15. *On some GAPS in the LIAS.* By EDWIN A. WALFORD, Esq.,
F.G.S. (Read February 26th, 1902.)

THE calcareous beds of the Middle Lias attain a maximum thickness near Banbury in Oxfordshire. They form the highlands of the escarpment (the outcrop) on the North Oxfordshire border at their highest altitude, 720 feet above Ordnance-datum.

The several zones of the Middle Lias may be put broadly into three lithological divisions :—

1. Zone of *Ammonites spinatus*, and Transition-Bed. (Calcareous.)
2. Zone of *Ammonites margaritatus*. (Argillaceo-calcareous.)
3. Zone of *Ammonites Jamesoni* or *ibex* and *Anm. capricornus*. (Argillaceous.)

The deposition of divisions 2 and 3 followed a long period of sedimentation, mainly of argillaceous type. They are, in fact, repetitions of the previously existing conditions of the Lower Lias, differing only in a gradual increase in the thickness of the argillaceous limestones towards the top of the zone of *Ammonites margaritatus*. Similar conditions prevailed over the whole of the English Liassic seas. Though the incoming of the zone of *Anm. spinatus* was with some argillaceous deposit, the true zonal type was reached in the calcareous bands at the base of the great Ironstone Series, wherein the true fauna of the zone rests. In the Midlands and in Yorkshire these limestone-beds are at the lowest part of the 30 feet of rock and clay of the *Anm.-spinatus* zone. Nodular and concretionary bands characterize them. The nodular limestones are represented in Somerset, Dorset, and Gloucestershire by marly limestones yielding also the molluscan fauna of that part of the zone.

The ferruginous limestones of the superior part of the zone I have elsewhere¹ shown to be mainly a sub-crinoidal bank of great thickness and importance in Northern Oxfordshire and Cleveland (Yorkshire), both now important centres of the iron-industry. Hence the zone of *Ammonites spinatus* may be divided into an upper and lower series :—

		Feet.
Zone of	{ 1. The Ferrocrinoid-Beds (superior)	30
<i>Anm. spinatus</i> .	{ 2. The <i>Spiriferina-oxygona</i> Beds (inferior)	20

Variations in thickness of the superior division in Oxfordshire are frequent, ranging from 30 feet (at an altitude of 700 feet) to 6 feet on the edges of the Cherwell Vale (at an altitude of 350 feet), owing to waste by water-flow.

Special or abundant fossils of the Ferrocrinoid-Beds (1) :—

<i>Ammonites spinatus</i> (very rare).	<i>Terebratula punctata</i> .
<i>Rhynchonella tetrahedra</i> .	<i>T. Edwardsi</i> .
<i>Rh. tetrahedra</i> , var. <i>northamptonensis</i> .	<i>Waldheimia indentata</i> .
	Ferrocrinoids.

¹ 'On the Making of the Middle Lias Ironstone of the Midlands' Journ. Iron & Steel Inst. vol. xlix (1896) p. 74.

The special or more abundant fossils of the *Spiriferina-oxygona* Beds (2) are :—

Ammonites margaritatus.
Amn. spinatus.
*Belemnites parillosus.**
Rostellaria admiranda.
Trigonia lingonensis.
Protocardium truncatum (mainly
 derived).
Lima Elea.

Harpax lævigatus.
Cardinia Philea.
Ostrea submargaritacea.
*O. sportella.**
Rhynchonella acuta.
Spiriferina oxygona.
Thamnastreæ Etheridgii.
Lewandra Walfordi.

[The fossils marked with an asterisk are especially abundant.]

Division 1 (the Ferrocrinoid-Beds) I take to be unrepresented in Dorset, Somerset, and Gloucestershire. There the marlstone yields large *Gryphæa*, *Ostrea*, and *Cardinia*, together with *Ammonites spinatus* and *Amn. margaritatus*. The fauna is that of the *Spiriferina-oxygona* Beds of Oxfordshire with, however, many of the brachiopoda of the higher division. The Leicestershire and Rutland beds are of the Oxfordshire type.

