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 p. 347; with Map.
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EXCURSION TO NORTHAMPTONSHIRE.

SATURDAY, MAY 16TH TO TUESDAY, MAY 19TH, 1891.

Directors: BEEBY THOMPSON, F.G.S., F.C.S., AND
 WALTER D. CRICK.

(*Report by the DIRECTORS.*)

The official Excursion comprised only the two days, Monday and Tuesday, in Whitsun week, *i.e.*, May 18th and 19th, but a preliminary Excursion was arranged for the Saturday previous. The programme of the Excursion contained a section, showing the sequence of the various beds in the particular area to be visited by the Members, which is here reproduced.

DETAILED DESCRIPTION OF THE BEDS.

CORNBRASH.

1. Rubbly ferruginous and fossiliferous limestone, with some large blocks, containing *Terebratula obovata*, *Pecten vagans*, *Avicula echinata*, *Anabacia orbulites*, &c.

FOREST MARBLE SERIES.

- 2 and 4. Variegated clays, greenish looking at a distance, containing much drift-wood and carbonaceous matter.
- 3 and 5. Fissile shelly limestones and hard shales, with many fossils, chiefly *Ostrea*, also much drift-wood; some surfaces of the stone being nearly covered with plant-remains.

GREAT OOLITE CLAY.

6. Blue and purple clay, containing much wood and carbonaceous matter, some of the larger pieces of wood bored by some boring mollusc. *Ostrea subrugulosa* is abundant in this bed at some places, but not in the area visited.

TRANSITION BED?

7. Ferruginous bed containing concretionary ironstone nodules, also much selenite in curious interlacing layers.

FIG. 1.—SECTION SHOWING THE SEQUENCE OF BEDS IN THE NEIGHBOURHOOD OF NORTHAMPTON.—*Betty Thompson, F.G.S.*

Scale, 1 inch=16 feet.

GREAT OOLITE LIMESTONE SERIES.

8. Light-coloured marl with small limestone nodules (concretions?), selenite, and vertical plant markings. Oysters fairly abundant.

9. Limestone in numerous courses, with thin partings of marl, clay, or other earthy matter, the stone often in large blocks, the joints of which facilitate quarrying operations. A hard semi-crystalline layer is met with toward the base, crowded with fossils such as *Nerinea*, *Astarte*, *Trigonia*, etc., locally called the *Nerinea*-bed. Fossils are very common throughout this limestone, but somewhat difficult to get, except from soft layers or weathered surfaces in fissures. The most common fossils are: *Strophodus*, *Nautilus*, *Eryma*, *Natica*, *Nerinea*, *Lima*, *Ostrea*, *Pecten*, *Perna*, *Pteroperna*, *Astarte*, *Cardium*, *Ceromya*, *Cypricardia*, *Isocardia*, *Modiola*, *Myacites*, *Pholadomya*, *Tancredia*, *Trigonia*, *Unicardium*, *Terebratulit*, *Acrosalenia*. *Clypeus*, *Echinobrissus*. At least two, and sometimes several species of the above occur. *Rhynchonella concinna* is very abundant in some places, but not in the area visited.

10. Calcareous clay, with vertical plant markings in places.

11. Hard fossiliferous limestone, characterized, over a considerable area, by the prevalence of specimens of *Acrosalenia*, though the stone is usually too hard for any to be extracted.

The beds 8 to 10 seem to vary considerably in their relations to each other; for instance, sometimes there is only one bed of limestone, in which case either 10 or 11, or both, are absent, or 10 is itself a limestone.

UPPER ESTUARINE BEDS.

12. Dark blue or purple clay, with ferruginous bands, also bands of shells, some of which latter are supposed to be fresh or brackish water forms (*Cyrena*, &c.). There is much carbonaceous matter in this bed, and sometimes large pieces of wood, also vertical plant markings.

UNCONFORMITY.

13. Irregular ferruginous layer forming a base to No. 12, persistent over a large area, and indicating the position occupied by the Lincolnshire Oolite in the north-eastern parts of the county (75 feet at Stamford).

LOWER ESTUARINE BEDS (NORTHAMPTON SAND).

14. White or slightly ruddy sands, frequently intercalated with clay, sometimes hard enough for building purposes. Vertical plant markings can usually be found in these beds, often on more than one horizon, these being probably the remains of equisetaceous plants, and not mere root perforations.

NORTHAMPTON SAND.

15. *Variable Beds*, consisting mostly of ferruginous sandstones, the amount of iron and calcareous or argillaceous matter varying considerably. It is probable that these beds encroach upon and are themselves encroached upon by the white sands in different places. The lower portion is commonly slaty in character, and has been used for roofing. These beds, however, are mere local modifications of the main bed, and vary a good deal in a small distance. False-bedding is very commonly noticed.

16. *Ironstone Beds*. These also vary much in thickness, in the quantity of iron in them, and in the mode of its occurrence. Most of the Inferior Oolite fossils are found in these beds, though where there is much iron they are chiefly casts only. *Ammonites opalinus* is here associated with a form very near to *Ammonites jurensis*. *Rhynchonella cynocephala* is not uncommon. (See description of Ironstone workings at Duston and Brixworth, &c.)

