Blake J. F. On the Infralias in Yorkshire.// The quarterly journal of the Geological Society of London, 1872.- Vol. 28, p. 2, №110.- p. 132-147.

Joliaf

2. *On the* Infralias *in* Yorkshire. By the Rev. J. F. Blake, M.A., F.G.S. *With an* Appendix *on some* Bivalve Entomostraca. By Prof. T. Rupert Jones, F.G.S.

Comparatively little attention has been paid to the Lias of Yorkshire for some time past; and consequently it is behind the Lias of other parts as to our knowledge of it. This is especially the case with the lowest beds—the zones of *Ammonites angulatus* and *Am. planorbis*—constituting the so-called Infralias, whose presence has as yet been scarcely even recognized. It has long been known that *Am. angulatus* occurs at Redcar, under the name of *A. Redcarensis*; and blocks of stone containing *Am. planorbis* (syn. *erugatus*) are thrown up on the coast; but no section, or list of fossils, has as yet been given of the beds.

In the present paper I hope chiefly to describe some remarkable sections at Cliff, near Market-Weighton, where the Infralias is well exposed, and the fauna it contains is large and interesting. But, while I describe this as the Infralias of Yorkshire, I must express my opinion that it does not form part of the typical Yorkshire basin. On glancing at a geological map of this part of England, it will appear probable that there has existed a ridge in Carboniferous-Limestone times, stretching west from a little south of Flamborough Head, which has separated the coal-basin of South Yorkshire from that of Durham, and made a gap in the overlying Permian rocks; and though the New Red Sandstone does not appear to be affected by it, all the overlying Jurassic beds are bent round in a curve on its north side, and to the south appear again as the thin end of a series stretching right across England. The beds to the north form the typical Yorkshire basin, while those at Cliff form part of the thin end of the wider-reaching series. Good sections of all the Infralias beds in the typical Yorkshire basin are still a desideratum, which I am unable to supply; but when they are discovered, it must be with the Cliff beds that we first compare them. The nearest beds with which to compare these latter, are those at Marton, near Gainsborough, the list of fossils from which, as given by Mr. Ralph Tate in Quart. Journ. Geol. Soc. vol. xxiii. 1867, proves them to contain a somewhat similar fauna, as will be seen in the sequel.

The Infralias beds of Cliff have been briefly described or, rather, noticed by the Rev. W. Norwood, in the 'Geologist,' vol. i.; but though he recognized their true age, the fossils contained in the beds were so cursorily examined that but little attention has been paid to his paper. Prof. Phillips also mentions them, but only to state their existence.

About three miles from Market-Weighton, on the road to North Cave, at the villages of North and South Cliff, and near the farm of Bielbecks (whose mammalian treasures were described by the Rev. W. V. Harcourt in the 'Phil. Mag.'), are a series of pits opened to extract the Lias clay for marling the adjoining sandy flats.

In the first of these pits (which for want of any local name must be called "Pit No. 1") we have the following section:—

Section in Pit No. 1.

Lithology.	Observations.
Surface soil.	
1. Sandy clay, 3 ft.	
2. Bed of stone, 6 in.	Very fossiliferous. *Am. angulatus.*
3. Sandy clay, 1 ft.	
4. Rubbly stone, 10 in.	Very fossiliferous. *Am. angulatus.*
5. Clay, sandy at top, blue at the bottom, extending to the base of the pit, 8 ft.	Fossils numerous, in the form of impressions. Foraminifera abundant.

In beds Nos. 1 and 3 I have found neither Foraminifera nor other fossils; but beds Nos. 2 and 4 are very rich. In fact these two beds here form the most fossiliferous zone of *Ammonites angulatus*. They are composed of rubbly irregular limestone, often crowded with fragments of shells; and from the heaps of them at the pit-side I have obtained the following fossils:—

Plesiosaurus (tooth).
Acrodus minimus (*Ag.*) (tooth).
Ammonites angulatus (*Schl.*).
—— Johnstoni (*Sow.*).
Nautilus striatus (*Sow.*).
Trochotoma striatum (*Hörn.*).
Pleurotomaria nucleus (*Terq.*).
Phasianella Morencyana (*Terq.*).
Littorina elegans (*Gldf.*).
Melania unicingulata (*Terq.*)
Turritella Dunkeri (*Terq.*).
Cerithium semele (*D' Orb.*).
Saxicava arenicola (*Terq.*).
Arcomya elongata (*Röm.* sp.).
Pleuromya galathea (*Ag.*).
—— striatula (*Ag.*)?
Pholadomya glabra (*Ag.*).
—— Fraasi (*Opp.*).
Cardinia Listeri (*Sow.*).
—— ovalis (*Stutchb.*).
—— crassiuscula (*Sow.*).
—— unioides (*Ag.*).
—— lanceolata (*Stutchb.*)?
—— Desoudini (*Terq.*).
—— Deshayesi (*Terq.*).
Astarte Guenxii (*D' Orb.*).
—— cingulata (*Terq.*).
Cardita Heberti (*Terq.*).
Unicardium cardioides (*Ph.* sp.).
Lucina ovula (*T. & P.*).
Protocardia Philippiana (*Dkr.*).
Cardium profundum (n. s.).
Cucullæa hettangiensis (*Terq.* sp.).
—— naviçula (*T. & P.*).
Leda texturata (*T. & P.*).
Modiola minima (*Sow.*).
—— psilonoti (*Qu.*).
Myoconcha psilonoti (*Qu.*).
Pinna semistriata (*Terq.*).
Perna infraliasica (*Qu.*).
Avicula longiaxis (*Buckm.*).
Lima gigantea (*Sow.*).
—— punctata (*Sow.*).
—— pectinoides (*Sow.*).
—— fallax (*Chap. & Dew.*)?
—— succincta (*Schl.*).
Pecten punctatissimus (*Qu.*).
—— textilis (*Mstr.*).
Waldheimia perforata (*Piette*).
Serpula capitata (*Ph.*).
—— plicatilis (*Mstr.*).
—— socialis (*Gldf.*).
Cidaris Edwardsii (*Wr.*).
Pentacrinus psilonoti (*Qu.*).
Septastræa excavata (*From.*).