While the concretionary beds of division 2 with a typical coral-fauna were being deposited, the more marly beds of Somerset and Dorset developed a fauna of large growth but of more widely-spread forms. The same conditions appear to have extended over Northern France, and I have grouped the Middle Lias of Calvados in Lower Normandy and that of the counties of Dorset, Somerset, and Gloucester together as the Anglo-Norman Basin. In Normandy, as in the South-west of England, the remains of the later Middle Lias and the Upper Lias are found resting upon Palæozoic rocks. The late Prof. E. Eudes-Deslongchamps brought evidence to prove the possession of the Palæozoic sea-floor by a Liassic fauna. My endeavour is to show that the fragmentary type of those deposits may be explained by long-continued waste (inter-waste) rather than by contemporaneous erosion.

The Ferrocrinoidal ironstone (div. 1) bears a sparse generic fauna, though from its thickness and apparently slow accumulation other results might be expected. Beds of brachiopoda make up in number of individuals for the deficiency in number of species. The common *Rhynchonella tetrahedra* attains wide diversity of form, reaching however its largest growth in the preceding *Spiriferina-oxygona* division. Banks of *Terebratulæ* occur, replacing for a time the *Rhynchonellæ*, but nearly all the species are common to the two horizons. Beds crowded with the remains of Ferrocrinoids range through the whole of the deposit of this time. The green limestone of the bottom beds and the fawn-coloured, more marly limestone of the top bed are packed with their sinuous stems, which may often be seen in the weathered masonry of old buildings. The excellence of the flaggy stone, locally known as 'top rag' and in great use as a paving-stone, is owing to the packing of the several beds with the stems of the same organism. This great calcareous bank, it may be assumed, was of sufficiently indurated type to allow the accumulation in its hollows and sides of the clinging masses of

brachiopoda, after the manner of their occurrence at the present day in the great Australian Barrier-Reef.

East of the Cherwell Vale the Ferrocrinoid-Beds lose type and importance. Along the Middle Liassic outcrop, on the north-western border of Northamptonshire, and trending eastward into Rutland, the same Ferrocrinoidal life appears to have prevailed, though perhaps less prominently. In the famous iron-ore-field of Cleveland it was a great factor in the making of the Liassic limestone, though of difference in type from the Oxfordshire beds.

Passing to consideration of the close of the Ferrocrinoid time, I think it is certain that the area of deposition was narrowed, or that waste over wide areas has supervened. We have been too prone to assume that the fact that several zones are welded into one course of limestone constitutes sufficient evidence of continuity of conditions. I shall show, by three sections from the neighbourhood of Banbury, that such conditions do not prove continuity.

At Bloxham, 3 miles north-west of that town, the 3 feet of the Liassic rock-bed at the top form one course, in the main made up of the stems of the Ferrocrinoid, but passing at the junction with the Upper Liassic clays into pinkish compact limestones crowded with Upper Liassic organisms. The pink limestones are of the *Ammonites-communis* zone, the intermediate Transition-Bed and zone of *Amm. serpentinus* having been removed by inter-waste.

At Fernhill, 6 miles north-west of Banbury, the rock-bed (*Amm. spinatus* zone 2) is overlain by the Transition-Bed (*b*), the *Posidonomya*-shales and limestones of the zone of *Amm. serpentinus* (*c*), and by thin fossiliferous limestones and thicker clays of the zone of *Amm. communis* (*d*). Rather high up, a thin limestone, made up of Pentacrinite-segments, constitutes a convenient line for demarcation. At the eastern end of the same cutting at Fernhill, the conditions of the Bloxham section are shown in the removal of the Transition-Bed and the whole of the zone of *Amm. serpentinus*. This is even more clearly shown at the Astrop Ironstone Company's works at Cobbler's Pits, near King's Sutton, where remains of certain of the fossils of each horizon prove a former continuity of zones. At Fawler, the farthest point south-westward, yet more waste is shown, the zone of *Amm. bifrons* being indicated by a few fossils characteristic of its limestone, of the same species as at Bloxham.

On the north-western border of Oxfordshire, where the Ferrocrinoidal ironstone is of greatest thickness, the Upper Lias has been removed for the most part, and here and there a patch with the limestone of the zone of *Amm. bifrons* welded with the limestone of *Amm. spinatus* shows an equal amount of inter-waste. The preservation of the several zones has been effected by the earlier subsidences of the Eastern Cherwell border, and by another small area of subsidence of the western border of Oxfordshire, where the fall is to the west and the River Avon. They are both in the areas of a divide—the one in the divide of the drainage of the Ouse and Cherwell, the other in the divide of the Avon and Cherwell.