17. *Phosphatic Layers*. Bluish green ironstone, quite continuous with No. 16, but containing about two per cent. of phosphoric acid as phosphate of iron, which determines its rejection for furnace purposes. The rock is mostly ferrous carbonate, with perhaps some silicate. Same fossils as in No. 16.

"JURENSIS" ZONE.

18. *Layer of bored nodules* resting on Upper Lias Clay, but surrounded and covered by Inferior Oolite Sand. They contain *Ammonites bifrons* and other Upper Lias fossils, together with some Inferior Oolite ones. The nodules have not been rolled, they are mostly bored by *Lithodomi*, and have on their surfaces Polyzoa, *Serpulæ*, &c.

19. *Upper Leda-ovum Beds*. Blue clay with numerous nodules, which latter, quite unlike those found below in the Upper Lias, are often crowded with fossils. All these gregarious forms are peculiar to the zone, and include *Mytilus gregarius*, *Protocardium substriatulum*, *Astarte minima*, &c. *Trigonia northamptonensis* and *Gresslya abducta* are other interesting forms.

20. *Oyster Bed*. An almost continuous layer of large water-worn nodules, covered with oysters (*Ostrea sandalina*) also many specimens of a large *Lima* (*L. toarcensis*?). This bed seems to form a very sharp palæontological boundary for a good number of fossils. No *Stephanoceras* has been found above it.

"COMMUNIS" ZONE.

The "*communis*" zone ought to include all the beds from 21 to 25 inclusive, but the name has no palæontological significance in Northamptonshire, for *Ammonites communis* is found in some abundance in the Transition bed, No. 29, which is below the so-called "*serpentinus*" zone. Other descriptive terms are therefore used.

21. *Middle Leda-ovum Beds.* Blue clay, with numerous nodules from which the best fossils are obtained. *Leda ovum* is more abundant in these beds than elsewhere. So far as is known, the bed has no characteristic fossils of its own, but is distinguished by absence of fossils characteristic of the beds above and below.

22. *Lower Leda-ovum Beds (Cerithium Beds).* Blue clay, indistinguishable from 21, except by fossils. Great numbers of small gastropods are found in this sub-zone, *Cerithium armatum* being the most common. The boundary between this zone and the next below is rather indefinite, but there is a good deal of nail-head spar, and some very large nodules on or about the horizon.

23. *Unfossiliferous Beds.* A considerable thickness of blue clay with many large nodules, but very few fossils.

"COMMUNIS" BEDS.

24. *Upper Cephalopoda Bed.* A hard argillaceous limestone, rather shaley, in places crowded with ammonites, mostly *A. communis* or *A. holandrei*, though a good many specimens of *A. bifrons*.

25. Blue clay containing abundance of small ammonites of the planulate group, *A. communis* and *A. holandrei* chiefly.

The "*communis*" beds yield a fair number of fossils not found above or below: such as *Ammonites subcarinatus*, long slender belemnites of two or more species, *Trochus duplicatus*, *Trochus northamptonensis*, *Eucyclus acuminatus*, *Nucula claviformis*, and small single corals.

"SERPENTINUS" BEDS.

26. *Lower Cephalopoda Bed.* A hard argillaceous limestone containing some very large ammonites of the "*falcifer*" group, mostly *A. Strangwaysi*. A fair number of other interesting fossils are also found, as *Amberlyia capitanea*, *Onustus spinosus*, &c.

27. A calcareous clay with very few fossils. Often only a few belemnites can be found.

FISH-BED AND PAPER-SHALES.

28. A hard fissile limestone imbedded in a finely laminated shale, the limestone often occurring in lenticular nodules. Both limestone and shale abound in fragmentary fish remains, and occasionally a nearly perfect fish is found—*Lepidotus*, *Pachycormus*, or *Leptolepis*. These are the only beds in which the aptychi of ammonites are found, also the only ones containing the cephalopods *Teudopsis*, *Beloteuthis*, &c.

TRANSITION BEDS.

29. A grey marl, capped by red sand or sandy clay, the former usually very fossiliferous. The ammonites are distinctly Upper

Lias ones, but most of the other fossils rather belong to the Middle Lias period. Gastropods are represented by a large number of species. *Ammonites acutus* is common and characteristic.

MIDDLE LIAS.

30. *Marlstone Rock-bed.* A limestone, generally ferruginous, and sometimes sandy. Worked for iron in the extreme south-western portion of the county. Fossils are very abundant, chiefly brachiopoda, *Rhynchonella tetrahedra* occurring in masses. *Terebratulina punctata*, *Pecten dentatus* (small variety of *P. equivalvis*) and *Pecten lunularis* are perhaps the commonest fossils.

SATURDAY, MAY 16TH.

Director: BEEBY THOMPSON, F.G.S., F.C.S.