Bed No. 5 is more sandy and lighter-coloured at the top, and gradually changes to a soft laminated clay without any distinct line of demarcation. The same fossils occur throughout as indistinct impressions. They are the following:—

Ammonites Johnstoni (*Sow.*).
Cardinia, sp.
Protocardia Philippiana (*Dkr.*).
Modiola minima (*Sow.*).
Pecten æqualis (*Quenst.*).
Ostrea irregularis (*Mstr.*).
Hemipedina Tomesii (*Wr.*).

The Foraminifera are very abundant, and form a different set in

the top and the bottom, Cristellarians being most numerous in the former and Polymorphines in the latter. The chief species are:—

In the top.	In the bottom.
Cristellaria acutauricularis (*F. & M.*).	Lingulina, sp.
—— crepidula, (*F. & M.*).	Polymorphina lactea (*W. & J.*).
—— varians (*Born.*).	—— gutta (*D'Orb.*).
Polymorphina, sp.	——, sp.
	Dentalina communis (*D'Orb.*).
	—— plebeia (*Rss.*).
	—— brevis (*D'Orb.*).
	——, sp.
	Nodosaria, sp.
	Marginulina lituus (*D'Orb.*).

A short distance further on we meet with another larger pit, in which is the following section:—

Section in Pit No. 2.

Lithology.	Observations.
Surface-soil 2 ft. 3 in.	
1. Rubbly stone, 1 ft. 10 in.	*Nautilus striatus.*
2. Sandy yellow clay, 2 ft.	
3. Rubbly stone, 1 ft.	*Lima gigantea.*
4. Blue clay, 5 ft. 4 in.....	*Ostrea irregularis.* Gypsum.
5. Stone-bed, 6 in.....	*Lima gigantea.* *Am. Johnstoni.*
6. Blue clay, 3 ft. 3 in.	
7. Irregular course of Septarian nodules.....	*Am. Johnstoni.* *L. gigantea.*
8. Blue clay, 3 ft. (with 7)	*Pentacrinitus psilonoti.* *Cerithium.*
9. Stone, 6 in	*Am. Johnstoni.* *Cardinia Listeri.*
10. Blue clay in layers, 10 ft. 8 in., to the base of the quarry.	

In a part of the quarry opened at a lower level are seen some oyster-bands (*Ostrea irregularis*, Mstr.), such as are seen better in the next pit.

The beds No. 1 and No. 3 of this pit evidently correspond to No. 2 and No. 4 of pit 1; and if they have yielded fewer fossils, it is probably only from being less exposed; the lower beds are decidedly less fossiliferous. In all the beds here *Am. Johnstoni* (Sow.) is the chracteristic Ammonite; and I have not detected the true *A. planorbis* in the clay beds. They are, however, full of Foraminifera and Entomostraca. The varieties are too numerous to be fully recorded here, and must await further study, with other Liassic representatives. Their chief forms, however, are:—

*Bairdia ellipsoidea (*Brady*).	Marginulina lituus (*D'Orb.*).
*Cythere Moorei (*Brady*).	—— ensis (*Rss.*).
*—— Blakei (*Jones*).	Polymorphina bilocularis (*Terq.*).
*—— Terquemiana (*Jones*).	—— lactea (*W. & J.*).
Lagena fusiformis (*Terq.*).	—— gutta (*D'Orb.*).
——, sp.	Cristellaria acutauricularis (*F. & M.*).
Vaginulina legumen (*L.*).	—— crepidula (*F. & M.*).
——, sp.	—— varians (*Born.*).
Dentalina communis (*D'Orb.*).	Planulina Bronnii (*Röm.*).
—— pauperata (*D'Orb.*).	Lingulina tenera (*Born.*).
—— plebeia (*Rss.*).	——, sp.
—— filiformis (*D'Orb.*).	Nodosaria paupercula (*Rss.*).
Marginulina glabra (*D'Orb.*).	—— lineolata (*Rss.*).

The other fossils obtained from this pit are:—

Ammonites Johnstoni (*Sow.*).	Lima fallax (*Chap. & Dew.*).
Nautilus striatus.	Pecten punctatissimus (*Qu.*).
Trochotoma striatum (*Hörn.*).	Ostrea irregularis (*Mstr.*).
Cerithium transversum (n. s.).	Waldheimia perforata (*Piette*).
Cardinia ovalis (*Stutchb.*).	Montlivaltia Haimei (*Chap. & Dew.*).
Unicardium cardioides (*Ph.*).	Pentacrinus psilonoti (*Qu.*).
Modiola minima (*Sow.*).	Serpula socialis (*Gldf.*).
Lima gigantea (*Sow.*).	—— capitata (*Ph.*).

In the oyster-bands:—

Ostrea irregularis (*Mstr.*).	Myacites musculoides (*Schl.*).
Avicula fallax (*Pflücker*).	

It is in the third pit, however, that we obtain the best section of all, which, from being constantly worked, leaves all the strata well exposed. It is as follows.

Section in Pit No. 3.