However complete the sequence of the sections may appear to be,

there is at the top of the Middle Lias of the Northamptonshire border a palæontological gap perhaps better defined than any other in the Lower Jurassic Period. It is shown in the stratum of marl that I have called the Transition-Bed of the Middle Lias, and the section of Fernhill near Banbury, on the Great Central Railway, is one, from its completeness, best suited for illustration. Other sections that I described twenty years ago are at Chipping Warden and Byfield, a few miles north-west of Fernhill.

		FERNHILL, G. C. R. (Aqueduct cutting, S. bank.)		FERNHILL ROAD BRIDGE. (N. bank.)		KING'S SUTTON. (Astrop Ironworks.)		BLOXHAM.		FAWLER.				
		Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.			
1. Humus and waste		2	0	6	0	2	4	2	0	2	0			
Amn. communis.	2. Blue Clay	8	0	16	0	.....		15	0	16	0			
	3. Pentacrinite-limestone	1	0			.....								
	4. Clay, with line of ferruginous rubble	2	0	.....		2	0	.....		.....				
	5. Limestone with <i>Am. bifrons</i>	1	0	10		5		.....		1				
	6. Clay, with small ammonites and belemnites	4	0	7	6	3		6		.....				
	7. Limestone, with small ammo- nites and belemnites	4	0	7	6	3		6		.....				
8. Clay	3	0	3	0	.....		.....			.....				
Amn. serpentinus.	9. Blue Limestone (sharp frac- ture) with <i>Am. Strangwaysii</i>	9	0	8		.....		.....		.....				
	10. Paper-shales	6	0	5		.....		.....		.....				
	11. Purple and black limestone (fish-bed) with <i>Amn. Strang- waysii, communis</i> , etc.	4	0	2		a trace		.....		.....				
Amn. spinatus.	12. Calcite-veined limestone ...	Transi- tion.	2	.....		.....		.....		.....				
	13. Grey argillaceous marl		3	.....		a trace		.....		.....				
	14. Red-brown marl		3	.....		.....		.....		.....				
	15. Marlstone—zone of <i>Amn. spinatus</i> (1) .....		.....	4	7	5	0	20	0	11	0			

In part welded with the upper part of the Middle Liassic rock-bed, and in part resting upon it, is a stratum of fawn-coloured marly limestone weathering to marl, varying from 3 to 6 inches in thickness. It brings in a large assemblage of life-forms, and attains greater importance owing to the Ammonitidæ being so abundantly developed therein. Tate & Beesley¹ noticed the occurrence of the fauna at Adderbury, but it is not there distinguished as a separate horizon. In Northamptonshire, where better conditions prevail, I collected and tabulated from the several localities 175 species of mollusca: now the number is considerably greater.

No period of geological life is better marked than the time of the incoming of *Ammonites communis* and its allies in the Lias. Throughout the whole of England, and also throughout the whole of the Anglo-Norman area, there had been a long pause in conditions favourable to the growth of the Ammonitidæ. The Spinati almost died out at the base of the great Ironstone Series of the Midlands, and it was apparently the same elsewhere. They occur but rarely in the ironstone of the Ferrocrinoid time. Early forms of the

¹ Thomas Beesley, Rep. of Excurs. to Banbury, Proc. Geol. Assoc. vol. iii (1873) p. 197.

communis-type do come in at the top of the Ferrocrinoid rock-bed, but not lower than a foot below the overlying Transition-Bed. With the incoming of the Transition-Bed limestones representatives of five groups of ammonites appear, not dwarfed but frequently of luxuriant growth. They are not represented by a few individuals, but by thousands, in which every gradation of growth and ornamentation seems to find place. Whenever and how they came in we do not know. England, France, and Germany fail to supply the genetic links of the chain. Perhaps we should look to the Middle Lias of Spain and Italy for deposits which may tell us the history of this interval of time. The gasteropoda partake much of the type of those of the *Spiriferina-oxygona* Beds, but are mainly of distinct specific form—about forty species in all. Polyzoa of like kind occur in the *Sp.-oxygona* Beds at the base of the *Ammonites-spinatus* zone and in the Transition-Bed at the top.