After having lunched at the Peacock Hotel, the headquarters of the Association during their stay in Northampton, the Members were met by the two Directors about twelve o'clock, and proceeded to examine the district directly south of the town.

Passing down Bridge Street, and crossing the Nen by the South Bridge, the party followed the road commonly known in the town as the Queen's Cross Road, leaving Delapre Park and Abbey on the left. The Cross is about a mile and a-half from the centre of the town, and situated at the top of a moderately steep hill, where the party halted to hear a description of the monument from Mr. Crick. This cross, one of the three remaining of those erected by Edward I. after the death of Queen Eleanor, in 1290, was built of stone brought from Swanage.

After doing respectful justice to the memorial, a move was made towards Wootton. A walk of about half-a-mile brought the party to a fairly large limestone quarry—Mr. Cockerill's—which occupied them for some time. Those who came prepared were here enabled to collect a fair number of the common Great Oolite fossils. Large specimens of *Pholadomya* are here common, so there need have been no difficulty in making a bag. They were, however, in most cases, considerably left for others.

SECTION OF GREAT OOLITE NEAR WOOTTON.

(Mr. Cockerill's Quarry.)

		ft.	in.
9.	1. Surface Soil	1	0
	2. Rubbly limestone	3	0
	3. Clay and earthy matter, with many fragments of <i>Ostrea</i>	0	3 to 4
	4. Rubbly limestone, three or four beds, many fossils, but difficult to get out well enough for identification	2	1
	5. Earthy matter, almost like soil, ruddy colour	0	7 to 8

SECTION OF GREAT OOLITE NEAR WOOTTON—*continued*.

9.	6.	Reddish limestone, hard, containing Corals, <i>Pecten</i> , &c.	1	7
	7.	Brown calcareous clay, many <i>Myacites</i> , &c.	0	9
	8.	Limestone in small blocks	0	7
	9.	Marl, brownish colour, containing <i>Pholadomya</i> , &c.	0	8
	10.	White and ruddy limestone, in thin beds, containing <i>Terebratula maxillata</i> and a few <i>T. digona</i>	3	7
	11.	Hard limestone in large blocks, many fossils, <i>Acrosalenia</i> , <i>Isocardia</i> , &c.	3	2
	12.	Earthy bed	0	8
	13.	Hard limestone, semi-crystalline, very fossiliferous <i>Clypeus</i> , <i>Acrosalenia</i> , <i>Trigonia</i> , <i>Astarte</i> , <i>Nerinae</i> , &c. (<i>Nerinae</i> -bed)	3	0

All the above beds are included in No. 9 of the General Section.

After a short delay, caused by a snowstorm, the party visited another section of Great Oolite near to the village.

SECTION OF GREAT OOLITE AT WOOTTON.

(Mr. Frost's.)

Beds numbered so as to show probable connection with the last section.

		ft.	in.
9.	6 to 9.	Three beds of soft limestone, separated by marly partings	3 8
	10.	Limestone in thin beds	3 7
		TEREBRATULA ZONE.—A thin layer almost made up of <i>Terebratulæ</i> , <i>T. digona</i> being particularly abundant	0 6
		Fairly hard limestone with <i>Ostrea</i> , &c.	1 1
	11.	Variable bed, badly exposed, very fossiliferous, but few fossils to be obtained: <i>Trigonia</i> , &c.	1 0 shown

A very little distance south of the last section the junction between the Inferior Oolite and Upper Lias was seen in a brickyard.

The Northampton Sand here is quite unfossiliferous, and of no great thickness; indeed, it dies out altogether, in a south-easterly direction, within a few miles. The clay is nearly as bad, only a few fragments of fossils being ever found here.

One object in visiting this section was to notice the conformable nature of the junction of the blue Lias Clay with the Ironstones of the Inferior Oolite above. It is very rare to get such a section on the side of a hill, on account of the slipping of the water-bearing sands on the impervious clay. The absence of such slipping here may be accounted for by a considerable dip into the hill; this is consistent with the comparative dryness of the junction.

After crossing a small stream, and near to the third milestone from Northampton, some Pre-Glacial deposits were inspected. These deposits consist chiefly of fine sand, much used for building purposes, but in some places the sand contains many small pieces of ironstone, such as might have come from the ironstone beds of the Northampton Sand; indeed, there seems to be good reason for believing that these beds consist of washed and re-deposited Northampton Sand. From the smallness of the particles throughout, and the general local character of the material, there is no reason to suppose that ice had anything to do with the deposit. That these beds are older than the Glacial Drift-beds is evident from the fact that the true Drift, with large and small pieces of chalk, flint, and the usual Drift fossils, may be seen resting upon them, but not mixing with them. The deposit extends for some miles in a comparatively narrow band, through the parishes of Courteenhall, Collingtree, Milton, Rothersthorpe, to Bugbrook, giving rise to very numerous springs.

