EXCURSION TO CAMBRIDGE, APRIL 10TH AND 11TH, 1871.

Directors—The PRESIDENT; PROFESSOR MORRIS, F.G.S.; The Rev. T. G. BONNEY, M.A., F.G.S., &c.; and HARRY G. SEELEY, Esq., F.G.S.

The Members left London at an early hour, and on arriving at Cambridge, proceeded at once to the Woodwardian Museum, where they were met by the Rev. Dr. Cookson, Master of St. Peter's College; the Rev. Thomas Wiltshire, M.A., F.G.S., &c., President of the Association; Professor Morris, F.G.S., H.M.G.A.; the Rev. T. G. Bonney, M.A., F.G.S., Fellow and Tutor of St. John's College; the Rev. Osmond Fisher, M.A., F.G.S., late Fellow and Tutor of Jesus College; and Harry G. Seeley, Esq., F.G.S., as the representative of the venerable Professor Sedgwick, who, much to his regret, was prevented being present.

The collection of Fossil Mollusca was ably described by the Rev. T. G. Bonney, M.A., who directed the attention of the visitors more especially to the illustrations of the palæontology of the neighbourhood of Cambridge. In this collection are preserved very fine examples of the Brachiopoda found recently so abundantly in the phosphatic Lower Greensand strata at Upware.

Mr. Harry Seeley then in an interesting discourse described the Cambridgeshire Reptilian Remains, which form a valuable portion of the Woodwardian Museum. It was pointed out that the Pterodactyles, though in some points essentially reptiles, presented curious affinities both to birds and mammals. Thus while the most fundamental part of the skeleton, the vertebrate column, is reptilian in its technical characters, the fore-limbs are those of a bird, and the femur that of a mammal. The brain cavity again is essentially that of a bird, while the bones of the face are reptilian. The Pterodactyles, the remains of which occur in the Cambridge Greensand, differ in some important respects from others. All others have at least four fingers on each hand, these have three at most, and the Cambridge Pterodactyles have only flexible tails. Remains of marine Chelonians (*Rhynchochelis*) were exhibited. These were stated to be generally allied in structure to living fresh-water species; but these alone, among Chelonians, have real nasal bones, hence the name given to the genus. Bones of birds allied to Penguin are also found. But perhaps the most interesting specimen shown was a vertebra of an

Oolitic whale, *Palæocetus*, which, if correctly determined, carries back the Placental Mammalia to a period in which their existence has been scarcely suspected, and almost gives encouragement to the expectation of Professor Jukes that the remains of mammals will some day be found in the Coal Measures. It was sufficiently wonderful to find mammalian remains at all in the Stonesfield Slate, but these were those of small animals. How the bones of whales could so long be overlooked in Mesozoic strata is difficult to conceive.

Attention was drawn to a skull of *Bos primigenius*, found in the Fens, having an aperture through the bone and a flint implement inside.

Professor Morris then delivered, in the Geological Lecture Theatre, a lecture on the Geology of the Country around Cambridge.

The geological structure of the country around Cambridge is, he remarked, of considerable interest, both in regard to its influence on the physical features of the district, as well as on account of the economical substances obtained from the strata of the neighbourhood. The geological formations chiefly belong to the Cretaceous System and to the Upper and Middle Oolites, here and there covered by the later Pleistocene deposits. In descending order we find—

MODERN DEPOSITS...River Alluvium and Fen-land.

PLEISTOCENE	{	Valley Gravels and Clays, with Mammalian Remains.
		Higher Gravels, with Flint and worn fragments of various rocks.
		Brown or Boulder Clay, with Chalk and various other rocks
CRETACEOUS	{	Lower Chalk and Chalk Marl.
		Upper Greensand. (<i>Coprolites</i>).
		Gault.
		Lower Greensand. (<i>Coprolites</i>).
OOLITIC	{	Kimmeridge Clay.
		Upware Limestone.
		Amphill or Tetworth Clay.
		Elsworth Rock.
		Oxford Clay.

