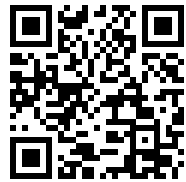


10.

Professor P. B. Studer
with the Authors
Kind regards
Sept 14/70

THE

CORRELATION OF THE JURASSIC ROCKS

OF THE

Côte-d'Or and the Cotteswold Hills.

By THOMAS WRIGHT, M.D., F.R.S.E., F.G.S.

VICE-PRESIDENT OF THE COTTESWOLD NATURALISTS' FIELD CLUB.

Read at the Meeting of the Cotteswold Club, Wotton-under-Edge, August 31st, 1869.

JOHN BELLOWS, STEAM PRESS, GLOUCESTER.

On the Correlation of the Jurassic Rocks, in the Department of the Côte-d'Or, France, with the Oolitic formations in the counties of Gloucester and Wilts, England. By THOMAS WRIGHT, M.D., F.R.S.E., F.G.S.

ON returning from Switzerland last summer, I determined to visit my former correspondent on Jurassic Geology, M. JULES MARTIN, F.G.S., of Dijon, author of several memoirs on that subject, for the purpose of paying my personal respects to him, and at the same time examining the fine collection of Fossils he had collected from all the different stages of the Terrains jurassiques, so well developed in the Department of the Côte-d'Or. M. MARTIN's admirable Monograph,* Paléontologie Stratigraphique de l'Infra-Lias du Département de la Côte-d'Or, had likewise long interested me, and I was very desirous of studying, from my own point of view, the Liassic Fossils so well described and figured in that work; more especially so, as it appeared to me, that the term Infra-Lias, as used by my friend, had given rise to much misapprehension on this side of the channel, in reference to the true position, character, and fauna of the beds he had described under that name. M. MARTIN received me in the kindest manner, and with great courtesy opened his numerous cabinets for my careful inspection, placing before me, for examination, all the type specimens he had figured and described in his works. The fossils are all neatly mounted on tablets, and most carefully described on the labels attached to each; the whole are disposed in glass cases, and stratigraphically arranged in stages as they lie naturally in the different super-imposed beds. The examination of such a collection is an easy and satisfactory one, and affords an observer acquainted with the subject the best means of

* Mémoires de la Société Géol. de France, 2e Série, tome vii, Mem. No. 1.

comparing opinions with facts, and deducing conclusions on the spot. It is the result of this examination, so interesting to all students of Jurassic Geology, that I now propose to lay before the members of the Cotteswold Club.

The Department of the Côte-d'Or comprehends the northern portion of the Duchy of Burgundy; it has the form of an irregular oval; is in length, from north to south, about sixty-five miles, and in breadth, from east to west, from twenty-five to fifty miles, with a superficial area of 3430 square miles. It is divided into four "arrondissemens communaux"—Dijon, Beaune, Châtillon, and Semur. Dijon is the ancient capital of Burgundy, and the chef-lieu of the Department of the Côte-d'Or. This region contains a very complete development of the different Jurassic formations which have formed the subject of many important memoirs made, from time to time, by some of the most eminent French geologists, and the result of their labors is seen in the accurate description of the different stages which are here exposed. As I was desirous of possessing the best teaching on this subject before bringing the matter before our members, since my return home, I addressed a letter to M. Jules Martin and begged of him to favor me with a Stratigraphical table of all the stages of the Jurassic rocks exposed in the Côte-d'Or, and to add to each zone a short list of the leading fossils contained therein, in order that I might be enabled to compare correctly the French series with our English beds. I was the more anxious to possess this information from M. Martin himself, as he has made the Geology of his Department the subject of extensive studies, and has carefully examined the Palæontology of all the beds. M. Martin kindly and promptly complied with my request, and I have very great pleasure in publishing his letter, and, at the same time, offering him our united thanks for this important communication:—

"Dijon, le 20 Août, 1869.

"Cher Monsieur,

Je m'empresse de déférer à votre désir en vous adressant ci-après le tableau sommaire de la constitution des étages

jurassiques et du Lias de la Côte-d'Or, en partant de l'étage Rhætien. Le voici :

Portlandien ... Calcaires marneux et marno-compactes à *Trigonia Boloniensis* et *Pinna supra-jurensis*, Calcaires marno-compactes à *Amm. gigas*.

Kimméridien ... Marnes et calcaires marno-compactes à *O. virgula*. Calcaires à Ptérocèren avec quelques *Ostrea virgula*.