Lithology.	Observations.
Surface soil, 2 ft. 3 in.	
1. Rubbly stone, 1 ft. 6 in.	*Cardinia Listeri, Ostrea irregularis, Lima gigantea, Am. Johnstoni.*
2. Rough rubbly clay, 1 ft.	
3. Rubbly stone, 8 in.	
4. Rough yellow clay, about 3 ft. ...	*Pentacrinites.*
5. Stone, 8 in.	
6. Clay, 1 ft.....	5, 6, 7 full of small broken shells.
7. Stone, 1 ft. 4 in.	Wood.
8. Bluer clay, 2 ft. 2 in.	
9. Double sandy stone, 8 in.	*L. gigantea, Modiola minima.*
10. Quite blue clay, 2 ft.	*Am. Johnstoni* and *Ostrea irregularis*, and finely costated *Avicula.*
11. Sandy layer, nearly stone, broken in pieces, 3 ft. 7 in.....	Oysters.
12. Blue clay, 5 ft. 6 in.	*Protocardia Philippiana, Ostrea irregularis.*
13. Stone, 5 in.	*Lima gigantea.*
14. Blue clay, 3 ft. 7 in.....	Numerous small casts and fragments of Echinoderms. Tooth of *Dapedius.*
15. Stone, 10 in.....	*Modiola minima.*
16. Clay containing scattered Septarian nodules, 2 ft.	*Am. Johnstoni, Hybodus minor.*
17. Stone, 5 in.	

* Kindly determined by Prof. T. R. Jones (see Appendix, p. 146).

Section in Pit No. 3 (continued).

Lithology.	Observations.
18. Blue clay with few fossils, 9 ft. ...	*Am. planorbis* (true). *Protocardia Philippiana.* *Ichthyosaurus* (vertebra).
19. Rubbly soft stone, 4 in.	
20. Rough yellow clay, 4 in.	
21. Rubbly stone, 4 in.	
22. Rough clay, 5 in.	
23. Double oyster-band.....	*Ostrea irregularis, Protocardia Philippiana, Nautilus striatus, Cucullæa hettangiensis.*
24. Clay, 2 in.	
25. Broken oyster-band, 5 in.	*Ostrea irregularis.* *Avicula fallax.*
26. Clay with light-coloured band at the top, 8 in.	
27. Rubbly stone, 2 in.	
28. Clay, 10 in.	
29. Light sandy rubbly clay, 4 in.	
30. Clay containing, about halfway down, flat layers of hard stone irregularly scattered, full of fossils, 1 ft. 6 in.....	*Protocardia Philippiana.* *Modiola minima.* *Myacites musculoides* (var. *α*).
31. Light sandy clay like 29, 2 ft. 6 in.	
32. Clay, 2 ft. 4 in.	
33. White, easily broken stone, 3 in.	
34. Clay, 1 ft. 8 in.	
35. Stone like 33, 3 in.	
36. Clay with layers of white clay, 6 in.	
37. Clay, 3 ft. 4 in.	
38. Whitish sandy stone, 5 in.	
39. Clay to base, about 2 ft.	

In this section there are plainly four sets of beds:—1st, from 1 to 7, in which the clays are yellowish and lie in narrow beds between narrow stone layers; 2nd, from 8 to 18, in which we have thick beds of blue clay separated by thin bands of stone; in both these sets Foraminifera abound, but suddenly cease with bed 22; 3rd, from 19 to 30, which consist of narrow alternating bands of rough clay and stone containing oyster-beds and other fossils; 4th, from 31 to the base, in which the stone layers are fissile and white, and fossils are absent or exceedingly rare.

The beds in this pit do not correspond very accurately with those in pit No. 2; but beds 1, 2, 3 appear to be equivalent in the two sections, and Nos. 10, 11, 12 in pit No. 3 to be equivalent to No. 10 in pit No. 2.

We have here, then, exposed as complete a series of Infraliassic beds as is to be found in this neighbourhood. The upper two or three beds belong to the zone of *Am. angulatus* proper, being the representatives of those which in the other pits are so fossiliferous. The beds from 4 to 22 may constitute the zone of *A. planorbis*, though that Ammonite is as yet found only in one bed; above this the beds with *Am. Johnstoni* seem a kind of intermediate zone, which

must, however, be united with that of *planorbis*; and the beds to 22 are included because of the Foraminifera. Below these the beds correspond well with the series called *White Lias*, including in that the oyster-bands and the white limestone below; and enclosing, as they do, the same fauna, they must be considered the equivalents of that series.

As none of the beds have as yet proved very fossiliferous, and all the fossils (except microscopic ones) have been mentioned in connexion with their respective beds, a list of them is unnecessary; but the chief species of Foraminifera are the following:—

Lingulina tenera (*Born.*).
——, sp.
Polymorphina bilocularis (*Terq.*).
—— lactea (*W. & J.*).
—— gutta (*D'Orb.*).
——, sp.
Triloculina liasina (*Terq.*).
Textularia, sp.
Lagena fusiformis (*Terq.*).
—— sulcata (*W. & J.*).
——, sp.
Cornuspira infima (*Stutchb.*).
Webbina irregularis (*D'Orb.*).
Lituola, sp.
Dentalina pauperata (*D'Orb.*).
—— gracilis (*D'Orb.*).
—— monilis (*Rss.*).
—— communis (*D'Orb.*).
—— plebeia (*Rss.*).
—— filiformis (*D'Orb.*).
—— obliqua (*D'Orb.*).
Dentalina brevis (*D'Orb.*).
—— oblique-striata (*Rss.*).
Nodosaria lineolata (*Rss.*).
—— glans (*D'Orb.*).
—— radicula (*L.*).
—— raphanistrum (*L.*).
Marginulina lituus (*D'Orb.*).
—— raphanus (*L.*).
—— ensis (*Rss.*).
Vaginulina legumen (*L.*).
Planularia Bronnii (*Röm.*).
—— cornucopiæ (*Brady*).
—— pauperata (*P. & J.*).
Cristellaria crepidula (*F. & M.*).
—— acutauricularis (*F. & M.*).
—— cassis (*F. & M.*).
—— rotulata (*Lam.*).
Flabellina rugosa (*D'Orb.*).
Frondicularia pulchra (*Terq.*).
——, sp.

At several places on the hill-side the lower beds of pit No. 3 may be seen exposed near the road-side,—in one place the oyster-bands, in which I found *Pecten pollux* (D'Orb.), and in another, thickish blocks of white limestone with impressions of sulcated shells, probably *Myacites musculoides* (Schl.).