After leaving the section just referred to, the party proceeded to Roade, about five and a-half miles from Northampton. The extensive limestone quarries here detained them until it was time to hurry to the trains. The section now exposed would probably include, and much resemble, beds 4 to 11 of the one at Wootton. This is considered to be about the best section in the county for corals, but the place where they particularly occur has been so often picked over that they are getting scarce. A few managed to get pieces of coral, and all who wished secured some of the commoner Great Oolite fossils, including some large specimens of *Terebratula maxillata*, the latter occurring in a thin band, probably corresponding with the *Terebratula* band at Wootton.

On the way back to Northampton the extensive cutting in the Great Oolite near to Roade was observed. When the loop-line to Northampton was being made, some eleven years ago, a very fine section of the whole of the Great Oolite and Inferior Oolite and ten feet of the Upper Lias Clay was exposed. The Inferior Oolite (Northampton Sand), only measured 7 ft. 6 in. altogether, showing rapid attenuation in this district.

MONDAY, MAY 18TH.

Director: BEEBY THOMPSON, F.G.S., F.C.S.

In spite of most unpromising weather, a few minutes before nine o'clock a start was made to the Castle Station to meet the new arrivals, and a drive of about two miles to the north-west of Northampton brought the party to Watkins' brickyard, where the Upper Estuarine Clay is worked for making bricks. Below is the section :—

SECTION AT WATKINS' BRICKYARD

(Hopping Hill).

		ft.	in.
	1. Soil	1	0
10.	2. Calcareous clay or marl, very light-coloured, with thin bands of a stiffer clay of a darker colour. Near the base some very thin bands of limestone. Oysters abundant	8	0
	3. Very hard limestone, blue-hearted, extremely fossiliferous, but very few fossils to be obtained. <i>Ostrea</i> and spines of <i>Acrosalenia</i> very abundant on the upper weathered surface	2	9
11.	4. Soft, reddish limestone, with <i>Rhynchonella concinna</i> , <i>Ostrea</i> , spines, &c. Fossils not so abundant as in No. 3	1	3
	5. Oyster bed	0	3
	6. Reddish marl with <i>Ostrea</i>	1	6
	7. A peculiar and remarkably fossiliferous layer, with reddish matrix, but quite white in places from the numerous fossils, mostly, if not entirely, <i>Conchifera</i> . The fossils are nicely preserved, but are so crowded, crushed, and fragile that identification is difficult	0	6
12.	8. Clay, dark blue, inclining to purple at top, yellowish or orange in the middle, light purple at bottom. Vertical plant markings in it	3	6
	9. Dark purple clay, highly carbonaceous at top, but lighter in colour and less carbonaceous lower down, with ochreous markings all about it. Vertical plant markings abundant, together with large pieces of wood or lignite in places	5	6

A "fault" runs across this pit nearly east and west, from corner to corner, and brings the two Estuarine beds, 13 and 14, side by side.

A short drive brought the party to the extensive quarries for building stone at NEW DUSTON (Mr. Goldby's). The three sections near to each other show the beds from the lower part of 14 to the lower part of 16 (see General Section). Here, however, the lower beds of the Inferior Oolite in no sense deserve the name of ironstone, although a little over a mile away, at Old Duston, the same beds constitute a very valuable ore.*

A few fossils were obtained (*Astarte elegans*, *Lima*, &c.), but the highly fossiliferous beds of the *opalinus* zone, near the base, have not been worked for two or three years. The slaty beds were best seen near to Mr. Goldby's house, which is built entirely of the stone from the adjacent quarries, and shows its architectural qualities well.

It is rather difficult to draw boundaries in a set of beds so variable as these, and so deficient in fossils throughout the greater part; but it appears fair to conclude that the ironstone beds are below the horizon of the slaty beds, and that the presence of

* This section was visited later, on the same day (p. 185).

FIG. 2.—SECTION FROM DUSTON TO DALLINGTON, NEAR NORTHAMPTON.—*S. Sharp, F.G.S.*

C. Sand
 D. Variable Beds
 E. Ironstone
 F. Upper Lias Clay.

} Northampton
 Sands.

X. Alluvium.
 A. Great Oolite Limestone.
 B. Upper Estuarine Series.

(Reproduced, by permission of the Council, from the *Quart. Journ. Geol. Soc.*)

Astarte elegans indicates the zone from which ironstone is obtained.

The White Sands (No. 14 General Section) are seen all along the top of the chief section at New Duston, but a larger portion is let down by a gully in one part of the pit. A detailed description of this quarry is given by Mr. Sharp.*

A better section of the White Sands, No. 14, was seen about a mile and a-half S.S.W. of the last sections, on the road from New Duston to Kislingbury. The Lower Estuarine beds—White Sands—are thicker here perhaps than at any other place in the county, but are slightly ferruginous. In this particular area, and in some other places, they contain enough clay to render them nearly impervious to water, and so water can sometimes be obtained from these upper beds of the Northampton Sand.

The road taken from Kislingbury to Bugbrook, in a south-westerly direction, is almost entirely over Marlstone, according to the maps, but there are no exposures of it. A little "drift" is found on the ground in some parts, and close to Bugbrook itself there is a small exposure of the Pre-Glacial sands referred to in the report of Saturday's Excursion.