An interesting part of the record of this time is the alteration in the type of the fauna in its spread over the Midland area. In the outlier of Badby, 14 miles north of Banbury, Mr. Beeby Thompson¹ found a Transition-fauna, and I have also collected from it. The Ferrocrinoidal rock is wasted, and the Transition-fauna occurs in holes and pockets in it. A remarkable group of Tellinidæ replaces the ammonites, which are few and dwarfed, and the rock is bored. The gasteropoda are dwarfed in size and in ornamentation, though very abundant; and the pelecypoda are of small size also. There are few corals. At Byfield, 4 miles to the south, the fauna is of normal type, as it is also in its easterly spread. At Fernhill, farther south-eastward, the ammonites are of larger growth. It may be that this was the coral-fringe of a deeper sea where the warmer shallows developed life, as in the inner shoals of the Great Barrier-Reef which Prof. Alexander Agassiz has described so well.

The Transition-gap, as I have shown, rests for evidence wholly upon a sudden appearance of molluscan life of new type. If the Ferrocrinoid-bank was reef-like and the development of life went on outside it, evidence of the sedimentation in the interval has yet to be sought for. The passage of life during the building-up of the 60 feet of strata of the *Ammonites-spinatus* zone went on with the usual alternating conditions. No one of the ammonites at the end of the Middle Liassic day is the same as at its dawn—no one of the ammonites of the '*spinatus*' beginning lives to the end of that time. It is an index of the imperfection of our study of genetic life.

Turning to the western and south-western side of the Cherwell Vale, with the exception of Adderbury which rests on its western bank, no remnant of the Transition-period has been found. Farther westward, a patch in the Vale of the Stour proves its extension there. At Constitution Hill, 1 mile west of Banbury, at Bloxham, and Milcombe, 3 or 4 miles farther south-west, the pink and white

¹ 'Middle Lias of Northamptonshire' 1888, p. 43.

limestones of the Upper Lias (*Ammonites-communis* zone) are welded with the Middle Liassic Ferrocrinoid-Beds; the whole of the intervening Transition-Bed, fish-bearing limestones, and paper-shales of the *Amm.-serpentinus* zone have been wasted. As far as the north-western escarpment near Shennington there is the same hiatus, and *Ammonites bifrons* is in the same rock-course as the *spinatus*-fossils. The interval must be looked upon as a belt of waste, such as the Inferior Oolite limestone shows at the base of the argillaceous beds of the Bathonian. Inter-waste seems to me a convenient term to define the removal of strata long subsequent to their deposition.

A succeeding gap, though in point of waste of strata represented best by the absence of 3 feet 2 inches of clays and limestones, yet corresponds with the 19½ feet of the same series at Alderton in Gloucestershire, and with the 50 or 60 feet of the zone of *Ammonites serpentinus* in Yorkshire. In point of palæontological time it includes:—

The genesis and expiry of groups of minute brachiopoda (*Leptæna*, *Thecidea*, etc.) and of many of the gasteropoda and pelecypoda. Charles Moore, in 1867,¹ made out 70 species from his *Leptæna*-beds.

The genesis of many large falciform ammonites and of the Belemnitidæ of the fish- and insect-beds (zone of *Posidonomya Bronni* of French authors); also its numerous gasteropoda, noticeably *Euomphalus minutus*. The first appearance of 6 species of saurians, 8 species of fishes, 6 forms of crustacea, and of many of the insecta and microzoa.

In all, adding the Somerset lists to those of the Midlands, quite 400 distinct species, fully one-half of which have not been collected or recorded from strata above or below the gap. Yet it is exceptional in the Midlands to meet with the fragmentary remains even of the beds which hold so important a record of life. Middle Liassic rock merges into high Upper Liassic rock without a line of interval or separation. Before the many processes of interstratal waste were understood, the gaps were put down to cessation of deposit, contemporaneous erosion, and like causes.

A curved band drawn through Central England from Yorkshire to Somerset, widening at the two ends, puts before us the waste of this gap in the Midlands, where yet the Middle Liassic rock rests at an altitude of 720 feet. The broadening of the band to the north-east and to the south-west indicates the remaining greater thickness of strata there.