The Fen-lands, so well known in the Eastern Counties, commence near Cambridge, on the Gault, and further eastward are underlain by the Kimmeridge and Oxford Clays. The Valley Gravels bordering the Cam appear to be ancient river deposits, consisting of the re-arranged materials of the older gravels and Boulder Clay, and contain many land and river shells now living in the district, with two species, *Unio litoralis* and *Corbicula (Cyrena) fluminalis*, extinct

in Britain, and associated with remains of *Elephas*, *Rhinoceros*, *Bos*, *Equus*, &c. The Higher Gravels and Boulder Clay, containing fragments of rocks brought from various distances, indicate that they have been drifted by currents of water or the action of ice, and hence are referred to the Glacial period. Of the two great divisions of the Chalk, the Lower Chalk only, with its characteristic fossils, is seen near Cambridge, the Upper Chalk forming the escarpment of the hills considerably to the east of Cambridge. The Upper Greensand, although of limited thickness, is well exposed at the numerous workings for phosphatic nodules; besides "coprolites" it has yielded the fine series of fossils now exposed in the Woodwardian Museum, including many species of Reptiles (Chelonians, Enaliosaurs, Pterodactyles, Crocodilians, Dinosaurs); Birds; Fish (20 or 30 species); many species of Brachiopoda, Lamellibranchiata, Gasteropoda, Cephalopoda, and Crustacea, as well as numerous Sponges, Corals, and Foraminifera. The Reptiles, especially the Ornithosauria, have been elaborately described by Mr. Harry Seeley. The Gault, or Cambridge brick earth, about 150 feet thick, extends over a wide area, and is well seen at Barnwell. It contains but few fossils, of which perhaps the *Belemnites minimus* is the species least rarely found. The Lower Greensand, exposed at Upware, and reached in deep sinkings below the town (this formation being here the source of an Artesian well water supply) is also worked, at Upware, for phosphatic nodules, but contains many fossils, chiefly Brachiopoda, palatal teeth of the fishes, *Sphærodus*, *Gyrodon*, &c., and bones of reptiles (*Iguanodon*), these latter being probably derived from some older deposits. At Potton, Bedfordshire, the *Iguanodon* remains are very abundant in a deposit of similar age. The Kimmeridge Clay, well seen at Ely, underlies the Lower Greensand, which latter deposit, however, is also unconformable to other formations in its range southwards and eastwards; this clay contains many fossils, remains of *Plesiosaurus* and *Pliosaurus*, and the usual characteristic shells, *Ostrea deltoidea*, *Ammonites biplex*, &c. The underlying strata of the Upware Limestone, Ampthill Clay, and Elsworth Rock, may possibly represent the Corallian Oolites of other districts, although Mr. H. Seeley sees good reason, from their fossil contents, for considering the Ampthill Clay only as the true representative of the Coral Rag. The Oxford Clay forming the great area of the Fen-land, is the lowest deposit seen within a limited distance from Cambridge. It is to be found at St. Neots,

Huntingdon, &c., and contains many fossils. Besides the physical features and economical substances to be noted, it is worthy of remark that the geological structure of this district is favourable for a good water supply, since an abundant supply of water may be derived from springs above the Chalk Marl, from those rising above the Gault, from superficial gravels, and from Artesian wells sunk into the sands between the Gault and the Kimmeridge Clay.

The afternoon was devoted to a visit to the Coprolite Workings and other excavations at Barnwell. Proceeding along the banks of the Cam, a fine section of Pleistocene deposits, yielding Mammalian Remains, and the usual species of Mollusca, was examined. This exposure exhibits some beautiful examples of false bedding, and many granite and other boulders from the Drift were seen. Descriptions of this interesting section and its contents are given by the Rev. T. B. Brodie, M.A., in the "Transactions of the Philosophical Society of Cambridge," vol. viii., and by Mr. H. Seeley, in the "Quarterly Journal of the Geological Society," vol. xxii. The last mentioned paper contains a list of species collected by Mr. Dewick, to which Mr. Alfred Bell now adds the following:—*

<i>Sphærium calyculata.</i>	<i>Ancylus lacustris.</i>
<i>Pisidium pulchellum.</i>	<i>Zonites radiatulus.</i>
„ <i>nitidum.</i>	<i>Helix fruticum.</i>
<i>Planorbis carinatus.</i>	„ <i>concinna.</i>
<i>Limnæa pereger.</i>	„ <i>rufescens.</i>
„ <i>truncatula.</i>	„ <i>pulchella.</i>
„ <i>palustris.</i>	<i>Pupa umbilicata.</i>
„ <i>auricularia.</i>	