At Bugbrook, a small section had been opened for geological purposes by the aid of a grant from the British Association, and this exposed the beds from 25 to 30 of the General Section. The material of the various beds had been placed in separate heaps, as far as possible, so that a good idea of the condition and contents of each could be obtained.

SECTION AT BUGBROOK.

(Mr. Ward's Farm, near the village, and south of the railway.)

		ft.	in.
25.	1. Soil and blue clay, much disturbed, with many little planulate ammonites lying on the weathered surface	3	0
26.	2. LOWER CEPHALOPODA BED. Irregular layer of small water-worn stones of a ruddy yellow colour. Oolitic in places. <i>Nautili</i> , <i>Ammonites</i> , <i>Nucula hammeri</i> , &c.	0	6
27.	3. Blue clay, with very few fossils	4	6
	4. Hard bluish-grey stone, quite red at joints and exposed surfaces, with many ammonites of the falcifer group, and very few of the planulate, the former often crushed quite flat, as they are in the shales below. <i>Nautilus astacoides</i> ?, <i>Aptychi</i> , <i>Ammonites strangewaysi</i> , <i>A. exaratus</i> , &c.	0	8
28	5. PALE SHALE. A grey, finely-laminated shale, weathering to a much lighter colour, containing fish fragments, and a good number of flattened ammonites, chiefly <i>A. strangewaysi</i> , also <i>Aptychi</i> .	0	4

* "The Oolites of Northamptonshire," by Samuel Sharp, Esq., F.S.A., F.G.S. *Quart. Journal Geol. Soc.*, vol. xxvi., p. 370.

SECTION AT BUGBROOK—*continued*.

		ft.	in.
28.	6. FISH BED. A bluish grey stone, laminated like the shales, and weathering quite white on the exterior. It comes out in large flat slabs, only nodular in one part, and that just over a large fissure in the rock-bed below. Fish fragments fairly abundant; only small ammonites— <i>A. latescens</i> chiefly. Saurian remains a good many, probably all belonging to the same animal	0	2
	7. PAPER SHALE. Like No. 5. A few <i>Ammonites</i> and <i>Aptychi</i>	0	3
29.	8. TRANSITION BED. Not present as a well-defined bed, and no red sandy clay; nevertheless clearly shown by the altered character of the top of the rock-bed, and by the presence in this of <i>Ammonites acutus</i> , <i>A. annulatus</i> , <i>A. holandrei</i> , <i>Cerithium ferreum</i> , small <i>Rhynchonellæ</i> , &c.		
30.	9. ROCK-BED OF MIDDLE LIAS. An oolitic rock of a greenish-grey colour internally, red at joints. Masses of <i>Rhynchonella tetrahedra</i> , <i>Belemnites paxillosus</i> , <i>Lima punctata</i> , <i>Pecten lunularis</i> (many), <i>P. dentatus</i> (fair number)	5	0

The bed No. 4 is only met with in a few places, and until this section was opened its presence at Bugbrook was not known. It is a trifle doubtful whether it should be included in the *serpentinus* beds or the Fish beds: it has been provisionally placed with the latter.

A halt was made at Bugbrook for luncheon. During the interval most of the Members visited the church, recently restored, in which restoration local Inferior Oolite stone played a conspicuous part.

A fresh start was made in the very welcome sunshine, which soon dissipated the lingering remnants of snow in the fields. A short drive over a hilly district brought the Members on to the well-known Roman Road called Watling Street, at a point where for some distance the wheel track is paved. This paving was laid down to facilitate the coach traffic along it at a time when there was a lingering hope that coaches might successfully compete with railways.

On the way to Stowe Nine-Churches, attention was called to a section of the ironstone beds of the Northampton Sand, by the side of the road, a remnant of once extensive ironstone workings. The ironstone of this district is cellular, as at Duston (see account of Duston quarries, p. 185), but the rich ironstone casings are thinner, so that the whole appears of a lighter colour, seen from a distance. The beds here are fifteen to twenty feet thick, and very unfossiliferous.

STOWE NINE-CHURCHES section was next visited. The quarry here is worked for limestone for the Heyford furnaces, which are very near. The district seems to have been much disturbed, and small "faults" are quite numerous. At least four have been passed

through in working the section visited, and the limestone, consequently, is met with at very variable depths. The faulting has preserved a number of beds here that are rarely to be seen in the county, and apparently they are rapidly being worked out. The reproduction of the photograph (Plate III.) shows a part of the section as it was a few weeks after the visit of the Association ; but it was not nearly as good as some two years back. The figures and letters in the description of the section given below refer both to those on Plate III. and to the General Section.