A third gap of minor importance, both in its waste of strata and in its change of life-forms, can be measured in Oxfordshire and Northamptonshire by the occurrence of a thin bed of Pentacrinite-Limestone. The layer is recognizable, owing to its being made up wholly of crinoid-segments. It is found to the north at Byfield in Northamptonshire, and southward as far as Souldern in Oxford-

¹ Quart. Journ. Geol. Soc. vol. xxiii (1867) p. 449.

shire; to the east it comes in at Fernhill, and extends thence to Bloxham on the south-west side of Banbury. Its area I have traced for 20 miles north and south by 10 miles east and west. Between the fish-bearing limestones of the *Ammonites-serpentinus* zone and the overlying Pentacrinite-band at Byfield but a few inches of strata occur; at Fernhill there is a thickness of $12\frac{1}{2}$ feet. At Bloxham the Pentacrinite-Limestone rests upon an argillaceous limestone of the lower part of the zone of *Ammonites communis*, with only 3 feet of deposit between the crinoidal limestone and the Middle Liassic rock below. A thin yellow limestone of the same zone lying upon the Middle Liassic rock I term 'the hemera of *Waldheimia Lycetti*,' and it yields a large and special fauna. At Fawler only a trace of it rests directly upon the Middle Lias.

At Fernhill, within the mile's length of the long cutting on the Great Central Railway, differences in sequence of strata are found, which elsewhere have to be sought for over wide areas of adjoining country. Fernhill is in itself the key to the right sequence of the stratigraphy of the Middle and Upper Lias, though in other localities palæontological stations are better marked. The Pentacrinite-Limestone rests upon the *Ammonites-communis* rock in places where the intervening beds have wasted, and the occurrence of *Waldheimia Lycetti* marks the hemera there. The subsidence or fault which runs along the line of railway at Fernhill breaks the bed on the west bank of the cutting abruptly down, and the *Waldheimia-Lycetti* beds are seen to rest upon the Middle Liassic ironstone in much the same way as at Bloxham. Worn out on it are great cable-like markings, bearing the appearance of remains of massive arborescent or trailing growth. The waste of the 'funnel-fault' at Fernhill has removed the strata of the intervening zones, in the same way as the slower and long-continued inter-waste has done on the 10-mile long slopes of the country from the western Middle Liassic outcrop to the banks of the Cherwell.

The measure of displacement of the Lias over the Cherwell Vale may be gathered by noting that the *Ammonites-margaritatus* zone at Fernhill occurs at the altitude of 570 feet near the divide of the Ouse and Cherwell, while on the western escarpment the altitude of the same beds I take to be 680 feet; fragments of the same zone along the river-banks are found at about 300 feet above Ordnance-datum. What was the old line of altitude is beyond our ken of today.

The key to the problem of inter-waste is sought in the necessarily associated lines of fall and drainage. Our local conditions show that the long fall from the escarpment south-eastward lessens the thickness of the Middle Liassic calcareous ironstone only as it nears the main line of drainage (the Cherwell). The thickness ranges from 30 to 10 feet. The drainage on the east side of the Cherwell with a south-westerly fall, and of but one third of the area of that to the west, alters the rule. Twelve feet may be taken as the maximum of the Middle Liassic calcareous ironstone—the thickness ranging from 6 to 12 feet irregularly over that region.

STRATIGRAPHICAL TABLE, SHOWING THE GAPS IN THE UPPER AND MIDDLE LIAS OF ENGLAND.

SOMERSET. GLOUCESTER. W. OXON. E. OXON. NORTHANTS. RUTLAND. YORKS. WORCESTER. S.E.

[Vertical scale : 1 inch = 16 feet.]

- A = Middle Lias (*Spiriferina-oxygona* zone).
- B = Middle Lias (*Ferrocrinoid*-zone).
- C = Middle Lias (*Transition*-Bed).
- D = Upper Lias (*Ammonites-serpentinus* zone).
- E = Upper Lias (*Ammonites-communis* zone).
- F = Upper Lias } (*Ammonites-bifrons* zone) { *Leda-ovum*
- G = Upper Lias } Bed.

Westerly vales draining into the Stour from the western escarpments and with a westerly fall show similar results in that area. The fall is also short. The Middle Liassic calcareous (ironstone) beds thin down to 4 or 5 feet.¹ At the hill dipping into Brailes the thickness is greater. I have spoken before of a remnant of the Transition-Bed, and of the fish-bearing limestones and paper-shales of the *Ammonites-serpentinus* zone in that part of the Stour Vale, preserved in like manner to similar beds in the Cherwell area draining westward.