About $1\frac{3}{4}$ mile further on is another pit in which the strata are regularly exposed and show beds lower down in the series than any yet seen. The following is the section.

Section in Pit No. 4.

Lithology.	Observations.
1. Clay, 2 ft. 6 in.	
2. Stone band, 3 in	*Ostrea irregularis.*
3. Clay with a narrow stone band at places, 2 ft. 6 in.	
4. Stone, 4 in.	*Myacites musculoides* (var. *α*). *Ostrea irregularis.*
5. Clay, 9 in.	
6. Double soft sandstone band, 4 in.	
7. Clay, 1 ft.	
8. Double stone band, 5 in.....	Fossils as in 12.
9. Clay, 15 in.	

Section in Pit No. 4 (continued).

Lithology.	Observations.
10. Narrow stone, 2 in.	Fossils as in 12.
11. Clay with sometimes a band of white stone, 2 ft. 3 in.	
12. Sandy stone weathering white, 4 or 5 in.	*Modiola minima.* *Myacites musculoides* (var. β).
13. Blue clay with a spring of water at the top, which colours the section red, 6 ft.	
14. Stone, 4 in.	Fossils as in 12.
15. Clay like 13, 10 ft. to base of the section.	

It is not difficult to correlate these beds with those of pit No. 3. The bed No. 4 is obviously equivalent to the irregular stone layer in No. 30 of pit No. 3, No. 2 to the oyster-bed No. 25, No. 8 to No. 33, and No. 12 to 38; so that we get two lower beds here. Even yet, however, we reach no bone-bed nor any signs of the Keuper marls. The beds of stone in this quarry are very finely laminated and weather white, altogether recalling the White-Lias bands of the south of England. As, however, several beds of clay (the "*contorta*" shales) and stone there intervene above the bone-bed, it is probable that the true horizon of the latter is not reached here, *Avicula contorta* not having been met with even in the lowest clays. Mr. Norwood, in his paper, states that here the Lias is seen gradually changing into the Keuper; but it certainly does not in this quarry, which contains the lowest beds discovered. Can he have mistaken the red weathering of the two lower clay-beds for the red Keuper marls?

No fossils have been found in this quarry beyond those mentioned in the section; and Foraminifera are entirely wanting.

The only place in this neighbourhood where there is any likelihood of seeing lower beds leading down into the Keuper, must be somewhere between Market Weighton and Pocklington, some six or seven miles from Cliff.

About 3 furlongs further on we come to another pit, No. 5, which is not now worked, and consequently the section is not well exposed. In this the white limestone is seen at the base, and oyster-bands occur about 10 feet above it; it has probably therefore been excavated in the same beds as pit No. 4.

The last pit in the series, or pit No. 6, is situated less than a quarter of a mile from No. 5, just at the cross road leading to Hotham. We have there the following section.

Section in Pit No. 6.

Lithology.	Observations.
Surface-soil	Good thickness.
1. Soft calcareous sands, 8 in.	
2. Sandy clay, 7 in.	2, 3, 4 contain broken fragments of *Ostrea irregularis.*
3. Stone, 7 in.	
4. Clay like 2, 8 in.	2, 3, 4 irregular.

Section in Pit No. 6 (continued).

Lithology.	Observations.
5. Strong blue Limestone, 10 in.	Fossiliferous; fossils like those of 30, pit No. 3, and 4 pit No. 4.
6. Clay, 1 in.	
7. Calcareous sands, 2 in.	7–9 contain oysters.
8. Bluer clay, 2 ft. 4 in.	
9. Irregular Limestone, 2 in.	
10. Clay, 2 ft. 4 in.	
11. Strong even-bedded Limestone 6 in.	White.
12. Clay, 1 ft.	
13. Three or four softish sandstones, 5 in.	
14. Rather bluer clay, 3 ft.	
15. Narrow white Limestone-band, very regular but septarian, 3 in.	
16. Clay to base, 2 ft.	

I have not been able to secure many fossils from this pit; but there appears little difficulty in correlating its beds to those of pit No. 4. Bed No. 5 in this pit corresponds to No. 4 in that; all above 5 in this corresponds to No. 3 in that; Nos. 6, 7, 8 here to No. 5; No. 9 to No. 6; No. 10 to 7; No. 11 to 8; No. 12 to 9; No. 13 to 10; No. 14 to 11; No. 15 to 12; No. 16 to part of 13, leaving about 13 feet more to be seen in pit No. 4 than in No. 6.

From the fragments of the oyster-bands scattered in this pit I have obtained the following fossils:—

Ichthyosaurus (phalange).
Cerithium, sp.
Myacites musculoides (*Schl.*).
Ostrea irregularis (*Mstr.*).
Ostrea arcuata (*Lam.*)?
Avicula fallax (*Plücker*).
Montlivaltia Haimei (*Chap. & Dew.*).

These, then, are the Infraliassic sections exposed in the neighbourhood of Cliff; and taking them all together, they give us the beds from the middle of the zone of *Ammonites angulatus* nearly to the horizon where *Avicula contorta* should be found.

The Middle Lias beds are found half a mile to the east, at Hotham; and it is therefore probable that sections opened in this interval would reveal the higher beds of the Lower Lias. The beds below this series we cannot perhaps hope to find, from the thickness of the alluvial sands which intervene between this and the nearest Keuper beds at Harswell.

With regard to the lie of these beds, there appears to be a slight anticlinal near pit No. 4, in which the lowest beds are seen, and where they seem to have been subjected to some disturbance, being twisted and thrown up in one part into a nearly vertical position.

To the north of this spot the beds dip at a small angle to the N.E., and to the south of it slightly to the S.E. Taking all together we have the general section as represented below (fig. 1).