SECTION AT STOWE NINE-CHURCHES.

	ft.	in.
A Position of small fault just shown in the Plate		
B Soil and dark blue clay, no fossils, but may be } OXFORD CLAY	5	0 to 6
<hr/>		
1. CORNBRASH. A fossiliferous limestone, rather red in } the upper part, nearly white in the lower part . . }	5	0
<hr/>		
2. Variegated clay	0	3 to 9
3. Hard fissile stone with abundant plant-remains	1	5
4. Variegated clay like No. 2	2	6
5. Hard fissile stone, very much like No. 3	2	6
<hr/>		
6. Blue and purple clay, containing much carbonaceous } matter.	9	0 to 12
C Only a small part of 6 can be seen in the photograph, all below being obscured by fallen material. The large blocks of stone (see Plate) are almost entirely Cornbrash, and by searching these many of the common Cornbrash fossils can be easily procured.		
7. Ferruginous bed, mostly cellular limestone	0	6
8. Light-coloured marl, almost limestone, with vertical } plant-markings	2	9
9. GREAT OOLITE LIMESTONE in numerous courses and large blocks	18	6
10 & 11. These beds do not appear to have been exposed in the section.		
<hr/>		
12. UPPER ESTUARINE BEDS. Blue and purple clay, seen over the white sands just at the entrance to the quarry.		
13. Ferruginous band forming the base of No. 12, very irregular, showing a want of conformity of this and the bed above with those below.		
<hr/>		
14. LOWER ESTUARINE BEDS, consisting of an upper portion, bluish and somewhat argillaceous, with a plant bed near its base ; and a lower portion nearly white, purer sand, also with a plant bed near its base	9	0
These are best seen just at the entrance to the quarry.		
15 & 16. VARIABLE AND IRONSTONE BEDS. It is prob- able that both these sets of beds are represented ; but the section is not clear enough to trace them.

Meisenbach, Sc.]

SECTION AT STOWE NINE-CHURCHES.

*From a Photograph taken a week after the Excursion by Mr. J. J. Wetherell, Hon. Sec. Photographic Section,
Northampton Nat. Hist. Soc.*

The Ironstone Beds are very well seen just where the section widens out; they are there thrown up by a fault and so brought into contact with the Great Oolite Limestone, *i.e.*, beds 9 and 16 face each other.

The plant-remains referred to, in bed No. 14 in particular, consist of upright carbonaceous markings, and were probably equisetaceous plants, for occasionally slabs of stone may be found full of vertical holes large enough to admit a lead-pencil, and when freshly exposed these contain carbonaceous matter.

On leaving the Stowe Nine-Churches section it was decided to omit the visit to Heyford brickworks, on account of the rain and snow of the previous night, and, instead, to visit FLOORE GRAVEL-PITS.

The gravel-pits are situated about half-way between Weedon and Floore, on the side of the hill overlooking the former place. The gravel deposits here are usually regarded as of Middle Glacial age; as they are always under the Chalky Boulder Clay where both are present, and no Boulder Clay has been found below them. The gravel is rudely stratified and contains a great quantity of chalk and flints, and, as is usual, it contains a large number of specimens of one or more species of *Gryphæa*.

The Director's remark that there were few or no Lower Lias fossils in the Drift gave rise to a lively discussion as to the origin of the *Gryphæa*, usually called *Gryphæa incurva*. The Director claimed that it was an Oxford Clay form, and came from the Kellaway Rock; and the President that it was certainly *Gryphæa incurva*. The discussion was so keen that a member of the party offered to eat a specimen if it were not *Gryphæa incurva*.*

On the way back to Northampton the very interesting gravel-pit at UPTON was visited. The gravel here contains the usual chalk, flints, *Gryphæa*, &c., and also large boulders of Great Oolite Limestone, and some Ironstone, resting upon the denuded White Sands of the Lower Estuarine Beds.

DUSTON IRONSTONE WORKINGS, about a mile from Northampton, next received the attention of the party. The ironstone has been dug here without intermission for a great number of years, and it is both a thick and rich seam of stone. Sometimes a depth of nearly twenty-five feet can be utilized, but more often the uppermost and lowest beds are rejected, the former being rubbly and sandy, and not rich enough in iron, the latter because of the phosphates in them. The character of the best ore is peculiar, consisting of nearly rectangular, or it may be oval, concentric boxes of rich dark ironstone in the condition of the hydrated peroxide (limonite), with cores of ochreous or green stone. The green stone is mostly carbonate of iron, with some

* The Kellaway Rock of Northamptonshire abounds in *Gryphæas*, and some of these were shown the next day, and their great similarity with those in the Drift was acknowledged.—B.T.

silicate probably, and in the lower beds about two per cent. of phosphate of iron, giving it a bluish tinge. This latter stone is thrown on one side. The proportion of iron in the workable stone varies from 25 to 40 per cent. of pure iron, though the casings may contain more and the cores less than these amounts.

The probable source of the iron in these beds has given rise to much discussion. The most satisfactory explanation appears to be that the organic acids, produced by decomposing vegetable matter in the Estuarine Beds above, gradually attacked the iron-containing minerals of the beds in which they occurred, and of those below, dissolving the iron and thus leaving the upper layers bleached (the White Sand). The impervious Lias Clay kept the ferruginous water in contact with the lower beds, so that as the hydrostatic pressure forced the solution along the lines of least resistance in these lower layers, lime was gradually replaced by iron in the beds, and iron by lime in the water. Oxygenated water finished the operation, and produced the hydrated peroxide as now seen.*

In the evening the party dined together at the Peacock Hotel.