Séquanien ... Calcaires marno-compactes à *Astarte minima* Calcaires marneux à *Terebratula humeralis*, Calcaires durs ou blancs crayeux à *Nerinea Bruntrutana*, Calcaires blanchâtres à *O. solitaria* et *Hemicidaris diademata*.

Corallien ... Oolithe corallienne à *Diceras* et calaire compacte. Calcaire fissile, sub-oolithique et calc. blanc à Polypiers, Calcaire grumeleux compacte, calcaire à chailles et marnes inferieures à *Glypticus hierogliphicus*, *Cidaris florigemma*, *etc.*

Oxfordien ... Marnes superieures à grandes *Amm. plicatilis* et *Pholadomya parcicosta*. Calcaires pseudo-lithographiques à *Pholadomya ampla*. Marnes grises et calcaires gris cendré à Spongiaires. Marnes ferrugineuses oolithiques à *Am. cordatus*, *Am. perarmatus*, *Am. oculatus*, etc., Marnes Calloviennes et calc. marneux à *Ammon. athleta*, *Am. lunula*, *Duncani*, *Pholadomya lineata*, *Ph. decussata*, *Collyrites elliptica*, etc.

Bathonien ou Grande Oolithe

Dalle nacrée et calcaire marneux inf. à *Pernostræa*, *Pentacrinus Buvignieri*, et nombreux Bryozoaires. Calcaires en plaquettes à Bryozoaires, *Ostrea costata*, *Terebratula coarctata* etc., Calcaires sub-oolithiques et marnes à *Terebratula*, *digona*, *obovata*, *ornithocephala et intermedia*, Calcaire gris sub-oolithique et marnes à *Terebratula cardium* et *T. hemispherica*, *Apiocrinus Parkinsoni*, *Hemicidaris Luciensis*, *Heteropora pustulosa*, etc.

Calcaires compactes ruiniformes à *Acrosalenia Lamarckii*.

Oolithe blanche miliare à *Purpura glabra* et *Purpura minax*.

Calcaires marneux à *Ammonites bullatus*, *Am. arbustigerus* et *Phaladomya Vezelayi*.

Calcaires marneux inférieurs à *Pholadomya bucardium*. Marnes à *Ostrea acuminata* et *Ammonites Parkinsoni*. Oolithe canabine à *Pholadomya. gibbosa* et quelques *Ostrea acuminata*.

Oolithe inférieure	Calcaires fissiles à Gervillies. Calcaires à Polypiers. Calcaire à entroques à *Pecten Bajocencis*, et *Cidaris Courtandina*, etc. Calcaire marbre inférieur à *Amm. Murchisonæ* et *Pecten personatus*. Feuillet grézeux à *Chondrites scoparius*.
Toarcien ou Lias superieur	Marnes jaunâtres à *Ammonites mucronatus*. Marnes brunes à *Turbo subduplicatus*. Marnes et calcaires marneux à *Ammonites complanatus*, Calcaire marn. et marnes schisteuses à *Am. serpentinus*.
Liasien ou Lias moyen	Marnes et calc. marneux à *Ostrea gigantea*. Marnes feuilletées et micacées. Marnes et calcaires argileux bleuâtres à *Am. Bechei* et *Davœi*.
Sinémurien ou Lias inférieur	Calaire marneux bleuâtre à *Am. oxynotus*, *Am. stellaris*, *Birchii*, etc. Marnes et calc. marneux à *Ammon. bisulcatus* Calc. marneux à *Am. Scipionianus* et *Am. rotiformis*.
Hettangien ou Infra-Lias	Calcaire marneux à *Am. angulatus* et *Am. liasicus*. Lumachelles à *Am. planorbis*, *tortilis* et *Burgundiæ* (*Am. laqueus*, Quenst.)
Rhætian ...	Grès et marnes à *Avicula contorta* et *Bone-bed*.

Marnes irisées ou granite.

Si quelque jour vous vous décidez à publier l'étude comparative, que vous vous proposez de faire, de ces terrains avec les votres, je lirai avec le plus vif intérêt le résultat de vos recherches à cet égard.

Veuillez agréer, cher Monsieur, l'expression de mes sentiments affectueux et dévoués.

J. MARTIN.

In making a comparison between the fauna of the Jurassic rocks of the Côte-d'Or and those of their correlative formations in England, I studied the beds in an ascending order, and I purpose following the same method in transcribing from my note-book the gist of these observations.