With regard to the palæontology, it appears that the greater number of fossils can be named from those of the same horizons

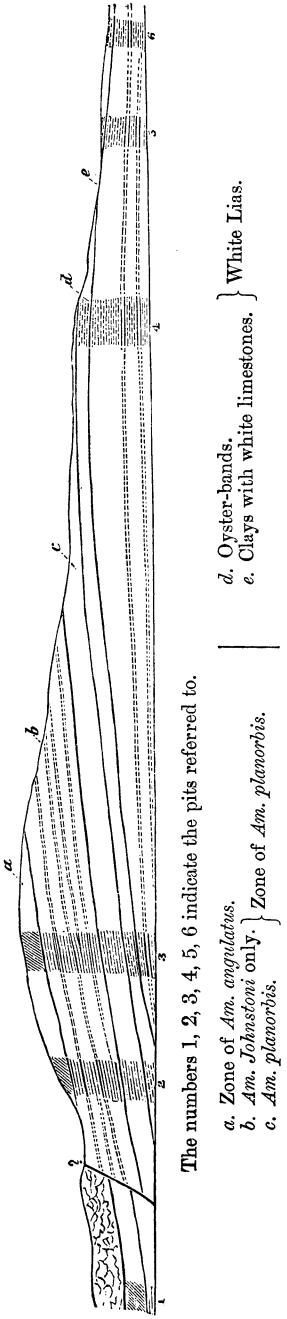

Fig. 1.—*Diagram Section of Infraliassic Beds near Cliff, Yorkshire.*

The numbers 1, 2, 3, 4, 5, 6 indicate the pits referred to.

a. Zone of *Am. angulatus*.
b. *Am. Johnstoni* only. } Zone of *Am. planorbis*.
c. *Am. planorbis*.

d. Oyster-bands.
e. Clays with white limestones. } White Lias.

elsewhere, although in their distribution there is something peculiar. The definite separation into zones is rather difficult. The upper limestones, in which alone *Am. angulatus* is found, contain a varied fauna, with which there is nothing to compare in the beds below. It is certain, however, that only the lower part of this zone is here exposed. *Am. Johnstoni*, however, ranges through these and the limestones lower down, and is here the most characteristic Ammonite. The true *Am. planorbis* has as yet been found only in one bed; but this is not separated from the others by any other features. The change to the oyster-bands is very marked in pit No. 3, accompanied as it is by a cessation of microscopic fossils; and the same may be said of the change into the white limestone beds below.

On comparing the "*angulatus*" fauna with that of Marton, it will now be seen how nearly allied they are—so much so that it is probable that a complete knowledge of both would prove them to be almost perfectly identical. As at present known, however, they present some decided differences. Of the 44 species recorded as certain from Marton, 23 are also found at Cliff; and it appears possible that an actual comparison of specimens would increase this proportion. Fifty-two species are here recorded as certain from the same horizon, excluding vertebrates and microscopic fossils; of these 15 belong to genera unrepresented at Marton. The difference consists chiefly in the more numerous gastropods and fewer bivalves found at the latter place; for whilst there the proportion is 8 gastropods to 22 bivalves, at Cliff it is 7 to 38, 3 gastropods only being common to both; these, however, and the other common species being those which are most characteristic of the horizon. It appears, however, highly probable that the Marton fossils are from a slightly higher part of the zone of *Am. angulatus*.

The beds at Redcar, when compared with those already described, are very insignificant. On the shore at that place are seen narrow ledges striking seawards, consisting of Lias shale hardened at the top; some few of the most easterly of these contain *Am. angulatus* and other associated fossils. The beds above these contain *Am. Bucklandi*; and no lower beds are anywhere visible, these being only brought up by an anticlinal elevation, and the next beds visible in the same direction being again higher in the series. As, however, all these form part of what I have called the typical Yorkshire basin, their character and contents are best studied in conjunction with the other Liassic beds of that series, and are therefore here passed over.

At Eston, not a mile from the Middle-Lias iron-mines, I saw, in the refuse heaps of a gypsum-shaft, several impressions of Rhætic and Infraliassic fossils, from which we may conclude that the series is complete in this neighbourhood.

References and Notes on the Fossils.

Plesiosaurus. Tooth not unlike that described by Owen as that of *P. rostratus*. Lias Reptiles, pl. 9. I. 4.*

Ichthyosaurus. Vertebra, $1\frac{1}{4}$ inch diameter, probably from III. 18; also a phalange $\frac{5}{8}$ in. by $\frac{3}{8}$ in. in the oyster-bands.

Acrodus minimus (Ag.), Poiss. Foss. vol. iii. pl. 22. figs. 6–12. I. 4.

Dapedius. Tooth. III. 14.

Hybodus (cf.) *minor* (Ag.), Poiss. Foss. vol. iii. pl. 23. fig. 23. III. 16.

Ammonites angulatus (Schl.), Petref. p. 70; Qu. Jura, pl. 3. fig. 1. The form of this, from Cliff, differs much in the narrowness and number of the whorls from that from Redcar. It is rare full-grown at Cliff; but small young specimens are commoner. I. 2, 4.

Am. Johnstoni (Sow.), M. C. pl. 449. fig. 1. There are two varieties of this, not worth separating into species:—1, the ordinary form, with 28 ribs per whorl; and, 2, one with 36 finer ribs. Common in all the upper beds.

Am. planorbis (Sow.), M. C. pl. 448. fig. 1. III. 18 only.

Nautilus striatus (Sow.), M. C. pl. 182. I. 2, 4; II. 1; III. 1, 23.

Trochotoma striatum (Hörn.), Stoliczka, Gast. & Aceph. Hallst. Sch. pl. 5. fig. 2. I. 4; II. 1. There are some smaller shells (those in pit I.) which I think are the young of this. This has some resemblance to *Pleurotomaria trocheata* (Terq.), but is less depressed, and the aperture is more rounded. The genus may be doubtful.

* I. 4. indicates that the fossil is found in pit no. 1, bed 4.