Mr. Bell writes, "The presence of so many species no longer living in Britain makes this an exceedingly interesting deposit. I refer to *Corbicula fluminalis*, *Unio littoralis*, *Hydrobia marginata*, *Helix fruticum*, *Helix rudrata?* and *Vertigo Moulinsiana*. No other fluviatile deposit that I am aware of contains such an assemblage." A very extensive excavation in the Gault, which is here capped by a thin deposit of Upper Greensand and Chalk, was next visited. The Gault, excavated for brick-making purposes, is exposed to a depth of seventy or eighty feet; and from the evidence of well-sinkers it is at this place, probably, from one hundred and fifty to two hundred feet thick. Fossils are rarely met with in the Gault at Barnwell,

* The Editor begs to express his obligations to Mr. Alfred Bell for his valuable note.

though in other localities this formation is very fossiliferous. Lying on the Gault, at its junction with the Upper Greensand beds before mentioned, occurs the stratum containing the phosphatic nodules, incorrectly called *coprolites*, for which this district is famous, and which, though from another locality, were first noticed as being valuable for agricultural purposes by the late Professor Henslow. At a short distance from this excavation the coprolite workings are found on all sides; indeed, the whole of the land is here being systematically explored for these valuable nodules, which lie at an average depth of six or seven feet from the surface. One field after another is taken in hand; the phosphatic bed of about twelve inches in thickness is removed; the soil is carefully replaced on the surface, and the field is then again ready for tillage. Upwards of £100 per acre is paid for the right of working these beds, the contractors being bound to replace the soil, which is generally found to have been improved by the overturning and exposure to which it has been subjected. The so-called coprolites are washed by horse-power, to remove the sand and loam in which they are embedded, and then they are ready for conversion into manure.* A considerable number of fossils, chiefly of Brachiopoda (*Terebratula biplicata* being most abundant), were obtained.

The party returned to Cambridge, and in the evening were most hospitably entertained at St. John's College, by the Rev. Mr. Bonney, M.A.

On the following day, Upware, between Cambridge and Ely, was visited. At this place, situated in the Fens, and near to the River Cam, very interesting sections have been exposed, in consequence of the search for phosphatic nodules. The Gault, which here becomes very thin, has been cut through, and Lower Greensand strata reached. At the base, as at the top of the Gault, curiously enough, a bed abounding in coprolites is found, and this bed contains characteristic Lower Greensand fossils, together with several new species of Brachiopoda, described by J. F. Walker, B.A., F.G.S. Cropping out within a very short distance from this exposure of Gault and Lower Greensand is a remarkable rock, full of fossil corals, which has hitherto been called Coral Rag, but which Mr. Harry Seeley, who has given great attention to the strata of this district, considers to be of Kimmeridgian age. This rock, to which Mr. Seeley has given the name of "Upware Limestone," is underlain

* See Proc. Geol. Asso., vol. i., p. 271.

by what that gentleman calls "Amphill Clay," which would appear to be, in accordance with these views, the equivalent of the Coral Rag of Oxfordshire, Wiltshire, Dorsetshire, &c. The Brachiopoda in the infra-Gault coprolitic bed are abundant, especially *Terebratula sella*, *T. praelonga*, and *Waldheima*, or *Terebratella Davidsoni*, many fine specimens of each of which species were obtained, as well as numerous teeth of fishes and reptiles.

In a notice of the strata exposed at this locality, which appeared in the "Geological Magazine," vol. iv, p. 309, Mr. Walker gives the following details of the

SECTION AT UPWARE.

7. Surface, black peaty soil, often containing bones of red deer, horse, &c.	.	.	.	about 1ft. 6in.
6. Layer of light-coloured Coprolites	.	.	"	1 0
5. Sand (called by the workmen Silt)	.	.	"	1 6
4. Vein of dark-coloured Coprolites	.	.	"	0 9
3. Silt	.	.	"	1 6
2. Vein of dark Coprolites	.	.	"	1 0
1. Clay not pierced				

AT ANOTHER WORKING.

Sand	.	.	.	.	.	"	6 0
Coprolitic vein	.	.	.	.	.	"	2 0
Conglomerate (hard rock)	.	.	.	.	.	"	0 4
Light-coloured Sand and Clay							

"The three layers of nodules noticed in the first section often become blended into one, but the top layer differs in the nodules being of a much lighter colour, and I was informed that they were less valuable.

"The hard rock (Conglomerate) consisting of nodules and pebbles, cemented together chiefly by carbonate of calcium, varies considerably, sometimes being so firm as to be penetrated with difficulty, at other times the coprolites near the clay are easily worked.