There is no reason to doubt that the calcareous (ironstone) beds of the zone of *Ammonites spinatus* were formerly as thick on the eastern side of the Cherwell Vale as on its western side. We must not overlook the fact that there was some difference in the organisms and growth of the Ferrocrinoid-bank of the east. Why should not the waste be the same, with the overlying clays and limestones of the east side of the Vale, with the shorter fall? Vales of shorter drainage, whether on the scarp-edge to the west, or on the east side of the Cherwell, show preservation of minor zones of the Upper Lias constituting elsewhere gaps 1, 2, and 3. On the west side of a divide, with a fall opposite to the common dip of the country, massive calcareous beds dwindle in thickness, while overlying thin strata of limestone and clay, as well as the greater capping of tenacious clays, are better preserved than on the long fall with the common dip.

I find the same preservation of minor zones of the Inferior and Great Oolite systems on the short flanks of a divide. Thus, in the long ridge of the boundary-lines of North-western Oxfordshire and South-eastern Warwickshire, remains of several of the lower divisions of the Great Oolite are found in faulted troughs on the side away from the prevailing easterly dip. In 1883,² I pointed out the existence of these remnants and the great interest of their fauna. The lesser volume of drainage of the short slope made less waste of strata. The faulted areas on the short slope appear also to have been of a more recent date of displacement than the longer underdrained slopes of the Cherwell Vale. When I am able to take up the description of the Great Oolite remanied deposits that I have discovered, I shall hope to enter more fully into the question of their time and conditions of displacement.

On p. 274 I have given a stratigraphical Table illustrating the gaps in the Upper and Middle Lias of England; and on pp. 276-77 Lists of the (more important) Fossils of the Upper and Middle Lias.

¹ Later search has proved 13 feet at the head of the vale draining into Tysoe.

² 'On the Relation of the so-called Northampton Sand of North Oxon to the *Clypeus-Grit*' Quart. Journ. Geol. Soc. vol. xxxix (1883) p. 233.

THE FOSSILS OF THE UPPER LIAS.

ECHINODERMATA & MICROZOA.	PELECYTODA.	GASTEROPODA.	BRACHIOPODA.	CEPHALOPODA.
{ Isla-ovum Beds.	<i>Astarte</i> sp. <i>Nucula Hameri</i> . <i>Corbicula</i> sp.			<i>Ammonites bifrons</i> . <i>Amn. fluitatus</i> . <i>Amn. exaratus</i> . <i>Amn. lythensis</i> . <i>Amn. fulcifer</i> .
	<i>Leda ovum</i> . <i>Inoceramus dubius</i> . <i>Thracia glabra</i> . <i>Astarte</i> sp.	<i>Cerithium</i> sp.	<i>Discina reflexa</i> .	
{ Zone of Ammonites communis.	<i>Hinnites Duvai</i> .			<i>Amn. heterophyllus</i> . <i>Amn. bifrons</i> . <i>Amn. cornucopiæ</i> . <i>Amn. subcarinatus</i> . <i>Amn. Stranguayssi</i> . <i>Amn. crassus</i> .
	<i>Diplocidaris Desori</i> .	<i>Eucyclus capitaneus</i> . <i>Onustus heliacus</i> . <i>Pleurotomaria Theresa</i> . <i>Natica pelops</i> .	<i>Waldheimia Lycetti</i> . <i>Rhynchonella jurensis</i> .	
{ Zone of A. scyphinus.	<i>Peltarion unilobatum</i> .	<i>Euomphalus minutus</i> . <i>Cerithium coronatum</i> . <i>Dentalium elongatum</i> . <i>Neritopsis</i> sp.		<i>Amn. cornucopiæ</i> . <i>Amn. acutus</i> . <i>Amn. Levisoni</i> . <i>Amn. communis</i> . <i>Amn. serpentinus</i> . <i>Amn. exaratus</i> . <i>Amn. crassus</i> .
		<i>Pecten textorius</i> . <i>Ceromya bombar</i> . <i>Posidonomya</i> sp. <i>Monotis substriata</i> .		

THE FOSSILS OF THE MIDDLE LIAS AND THE TRANSITION-BED.