The Avicula contorta, or Rhætian, Series.

These *Arkoses* are composed of Sandstone and Marls, with *Avicula contorta* and the Bone-bed; the sections given in M. J. Martin's memoir, shewing the presence of these, agree very closely with the order of sequence of the same beds seen in Gloucestershire.

1. Marcigny-sous-Thil.—*Lumachelle du lias (assises peu développées.)*

Lithology.	Fauna.
Sandstone, with fucoids ...	Cerethium Semele, *d'Orb.* Cardium cloacinum, *Quenst.* Avicula Dunkeri, *Tqm.*
Arenaceous strata, formed of disaggregated Arkose	Non-fossiliferous.
Arkose, with large elements	Pecten Valoniensis, *Defr.* Avicula contorta, *Portl.* Mytilus minutus, *Goldf.* Ostrea marcignyana, *Mart.*
Whitish, micaceous, fine-grained Sandstone, traversed by veins colored by Oxide of Iron	Chemnitzia Oppeli, *Mart.* Turbo subcrenatus, *Mart.* Anatina præcursor, *Quenst.* A. Suessi, *Opp.* Myophoria inflata, *Emm.* M. multiradiata, *Emm.* Cardium Rhæticum, *Mérian.* C. cloacinum, *Quenst.* C. Philippianum, *Dunk.* Avicula contorta, *Portl.* Lima præcursor, *Quenst.* Pecten Valoniensis, *Defr.* With many other new sp. of Gasteropods and Conchifers.
Sandstone like the above resting upon Granite	Non-fossiliferous.

2. Montigny-sur-Armançon.—*Lumachelles. Banc de* 30 *à* 35 *centimètres.*

Lithology.	Fauna.
Granitoid Arkose	Without any known fossils.
Deep red fine-grained Sandstone, feebly aggregated and browned by the Oxide of Iron	Avicula contorta, *Portl.* Gervillia præcursor, *Quenst.* Lima præcursor, *Quenst.* Pinna semistriata, *Tqm.* Lima Bochardi, *Mart.* Ostrea Marcignyna, *Mart.* Anomya irregularis, *Tqm.*

Two sections are given from the S.E. and S.W. of Semur, and another from Pouillenay, which resemble the preceding in their lithological character and organic contents.

In a subsequent memoir* M. J. Martin has given more extended investigations on this zone, and has discovered the presence of the Bone-bed in several localities.

At Savigny-sous-Malain, in the Arrondissement of Dijon.—"Ce gisement que j'explorai dans toutes ces parties alors visibles ne me présenta d'abord aucune trace de fossiles. Cependant en fouillant à travers les décombres arrachés sur place pour la plantation des vines, et amoncelés à la limite de chaque parcelle de terrain, je découvris quelques écailles de poisson, puis une magnifique dent du *Sargodon tomicus*, Plien., et enfin, en retournant à la roche en place où j'opérai un petit découvert, plusieurs dents de *l'Acrodus minimus*, Ag., et de *l'Hybodus minor* du même auteur.

"Je me trouvais donc définitivement en possession de ce *Bone-bed* que j'avais si longtemps et si minutieusement cherché sans succès, et c'était à une simple donnée minéralogique que je le devais; tant il est vrai que, pour ces sortes d'investigations, le moindre indice, la plus vague indication, doivent être utilisés et mis à profit. Une fois sur la trace de cet intéressant dépôt, qui à Savigny semble occuper principalement la partie supérieure de la zone à *Avicula contorta*, je devais facilement arriver à en constater la presence sur d'autres points au même horizon géologique.

"Mémont.—Un gisement très riche sur la rive nord du ravin de Pissou est trouvé dans les bancs gréseux qui surmonte les arkoses à gros éléments. Les dents de *Saurichthys d'Hybodus, d'Acrodus*, de *Sphœrodus*, et de *Sargodon*, y sont en telle abondance qu'il est difficile, en cassant la roche de trouver un seul fragment qui n'en présente des traces. Le sommet de l'assise est surtout la partie la plus fossilifère; mais il est rare qu'elle ne le soit pas dans toute son épaisseur."†

Remilley-en-Montagne.—Les deux bancses de la zone à *Ammonites angulatus* sont argilo-calcaires, comme dans l'Auxois et qu'ils reposent sur une assise de lumachelle à *Ammonites*

* De la Zone à *Avicula contorta* et du *Bone-bed* de la Côte d'Or. Mem. de l'Académie des Sciences et Belles Lettres de Dijon, tome XI: 1863.