"The Kimmeridge Clay is not pierced, as there is no occasion for a well, the works being near the river. Among the nodules there are found phosphatic shells, as in the bed near Potton. They consist of fragments of Ammonites (and some of

the nodules are marked by impressions of Ammonites), casts of Brachiopoda, Conchifera, and Gasteropoda, also remains of large Belemnites, and *Gryphæa dilatata*, composed of carbonate of calcium, occur, derived from the Oxford Clay."

From the lists given in the paper whence the above is taken, and from others since published by Mr. Walker, the following catalogue of fossils found in the calcareo-phosphatic Lower Greensand deposit of Upware has been compiled.

ORGANIC REMAINS FROM THE LOWER GREENSAND AT UPWARE.

SPONGIDA—	LAMELLIBRANCHIATA—
Manon macroptera.	Cardium, sp.
Verticillites anastomosans,	Cyprina, sp.
Mant.	Janira neocomiensis, D'Orb.
POLYZOA—	Opis neocomiensis, D'Orb.
Sp.	Ostrea macroptera, Sow.
BRACHIOPODA—	" sp.
Rhynchonella antidichotoma, Buv.	Pecten Carteronianus, D'Orb.
" depressa, Sow.	" Cottaldianus, D'Orb.
" Gibbsiana, Sow.	Plicatula Carteroniana, D'Orb.
" lata, D'Orb.	" sp.
" parvirostris, Sow.	Trigonia spinosa, Park.
Terebratella Fittoni, Meyer.	GASTEROPODA—
" ? Davidsoni, Walker.	Cerithium, sp.
Terebratula Dallasii, Walker.	Nerinea, sp.
" depressa, Lam.	Scalaria, sp.
" var. Cantabrigensis.	Trochus, sp.
" var. Cyrt.	Turbo, sp.
" var. uniplicata.	CEPHALOPODA—
" Dutempleana, D'Orb.	Ammonites, sp.
" extensa, Meyer.	Belemnites, sp.
" Lankesteri, Walker.	PISCES—
" Meyeri, Walker.	Asterocanthus ornatissimus, Ag.
" microtrema, Walker.	Edaphodon.
" Moutoniana, D'Orb.	Gyrodus.
" prælonga, Sow.	Hybodus.
" Seeleyi, Walker.	Psammodus reticulatus, Ag.
" Sella, Sow.	Pycnodus gigas ?
" Tornacensis, D'Arch. ?	Sphærodus gigas, Ag.
Waldheimia celtica, Morris. ?	Sphenonchus.
" mutabilis, Walker.	REPTILIA—
" pseudo-jurensis,	Dakosaurus.
Leymerie.	Ichthyosaurus.
" rhomboidea, Walker.	Iguanodon.
" tamarindus, Sow.	Plesiosaurus.
" Woodwardi, Walker.	Pliosaurus.

Mr. Walker remarks that—"This bed and the conglomerate bed near Potton, appear to be of the same age, and probably, also, the Farringdon beds, viz., Lower Greensand, containing large numbers of fossils from other formations."

Mr. H. Keeping, the Assistant Curator of the Woodwardian Museum, Cambridge, has given an interesting section (" Geological

Magazine," vol. v., page 273), showing a "sequence from the Coral Rag to the Gault," of which the following are the details.—

Non-fossiliferous Gault, seven feet.
 Phosphatic bed in Gault of five inches in thickness.
 Gault of about one foot in thickness.
 Upper layer of Lower Greensand.
 Upper Phosphatic bed of Lower Greensand.
 Lower Greensand, with few or no fossils.
 Lower Phosphatic bed of Lower Greensand, rich in fossils, and often cemented,
 so as to form hard conglomerates, and containing a large quantity of
 derived fossils.
 Pure Kimmeridge Clay.
 Coral Rag, intermixed with Kimmeridge Clay.
 Coral Rag *in situ*.

At a little distance from the Coprolite Workings, and very near to the outcrop of the "Coral Rag" (the "Upware Limestone" of Mr. H. Seeley), Mr. Keeping had an excavation made of about ten feet, cutting through the Gault, from which he derived the following species.—

Inoceramus concentricus, *Park*.
Nucula ovata, *Mant*.
 „ *pectinata*, *Sow*.
Dentalium ellipticum, *Sow*.

Ammonites interruptus
 „ *serratus*, *Park*.
Baculites
Belemnites attenuatus, *Sow*.
 „ *minimus*, *List*.

The drive back to Cambridge—twelve miles through "the Fens"—was quickly and agreeably accomplished, and the Members returned to London highly gratified by their instructive visit to Cambridgeshire.