<i>Pentacrinus juvenis.</i> <i>Montlivaltia tuberculata.</i> <i>Cisternifera inconstans.</i>	<i>Cardinia Phila.</i> <i>Phasianella Buvignieri.</i> <i>Cerithium ferreum.</i> <i>Pitonillus linctus.</i> <i>Littorina biornata.</i> <i>Pleuronomaria heliceiformis.</i> <i>P. heliconoides.</i> <i>Eucyclas Gaudryanus.</i> <i>Nerinea liassica.</i>	<i>Waldheimia Darvini</i> (?). <i>W. Bakeri.</i> <i>Rhynchonella serrata</i> , var. <i>Rh. northamptonensis.</i> <i>Rh. tetrahedra.</i> <i>Rh. Amathet.</i> <i>Rh. Bouchardi.</i> <i>Leptæna</i> sp.	<i>Ammonites acutus.</i> <i>Amm. Hollandæi.</i> <i>Amm. annulatus.</i> <i>Amm. heterophyllus.</i> <i>Amm. communis.</i> <i>Amm. subspinatus.</i> <i>Amm. subarmatus.</i>
<i>Ferrocrinoids.</i>	<i>Pecten liosinus.</i> <i>P. æquivalvis.</i> <i>P. lunularis.</i> <i>P. æquivalvis.</i> <i>Himites Dancæi.</i> <i>H. tumidis.</i> <i>Mytilus numismatis.</i> <i>Linæa cristata.</i> <i>L. Juliana.</i> <i>Lima Hermann.</i>	<i>Rhynchonella tetrahedra.</i> <i>Rh. tetrahedra.</i> <i>Terebratula punctata.</i> <i>Spiriferina rostrata.</i> <i>Rhynchonella northamptonensis.</i> <i>Rh. tetrahedra.</i> <i>Terebratula punctata.</i> <i>T. punctata.</i> <i>T. Edwardsi.</i> <i>Waldheimia indentata.</i> <i>W. florella.</i> <i>Rhynchonella tetrahedra.</i>	<i>Amm. Hollandæi.</i>
<i>Ferrocrinoids.</i>	<i>Pecten lunularis.</i>		<i>Amm. spinatus.</i>
<i>Hemipetina Jardini.</i> <i>Leucandra Walfordi.</i> <i>Thamastrea Eheridgii.</i> <i>Montlivaltia sp.</i> <i>Astrocentia sp.</i> <i>Ferrocrinoids.</i> <i>Cisternifera inconstans.</i>	<i>Gastropachia lugdunensis.</i> <i>Cardinia Phila.</i> <i>Harpax levigatus.</i> <i>Spondylus Elea.</i> <i>Lima Elea.</i> <i>Avicula cynipies.</i> <i>Ostrea sporiella.</i> <i>Mytilus aviothensis.</i> <i>Trigonia liogonensis.</i> <i>Harpax levigatus.</i> <i>Myacites.</i> <i>Pleuromya liasina.</i>	<i>Terebratula subpunctata.</i> <i>Rhynchonella tetrahedra.</i> <i>Spiriferina oxygonia.</i> <i>Sp. rostrata.</i> <i>Rhynchonella acula.</i>	<i>Amm. spinatus.</i> <i>Amm. margaritatus.</i> <i>Belemnites parillosus.</i>

DISCUSSION.

The Rev. J. F. BLAKE observed that there were several points of considerable interest in the paper, as, for instance, the proof of the dwindling-out of the hard beds of the Upper Lias towards the Midland Counties. Shore-deposits seemed to be absent here, and the Author appeared to indicate that the sandy littoral zone of *Ammonites capricornus* was not to be found in the district described. The Author's junction-bed between the Marlstone and the Upper Lias was what he (the speaker) would term an 'aggregate-deposit.' He criticized the use of such a term as 'ferrocrinoid,' which appeared rather to suggest the advent of such appellations as 'pyritograptolites.' He failed to see any true crinoidal remains in the slides last shown, and the so-called 'stems' had more the look of worm-tubes made up of fragments of shell. He enquired whether 'inter-waste' was intended to express subsequent or contemporaneous erosion. If the phenomena described were examples of Mr. Rutley's 'dwindling of limestones,' the most soluble part should disappear first. The strata thin naturally eastward, and an original dip would more or less follow the same direction. There were examples of occurrences similar to those described in the Lias of the South of England, but not in the Yorkshire Lias.

Mr. W. WHITAKER pointed out, with regard to the Author's observation that the calcareous beds on the scarp-face are thin, that the conditions of the underground waters are very different on either face. The flow is quick on the scarp-face and slow on the dip-slope, a difference which would probably affect calcareous deposition. Moreover, deposits on a scarp-face are more liable to landslips.

The AUTHOR, in reply, said that the microscopic sections shown through the lantern were of the Pentacrinite-Bed from the Upper Lias; of a crinoid from the Middle Lias; and of stems of the ferrocrinoid, also from the Middle Lias.