Pleurotomaria nucleus (Terq.), Pal. Hett. pl. 5. fig. 5. One showing the small umbilicus. I. 4.

Phasianella Morencyana (Piette), Terq. & Piette, Lias de l'Est de France, pl. 4. figs. 9–11. ?=*P. nana* (Terq.). I. 2, 4. Common.

Littorina (Tectaria) elegans (Gldf.), pl. 193. fig. 10. Common in pit I. It is better described and figured by Rolle (Sitz. Ak. Wiss. Wien, Bd. xlii. No. 23) as *Littorina Schimperi*; but a little change in Goldfuss's description would make it include both. He says, "it has four ribs, the upper one knobbed." For this we must substitute four or more ribs, the second and third from below being the strongest—and above these being one or more small ribs, which are the most raised into knobs by the cross ribs. ?=*Amberleya alpina* (Moore).

Melania unicingulata (Terq.), *l. c.* pl. 3. fig. 10 (?). A worn specimen. I.

Turritella Dunkeri (Terq.), *l. c.* pl. 3. fig. 5. I.

Cerithium semele (D'Orb.), Martin, pl. 2. figs. 8–10. II. 8.

Cerithium transversum (n. sp.). This differs from *C. etalense* (Piette), to which I at first referred it, only in having no longitudinal striæ, and having a minute umbilicus, by which two characters, besides its fewer ribs, it is also distinguished from *Chemnitzia Berthaudi* (Dum.). II.

Cerithium, sp. A cast only. VI.

Saxicava arenicola (Terq.), pl. 7. fig. 7. I.

Pleuromya galathea (Ag.), Mon. des Myes. pl. 28. figs. 1–3. I.

Pleuromya striatula (Ag.), *l. c.* pl. 28. figs. 10–12. I.? Compressed specimens.

Arcomya elongata (Röm. sp.), Ool. pl. 8. fig. 1. I. A cast.

Pholadomya glabra (Ag.), *l. c.* pl. 3. fig. 12. I.

Pholadomya Fraasi (Opp.), Juraformation, p. 95=*P. prima* (Qu.), Jura, pl. 5. fig. 2. I.

Myacites musculoides (Schl.), dwarfed form. See Phillips, Geol. of Oxford, pl. 7. fig. 36. III. 30, and IV. 6. The characteristic shell of the White Lias beds here. This appears to correspond to the shell so named by the Geol. Survey; but it seems to me at least doubtful if all can be referred to Schlotheim's species. There may possibly be two species here: the ribs on one (α) are very regular, but become obsolete after a light ridge which runs from the umbo; the other (β) is more irregular.

Cardinia Listeri (Sow.), M. C. pl. 154. figs. 1, 3, 4. I., II., III. 1.

Cardinia ovalis (Stutchb.), An. N. H. 1842, vol. viii. pl. 10. figs. 17–19. I. Common.

Cardinia crassiuscula (Sow.), M. C. pl. 185. II.

Cardinia unioides (Ag.), *l. c.* pl. 12". figs. 7–9. I., II.

Cardinia lanceolata (Stutchb.), *l. c.* page 484. I. Rather a doubtful determination, perhaps only an elongated variety of *C. ovalis*.

Cardinia Deshayesi (Terq.), *l. c.* pl. 8. fig. 6. I. 4?. I have long thought the specimen now referred to this distinct, and called it *C. inflata*, it being more inflated and more angular posteriorly.

Cardinia Desoudini (Terq.), *l. c.* pl. 9. fig. 1. I.

Astarte Guenxii (D'Orb.)? Prod. vol. i. p. 216. [=*consobrina*, (Chap. & Dew)]. I. The specimens from Cliff do not agree very well with others referred to this species, being smaller, shorter, and with the ribs confined to the umbo; but I am not prepared to separate them.

Astarte cingulata (Terq.), *l. c.* pl. 9. fig. 6. I.

Cardita Heberti (Terq.), *l. c.* pl. 9. fig. 10. I.

Unicardium cardioides (Ph. sp.), Geol. of Yorks. pl. 14. fig. 12. I., II.

Lucina ovulum (T. & P.), Lias de l'Est de France, pl. 8. fig. 14. I. A young specimen connected by invisible gradations with the adult form in specimens from the zone of *A. Bucklandi*.

Protocardia Philippiana (Dkr. sp.), *l. c.* pl. 17. fig. 6. In almost all the beds in the section at Cliff. I regard this as identical with *Cardium rhæticum* (Mer.), and use the earlier name.

Cardium profundum, n. sp. A minute species, rather oblique and deep, and ornamented with numerous (20–24) ribs. Length rather less than the breadth. Most nearly allied to *Cardium Stoppanii* (Renev.); but the ribs are more numerous, and the shell is shorter. I.

Cucullæa hettangiensis (Terq.), *l. c.* pl. 10. fig. 3. I. There are some smaller shells which seem to be the young of this. These specimens have both the posterior ridge and the sulcus running from the umbo, which latter becomes obsolete with age. I.

Cucullæa navicula (Terq. & Piette), *l. c.* pl. 11. figs. 16, 17. I. These differ from the type (which is apparently an old individual) in being narrower and having the hinge-line straighter, but agree in other respects. They cannot be separated.

Leda texturata (Terq. & Piette), *l. c.* pl. 11. figs. 5–7. I.

Modiola minima (Sow.), M. C. pl. 210. figs. 5–7. In all beds. My shells agree better with some others described by foreign authors; but the species is common and characteristic, and is therefore probably the same. See Phil. Geol. of Oxf. pl. 7. fig. 37.

Modiola psilonoti (Qu.), Jura, pl. 4. fig. 13. I.

Myoconcha psilonoti (Quenstedt), Jura, pl. 4. fig. 15. I. In naming this, as well as many others, I must thankfully acknowledge the valuable corrections supplied by R. Tate, Esq., F.G.S.

Mytilus lamellosus (Terq.), *l. c.* pl. 10. fig. 5. I.

