: differences due to age, sex, or variety, probably the first. Fig. 11*a*, Left valve, old; 5 diam. 11*b* and *c*, Ornament (*c*, near the margin); 40 diam. Fig. 12, Left valve, adult (typical form); 5 diam. Figs. 13 and 14, Young right valves; 5 diam.
 15. *Estheria Dawsoni*, sp. nov. Left valve (cast); 5 diam.
 16. *Estheria tenella*, Jones. Right valve; 5 diam.
 17. *Estheria Peachii*, sp. nov. Right valve; 5 diam.
 18. *Anthracomya* (young of *A. Phillipsii* ? See fig. 3.). Magn. 10 diam.

VII.—ON THE USE OF THE TERM *NEOCOMIAN*.

By JOHN W. JUDD, F.G.S., of the Geological Survey of England and Wales.

THE confusion which has of late years resulted from the multiplication of names for the same geological stratum, formation, or system, sufficiently indicates the necessity for the adoption of certain rules by which our geological nomenclature may be reformed and brought into a state of something like uniformity. When this necessity is acknowledged, but little doubt can arise as to the principles on which such rules must be based; the law of *priority*, with certain necessary limitations and exceptions, will be made to govern the terminology of Geology, as it already does that of almost every other Natural Science. The nature and mode of application