TUESDAY, MAY 19TH.

Director: WALTER D. CRICK.

The party first of all proceeded to investigate the large section at Vigo Brick-works, excavated in the Middle and Lower *Ledaovum* beds of the Upper Lias, on the south-west of Northampton. Fragments of River-Gravel are seen at the entrance to the workings, while the Northampton Sand overlies the present face. The President pointed out the unconformability of this to the clay beneath. Considerable time was spent in looking for fossils, and some good specimens of *Ammonites bifrons*, *A. holandrei* and *A. lythensis*, as well as others, were obtained. The processes of making bricks from dry and wet clay were then seen, as well as the methods of drying and burning them afterwards.

Driving through the town, the party visited Greenough's Pit on the north, a section upon about the same horizon as Vigo, but not nearly so deep. Here, thanks to the proprietor, a quantity of the characteristic fossils awaited the collectors. A little further to the east, Bass's Pit was visited. This quarry is not so extensively worked as formerly; but the Northampton Sand is less impregnated with iron than usual, the beds are looser, and more sandy, and the fossils are in very good condition; whilst the Boulder Clay, with large local boulders, forms the capping of the section.

On the drive towards Kingsthorpe, attention was called, in passing to the Shittlewell Pit, now disused. This and the last section were visited by the Members of the Association during their last visit to the county, in 1874.† The party passed through the picturesque village of Kingsthorpe to New Sand-pits, where the white sand

* See "On the Geological History of Iron Ores," by W. H. Hudleston, F.R.S., Sec. G.S. Proceedings of the Geologists' Association, vol. xi., p. 104.

† "Proc. Geol. Assoc.," vol. iv, p. 123.

of the Lower Estuarine Beds is largely quarried : at the time of the visit but few traces of the vertical plant-remains could be seen.

A call was made at the Pitsford Brick-works, a small section in the Upper Lias Clay, with but few fossils, surmounted by the Northampton Sand.

Proceeding farther north, the members inspected the extensive Spratton iron-ore workings near to Brixworth. Here the Northampton Sand is rich in iron, and is quarried for the extraction of that metal. The fossils, of which considerable quantities were available, are all casts in iron, and include the characteristic *Ammonites opalinus*. The white sand of the Upper Estuarine Beds in the upper part of the section made a beautiful contrast with the rich brown of the ironstone.

After luncheon at the Coach and Horses, a visit was made to Brixworth Church, where Mr. T. J. George, F.G.S., read a paper on Brixworth and its church. In excavations for the ironstone of the Northampton Sand, undertaken for many years past on three sides of the village, remains had, he said, been unearthed, belonging to the Neolithic, Bronze and late Keltic periods. The church, one of the oldest in England, had been described by the late vicar, the Rev. C. F. Watkins, as built by the Saxons towards the end of the seventh century upon the type of the basilica, or Roman Hall of Justice, and from materials taken from a pre-existing building. The masonry included Roman bricks and large uncut blocks of granite, sandstone, etc., obtained, no doubt, from the Boulder Clay of the neighbourhood.

Owing to the rain, and the wish of some of the party to reach town by the early train, the Members drove straight to Moulton ; but a full investigation of the interesting section at the brick-pit was impossible.

A full description of this and similar sections is given by Mr. Beeby Thompson, in the Journal of the Northampton Natural History Society, vol. v., p. 54, No. 34, June, 1888.

MOULTON SECTION.

The blue clay of the Upper Lias is dug here to a depth of about 15 feet, and is surmounted by the red ironstone beds of the Northampton Sand. In the upper part they are sandy, with layers of stone ; but the lowest three feet consist of a hard blue-hearted stone. The junction between the two formations is clear and distinct, the red of the Ironstone contrasting strongly with the blue of the clay. The bottom bed of the ironstone contains in places large numbers of water-worn Upper Lias nodules, bored by bivalves and having upon their surfaces *Serpula*, polyzoa and corals. The fossils from the Northampton Sand are very well preserved ; but the Upper Lias fossils from the clay itself are often in bad condition. At an average depth of 13 feet below the junction with the Inferior Oolite, occurs a bed of nodules covered with oysters in many parts. From the fossils obtained from this sec-

tion, a list of which is given in the paper referred to, Mr. Thompson infers that the blue clay of this section was laid down contemporaneously with the sands and *jurensis* beds of Gloucestershire and other counties. This conclusion has been disputed by Mr. S. S. Buckman, F.G.S. (Journ. Northampton Nat. Hist. Soc., vol. vi. (1890), p. 76), to whom Mr. Thompson has replied (*id.* p. 96).