Pinna semistriata (Terq.), *l. c.* pl. 11. fig. 1. I.

Perna infraliasica (Qu.), Jura, pl. 4. fig. 19. I.

Avicula longiaxis (Buckman), Geol. of Cheltenham, pl. 10. fig. 2. I. The long hinge is gone in this specimen; but the general form agrees so well, and it appears probable that the corresponding part *was* produced, that I have no doubt of the identification. ?=*A. Pattersoni* (Tate).

Avicula, sp.? (finely costated). III. 10. Lost.

Avicula fallax (Pflücker y Rico), 1865, Rhat. p. 15 (see Braun's Untere Jura, p. 36), =*Monotis decussata* (auct. Angl.). II., III.

Lima gigantea (Sow.), M. C. pl. 77. Common in all the beds. There

are numerous smaller specimens, all of which attain the same size, and are more oblique. They may be distinct.

Lima punctata (Sow.), M. C. pl. 113. fig. 12. I.

Lima succincta (Schl.), Taschenb. 1813, p. 72,=*Hermanni* (Voltz.), Goldf. pl. 100. fig. 5. I.

Lima pectinoides (Sow.), M. C. pl. 114. fig. 4,=*L. acuticosta*, in Tate, Geol. Journ. 1867, p. 312. Common in pit I. There are some specimens more oblique, with curved hinge-line, and having no sign of any intermediate ribs at all. They are of small size, and *may be* the young of the above, though there are others as small not showing these characters. If they prove distinct, they should be called *L. pura*.

Lima fallax? (Chap. & Dew), Terr. Sec. de Lux. pl. 27. fig. 4. I., II. Small specimens, mostly casts.

Pecten punctatissimus (Qu.), Der Jura, pl. 9. fig. 14. I. Common.

Pecten textilis (Mstr.), Gldf. pl. 89. fig. 3. I.

Pecten æqualis (Qu.), *l. c.* pl. 9. fig. 13. I. 5.

Pecten pollux (D'Orb.), Prodrome, p. 220. Oyster-bands.

Ostrea irregularis (Mstr.), Gldf. pl. 79. fig. 5, = *O. sublamellosa* (Dkr.), and *O. liassica* (Strickl.). There are specimens exactly corresponding to all these, which, however, I regard as one species. They are common in all the beds, and are the oysters which form the "oyster-bands." Two varieties may be marked: —var. *ungula* (Mstr.); and var. *concava*, like var. *ungula*, but the attached valve very concave, and only attached at the umbo.

Ostrea arcuata (Lamk.), An. S. Vert. p. 398,=*Gryphæa incurva* (Sow.), M. C. pl. 112. figs. 1, 2. VI. Not found *in situ*, *possibly* from the surface.

Waldheimia perforata (Piette), Bull. Soc. Géol. de France, t. 13. pl. 10. fig. 1,=*Terebratula psilonoti* (Qu.). I., II.

Serpula capitata (Ph.), Geol. of Yorks. pl. 14. fig. 16. I.

Serpula plicatilis (Mstr.), Goldf. pl. 68. fig. 2. I.

Serpula socialis (Goldf.), pl. 69. fig. 12,=*Galeolaria filiformis* (Terq. & Piette). I., II.

Cidaris Edwardsii (Wr.), Brit. Foss. Ech. pl. 1. fig. 1. Represented by a plate and numerous spines. I.

Hemipedina Tomesii (Wr.), *l. c.* p. 457. I. 5. A test and numerous spines, also teeth probably belonging to this. Spines of another species; longitudinal ribs toothed. I.

Pentacrinus psilonoti (Qu.), *l. c.* pl. 5. fig. 7. Common in all the upper beds.

Septastræa excavata (From.), Martin, *l. c.* pl. 8. figs. 1–5. I. A magnificent specimen, 10 in. by 7 in. by 4 in.

Montlivaltia Haimei (Chap. & Dew.), *l. c.* pl. 38. fig. 5. II., VI.

Foraminifera.

It is unadvisable here to attempt a full description of these, as they are exceedingly numerous, and, when fully studied, likely to add much to the knowledge of the microscopic fauna of the Lias; the chief features of the fauna, however, may be noticed.

Nodosaria.—Of this there are smooth varieties, elongated like *N. radicula* (L.), and shortened like *N. glans* (D'Orb.); and also striated varieties, thick like *N. raphanistrum* (L.), and narrow like *N. lineolata* (Rss.).

Dentalina.—This is in great abundance and variety. Of smooth kinds, some are oblique, as *D. communis* (D'Orb.) and *D. obliqua* (D'Orb.); some have the cells perpendicular to the axis, as *D. pauperata* (D'Orb.), or elongated, as *D. monile* (Rss.); and there are others differing from all the well-known forms. There are also some ribbed varieties, as *D. obliquestriata* (Rss.).

Lingulina.—Some few may be referred to *L. tenera* (Born.).

Frondicularia.—These are the characteristic Foraminifera of the beds, occurring in great abundance, but not in very numerous varieties; they may be referred to *F. pulchra* (Terq.), and other species of that author.

Vaginulina is present in its usual form of *V. legumen* (L.).

Planularia.—The identity of these with the forms previously described by Brady from the Lias of S.W. England is very marked, *P. Bronnii* (Röm.), *P. cornucopiæ* (Brady), and *P. pauperata* (P. & J.) being common.

Marginulina.—These are present in the form of *M. raphanus* (L.), ribbed, and *M. lituus* (D'Orb.), smooth, besides many other less-known forms.

Flabellina rugosa (D'Orb.) is certainly present, though rare.

Cristellaria.—These are abundant and present nothing novel, all being referable to *C. crepidula* (F. & M.), *C. cassis* (F. & M.), *C. rotulata* (Lam.), and other well-known varieties.