† *Ibid* p. 5.

Burgundiæ dans laquelle abondent les cardinies et *l'Ostrea irregularis*, Munst. Cette lumachelle qui n'a guère que 15 à 20 centimètres d'épaisseur, s'appuie à son tour sur mince assise argilo-calcaire très compacte, sorte de lumachelle aussi, riche en espèces de la zone à *Avicula contorta* et en debris du *Bone-bed*. Ce n'est pas tout: non seulement il y à transition dans le caractère mineralogique, qui prend insensiblement l'aspect liasique; mais cette transition existe aussi dans la faune, car *l'Ostrea irregularis* apparaît fréquemment au sommet de l'assise dont il est question, à travers les espèces les plus caractéristiques de la zone à *Avicula contorta* et les dents de poisson du *Bone-bed*, tandis que ses derniers débris (*Saurichthys acuminatus*, *Sargodon tomicus*, *Sphærodus minimus*, *Hybodus minor*, etc.,) ne sont pas rares dans les lumachelles à *Ammonites planorbis*, j'ai même trouvé une dent de *Saurichthys acuminatus*, jusque dans les calcaires de la zone à *Ammonites angulatus*.†

Montigny-sur-Armançon.—Les grès et arkoses de la zone à *Avicula contorta* y sont entièrement développés et très fossilifères. *L'Ostrea marcignyana* Mart., y pullule au point de former des bancs. Dans les grès à *Avicula contorta* nous avons pu recueillir également en abondance le *Pecten Valoniensis*, la *Lima præcursor*, le *Mytilus minutus*, *l'Avicula contorta* et autres espèces; puis le *Mytilus rugosus*, *Panopœa arkosiæ*, et un gros gasteropode canalifère, un *Fusus Montignyanus*, Mart.

The following species have been collected from the zone of the *Avicula contorta* in the Côte-d'Or.

Reptilia.

Termatosaurus Alberti, *Plien.*	Teeth, Saurian, not determined.
" Crocodilinus, *Quenst.*	Vertebræ, " "

Fishes.

Saurichthys acuminatus, *Agass.*	Ceratodus cloacinus, *Quenst.*
Hybodus minor, *Ag.*	Sargodon tomicus, *Plien.*
" sublœvis, *Ag.*	Sphœrodus minimus, *Plien.*
" cuspidatus? *Ag.*	Gyrolepis tenuistriatus, *Ag.*
" cloacinus, *Quenst.*	Dapedius, *Sp.*
Nemacanthus filifer, *Ag.*	Tetragonolepis, *Sp.*
Acrodus minimus, *Ag.*	Placodus gigas, *Ag.*

† *Ibid* p. 23.

Gasteropoda.

Chemnitzia Oppeli, *Mart.*
Acteonina elongata, *Moore.*
" oviformis, *Moore.*
Natica Opelli, *Moore.*
Turbo, *Sp.*
Cerithium semele, *d'Orb.*
" subundum, *Mart.*
Fusus Montignyanus, *N. Sp. Mart.*

Conchifera.

Panopœa depressa, *Mart.*
" Montignyana, *Mart.*
" rugosa, *Dunk.*
Leda Deffneri, *Opp.*
" Heberti, *Mar.*
" Schiavi, *Stop.*
Venus cloacina, *Quenst.*
Pullastra arenicola, *Strick.*
Venus depressa, *Moore.*
Corbula arkosiæ, *Nov. Sp.*
Cardita Austriaca, *Houer.*
" lucræ, *Stopp.*
Cyprina lens, *Stopp.*
" Marcignyana, *N. Sp.*
Cypricardia Suevica, *Opp.*
Pteromya Crowcombeia, *Moore.*
Myophoria inflata, *Emmr.*
" multiradiata, *Emmr.*
" Emmerichi, *Winkl.*
Myophoria ? isoceles, *Stopp.*
" Reziæ, *Stop.*
" arkosiæ, *N. Sp.*
Cardium Philippianum, *Dunk.*
Anatina præcursor, *Quenst.*
Saxicava Sinemuriensis, *Mart.*
Arca Sinemuriensis, *Mart.*
Pinna semistriata, *Tqm.*
Mytilus minutus, *Goldf.*
" rugosus, *Stopp.*
Lithophagus faba, *Winkl.*
Lima præcursor, *Quenst.*
" Bochardi, *Mart.*
" compressa, *Tqm.*
Avicula contorta, *Portl.*
Gervillia præcursor, *Quenst.*
Pecten Valoniensis, *Defr.*
" Hehlii, *d'Orb.*
Plicatula intusstriata, *Emmr.*
Ostrea Marcignyana, *Mart.*
" irregularis, *Münst.*
Anomia irregularis, *Tqm.*
" pellucida, *Tqm.*
" Renovii, *Stopp.*
Terebratula pyriformis, *Suess.*
Nucula Hausmanni, *Stopp.*
" Bocconis, *Stopp.*

Echinodermata.