The Director said that at present the evidence was not sufficiently strong to convince him that these beds could be correlated with the *jurensis* zone of either Gloucestershire or Yorkshire, and called attention to the following facts :—

1. That *Ammonites lympharum* was represented by two or three specimens that occurred together in one nodule, and *A. lilli* by two large fragments of a very large specimen, and that, as far as the Northamptonshire Lias was concerned, *A. bifrons* here attained its maximum development as to size.

2. That in the list of fossils some distinctly Oolite forms had been included in the Upper Lias, namely, those specimens connected with the Upper Lias nodules found in the Inferior Oolite ; for it was not possible for these nodules to have become removed from their place of deposition, water-worn, bored, and incrustated with parasitic life, which occurred on both sides of the nodules, until after the close of the Liassic period, and these actions must have taken place immediately before or at the time the conditions were favourable for the deposition of sediment. Again, some of the fossils found were in such bad condition that it was impossible to give specific names with accuracy, and names of Oolitic species had been given to fossils that, when better specimens were obtained, might be referred to Liassic species. So that at the present time the list of fossils needed revision ; and, as the sections were small and but little worked, considerable time would have to elapse before sufficient specimens in good condition could be obtained to clear up some of the doubtful nomenclature and obtain a reliable list.

3. That all previous workers in the district had recognised the fact that a considerable interval of time occurred between the deposition of the clay of the Upper Lias and the sandy ironstone of the Northampton Sand. This was confirmed in an examination of the section at Moulton by the sudden change in the nature of the rocks at the junction ; by the entire change in the fauna of the different beds ; and also by the presence of the water-worn nodules, which were derived from the denudation of the Upper Lias, and had been water-worn during the interval of time that the Director believed to have taken place between the two formations.

He ventured to predict that if ever the *Jurensis* zone were found in the Midlands, it would be in sediment not now known, which would be found between the clay of the Upper *Leda-ovum* bed and the ironstone of the Northampton Sand.

Mr. Beeby Thompson replied, stating, among other arguments:—

1 (A). That *Ammonites bifrons* did attain a large size in these beds; but that it did so also in the Rhone district, as described by Dumortier, right up to the *opalinus* zone, showing the similarity of those districts to our own in that respect.

(B). That *Ammonites jurensis*, or the form usually called by that name, had not arrived in our district until a later period, and was found not uncommonly in the *opalinus* zone, and that accounted for its absence in the *jurensis* zone.

2 (A). That, in the case of the nodules, if the animals lived after Upper Lias sediment ceased, they certainly lived before Inferior Oolite sediment covered them up, and so truly represented a transitional period such as he contended the whole *jurensis* zone to have been; and (B) that he did not admit the nodules to be either rolled or water-worn.

At the close of this discussion, the President observed that from what they had seen during the course of the Excursion two things were very clear: first, that in this district there was an unconformity between the Inferior Oolite and the Lias. Of this they had had every kind of evidence. In the Vigo Brick-yard, they had seen an eroded surface of the Lias, with the edges of the laminae cropping out, and on this the sandy Oolite beds were lying in beds parallel to the surface of the erosion. In the various other brickyards visited, they had found the Inferior Oolite lying on different members of the Lias, and now at Moulton they had been shown Lias nodules which, whether water-worn or not, had been lying about on the bottom of the Inferior Oolite sea, *i.e.*, of the sea in which the Inferior Oolite was being deposited, and had there been used by boring shells, oysters and *Serpulae* of the Inferior Oolite period. These nodules having been produced by agencies subsequent to the deposit, their existence at the time indicated a considerable interval. On these accounts it was to be expected that some of the Lias or Oolite should be absent. All possible zones could not be represented. Secondly, in this Moulton Clay they had seen and heard of a fauna very distinct from that of the clays elsewhere, and this fauna was in part, at least, such as characterised the zone of *Ammonites jurensis* elsewhere. Whether the Ammonite itself was there made little difference, if the fauna as a whole was there. Hence he could himself have no doubt that some part of the *jurensis* zone was here; but, in view of the unconformity, it was probable that the upper part was wanting, and that in this part, when found, would occur the rest of the fauna, including the most remarkable of the Ammonites

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EXCURSION TO UPNOR.

SATURDAY, JUNE 6TH, 1891.

Directors: W. WHITAKER, F.R.S., and C. BIRD, B.A., F.G.S.*(Report by H. W. MONCKTON, F.G.S. Revised by W. WHITAKER.)*

Leaving Rochester Station about 3.0 p.m., the party walked to the Whitewall Chalk-pit on the slope of Frindsbury Hill. This pit shows a magnificent section in Upper Chalk, with very regular layers of flint throughout.

On the northern and higher part of the pit there was seen to be no gravel capping; but a considerable patch was shown on the

DIAGRAM SECTION ALONG THE LEFT BANK OF THE MEDWAY NEAR UPNOR.—
W. Whitaker, F.R.S. Length 1½ miles, vertical scale exaggerated.

south, resting in an irregular hollow in the Chalk, not quite at the top of the hill. A very large stone was seen in place in this gravel, and some portions of elephants' tusks and some bones from this gravel were exhibited.

At the east end of the pit, low down near the river, a mass of