Lagena.—These are among the most interesting of the collection. There are two distinct sets of varieties—one elongated and narrow, like those called "Oolina" by foreign authors, and the other small and globular, variously ornamented, as *L. sulcata* (W. & J.).

Polymorphina.—These are in great variety, and cannot be named with accuracy. Some compare well with *P. lactea* (W. & J.) and *P. gutta* (D'Orb.), and many with *P. bilocularis* (Terq.) and others of that author. Some may eventually turn out to be *Buliminæ*.

Textilaria.—Two well-marked specimens are all that have been found of these; they differ from all well-known forms.

Triloculina.—One doubtful specimen appears to represent this genus.

Cornuspira.—Numerous specimens of this, mostly casts, can scarcely be distinguished from *C. infima* (Strickl.).

Webbina.—Some specimens of this, with irregular chambers, occur attached to fragments of shells. They may probably be identified with *W. irregularis* (D'Orb.).

Lituola.—There are several specimens in casts, which have the appearance of Rotalines, but are supposed to belong to anomalous forms of this genus. The absence of the original shell renders the decision perhaps impossible.

Note.—Among the microscopic fossils are two which require notice from their liability to be taken for Foraminifera:—1. Some hook-shaped spicules ending generally in a complete circle at one end. They are described by Terquem as Foraminifera, under the name of *Uncinulina polymorpha*, in his 'Mém. sur les Foram. du Lias,' but have since been recognized by him as spicules of *Astrophyton* (*Saccocoma*), Terq. & Jourdy, Et. Bathon. de la Moselle, pl. 15. fig. 12–14. 2. Some joints of a Crinoid (?), thin and flat, and perforated with numerous large openings disposed in a subcruciform manner, resembling the cut section of a *Nubecularia*.

Appendix. *On some* Bivalve Entomostraca *from the* Lias ("Infralias") *of* Yorkshire. By Prof. T. Rupert Jones, F.G.S.

1. Bairdia (?) ellipsoidea, G. S. Brady, MS.

Carapace ovato-trigonal; somewhat compressed; highest (broadest) in the anterior third. Valves smooth, thick; right valve the largest, overlapping the other on the dorsal and ventral borders, and marked with a furrow within each of those edges for the reception of the fellow valve. Length $\frac{1}{48}$ inch. Four specimens.

This somewhat resembles *Bairdia ovata*, Bosquet, sp. ('Mém. Commission descr. Carte Géol. Néerlande,' vol. ii. p. 73, pl. 5. fig. 6), and probably belongs rather to *Pontocypris* than to *Bairdia*, both of which are marine members of the family *Cypridæ*. See G. S. Brady's "Monograph of the Recent British Ostracoda," Linn. Trans. vol. xxvi. p. 360, &c.

2. Cythere Moorei, G. S. Brady, MS.

Carapace tumid; egg-shaped, with terminal lips and flattened ventral surface; somewhat like a peach-stone in shape and ornament. Surface of the valves reticulate; the meshes rather coarse on the middle, but having a tendency to become longitudinal and parallel on the sides and towards the extremities.

Length $\frac{1}{32}$ inch. Three specimens.

In general form this approaches *C. striatopunctata* (Römer) and *C. concentrica* (Reuss); but the reticulation differs. It takes its name after Mr. Charles Moore, F.G.S., one of the most enthusiastic of geologists, and a successful labourer among Lias fossils.

3. Cythere Blakei, sp. nov.

Carapace oblong, subcylindrical, with marginal lips at the ends, obliquely rounded in front, contracted and rounded behind, somewhat compressed dorsally at the median third. Surface rough, with faint irregular reticulation, and bearing traces of ventral striæ.

Length $\frac{1}{48}$ inch. Three specimens.

Cythere clathrata, Reuss, and its allies have this form of carapace; but the details are distinct. The name of its discoverer, the Rev. J. F. Blake, F.G.S., distinguishes this species.

4. Cythere Terquemiana, sp. nov.

Carapace narrow-oblong, incurved on the back by the projection of the anterior hinge, and pinched in between that hinge and the muscle-spot; rounded at the ends, with broad delicate margins, that of the front divided into about eight neat fossets. Surface sculptured with a coarse, irregularly hexagonal network, about eight meshes to the transverse width of the valve.

Length $\frac{1}{50}$ inch. Three specimens.

This form reminds us of the Tertiary *Cythere canaliculata* (Reuss) and its varieties; but its compression is stronger and more central, and its reticulation has far less tendency to run into ridges by the hypertrophy of the meshes.

This species is dedicated to M. O. Terquem, the veteran explorer of the Lias of Metz and its neighbourhood.

Discussion.

Prof. Duncan remarked that English geologists had been backward in receiving the term Infralias, which he had suggested with respect to the Sutton Down beds some years ago, and the propriety of which was shown by the term having been applied to the same beds by French geologists at a still earlier period. As to the White Lias, he regarded it as a mere local deposit, not to be found out of England. He traced the existence of the Infralias from Luxembourg through France into South Wales, where Corals were abundant. In Yorkshire, though one fine Coral had been found, the Ammonites seemed to point to a difference in condition.

Mr. Hughes remarked that the lithological character of the beds, as described by the author, did not agree with that of the Infralias in the S.W. of England or the N. of Italy, and that the palæontological evidence which had been laid before the Society did not confirm the view that they were Infralias. Also, by reference to the author's section, Mr. Hughes pointed out that below what he described as Infralias he drew other beds which were not Trias, the author having explained that some beds which had been called Trias were only stained beds of Liassic age.

The Rev. J. F. Blake, in reply, acknowledged the differencce between the Yorkshire section and those of the neighbourhood of Bath, but insisted on the similarity of the fossils.

February 7, 1872.

W. G. Thorpe, Esq., of Gloucester House, Larkhall Rise, S.W., and Barton's House, Ipplepen, Newton Abbot, and James Plaat, Esq., of 40 West Terrace, West Street, Leicester, were elected Fellows of the Society.

The following communications were read:—