Asteria lombricalis, *Schl.*
Ophiura, *Sp.*

Anthozoa.

Thecosmilia Martini, *From.*

Spongia.

Achilleum grande, *Winkl.*

Annelida.

Serpula strangulata, *Tqm.*
" Blaisyana, *N. Sp.*
Terebella Liasina, *Tqm.*

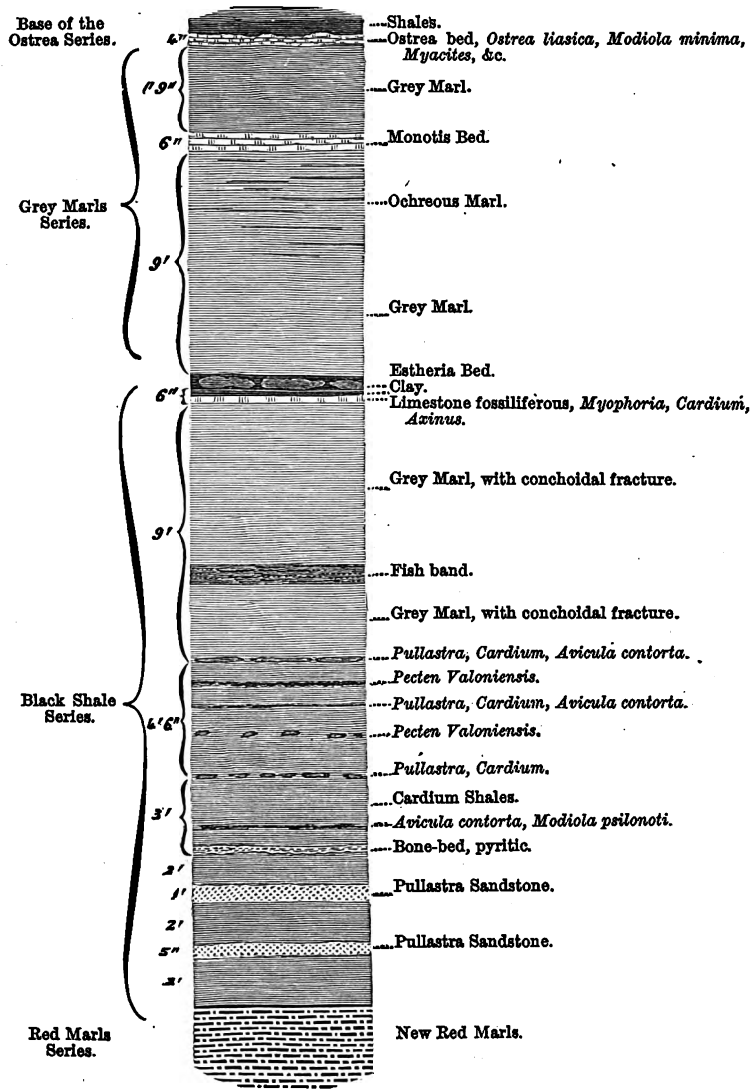
Plants.

Calamites arenaceus, *Broug.*
" *N. Sp.*

Ainsi quatre-vingt-dix espèces animales ou végétales ont été recueillies dans la zone à *Avicula contorta* de la Côte-d'Or.

Sur ce nombre cinquante-deux paraissent spéciales à cet horizon ; six ont déjà été signalées dans le Trias et vingt-six continuent à se propager dans l'Infra-Lias proprement dit. Les autres sont douteuses.

FIG. I. GENERAL SECTION OF GARDEN CLIFF, NEAR WESTBURY-ON-SEVERN.



This general section of Garden Cliff was drawn by my friend R. Etheridge, Esq., F.R.S.E., for Professor Rupert Jones' Monograph on the Fossil Estheriæ, Palæontographical Society's volume for 1862; and I have to thank my friend the Rev. T. Wiltshire, F.G.S., Secretary to the Society, for the loan of the wood-cut, and Mr. Etheridge for his permission to use it.

The Avicula Contorta Beds in Gloucestershire.

In the Severn valley the *Avicula contorta* series has a similar development in several well known exposures, as at Coombe Hill, Wainlode Cliff, Garden Cliff, Aust Cliff, Penarth Cliff, on the banks of the Severn, and in several other localities in Somerset and Dorset. Garden Cliff, near Westbury-on-Severn, forms the best type of the whole. The following section, made by me many years ago, gives the details of the Lithology and Palæontology of this most beautiful river section.

Lithology.	Fauna.
Cream-coloured argillaceous fissile Limestone, *Monotis bed*	Monotis decussata, *Goldf.* Myacites musculoides, *Schl.* Cardium Rhæticum, *Mer.* Modiola minima, *Goldf.* Ostrea liassica, *Sow.*
Light grey nodular Limestone, *Estheria bed*	Estheria minuta, *Bronn.* Pecten Valoniensis, *Defr.*, and other shells.
Dark, chocolate-colored, friable, laminated Shales, containing many shelly seams; fossils very abundant	Pecten Valoniensis, *Defr.* Cardium Rhæticum, *Mer.* Axinus cloacina, *Opp.* Myacites musculoides, *Schl.* Lima præcursor, *Quenst.* Anatina Suessii, *Opp.* Avicula contorta, *Portl.* Gervillia præcursor, *Quenst.* Neoschizodus posterus, *Quenst.* Nearly all in the form of sharp moulds which had to be determined on the spot, with many species that were indeterminable.
Dark shaly Clay, containing many seams of compressed shells	Pullastra arenicola, *Strick.* Pecten Valoniensis, *Defr.*, very abundant.
Dark laminated shales ...	Avicula contorta, *Portl.* Cardium Rhæticum, *Mer.*, forming compressed layers of crushed shells.

The *Bone-bed*, a thin band of grayish calcareo-siliceous rock, with much sulphuret of iron, coprolites, bones, teeth and scales of fishes, and bones of Sauria; a true osseous breccia in parts	Acrodus minimus, *Ag.* Nemacanthus filifer, *Ag.* N. monolifer, *Ag.* Hybodus minor, *Ag.* H. pyramidalis, *Ag.* Gyrolepis Alberti, *Ag.* Saurichthys apicalis, *Ag.* Sargodon tomicus, *Plien.* Bones of Ichthyosaurus, Plesiosaurus; tooth of Ceratodus, with shells. Avicula contorta, *Port.* Axinus cloacina, *Opp.*, Pullastra arenicola, *Strick.*
Black Shales	Non-fossilliferous.
Pullastra bed, dark grey, micaceous, ripple-marked Sandstone	Avicula contorta, *Portl.* Cardium Rhæticum, *Mer.* Pullastra arenicola, *Strick.* Modiola minuta, *Goldf.*
Dark gritty Sandstone, containing fishes' teeth and pyrites	Pullastra arenicola, *Strick.* Avicula contorta, *Portl.* Saurichthys apicalis, *Ag.* Gyrolepis Alberti, *Ag.* Sargodon tomicus, *Plien.*
Black Shales, laminated...	No fossils.
Hard black Shale... ...	Bodies resembling Coprolites.
Grey Marls of the Keuper.	

The Côte-d'Or specimens of this stage consisted of coarse-grained Sandstones or Arkose, in which *Pecten Valoniensis* and *Cardium Rhæticum* were conspicuous. I observed several fragments of the Bone-bed recently found in the Department; its presence in this stage has likewise been indicated at Mont d'Or, west of Lyons, from whence M. Fournet * obtained a Saurian tooth. The whole facies of this bed much resembled the specimens from Garden Cliff, and other well known localities in England, and it was interesting and instructive to observe the great similarity subsisting between formations of the same age, accumulated so widely apart as the shores of the Triassic sea of the Côte-d'Or, and those in the centre of England.

The following section was made by my friend R. Etheridge, Esq., F.R.S.E., to illustrate his paper on the Rhætic beds of Garden Cliff, which appeared in the transactions of the Cotteswold Club, for 1864. It is, by his kind permission, re-produced here, as it gives all the details necessary for fully understanding this most instructive river section.

* Fournet, Geologie Lyonnaise, p. 141 : 1861.

FIG. II. DETAILED SECTION OF THE AVICULA CONTORTA BEDS AT GARDEN CLIFF, NEAR WESTBURY-ON-SEVERN.

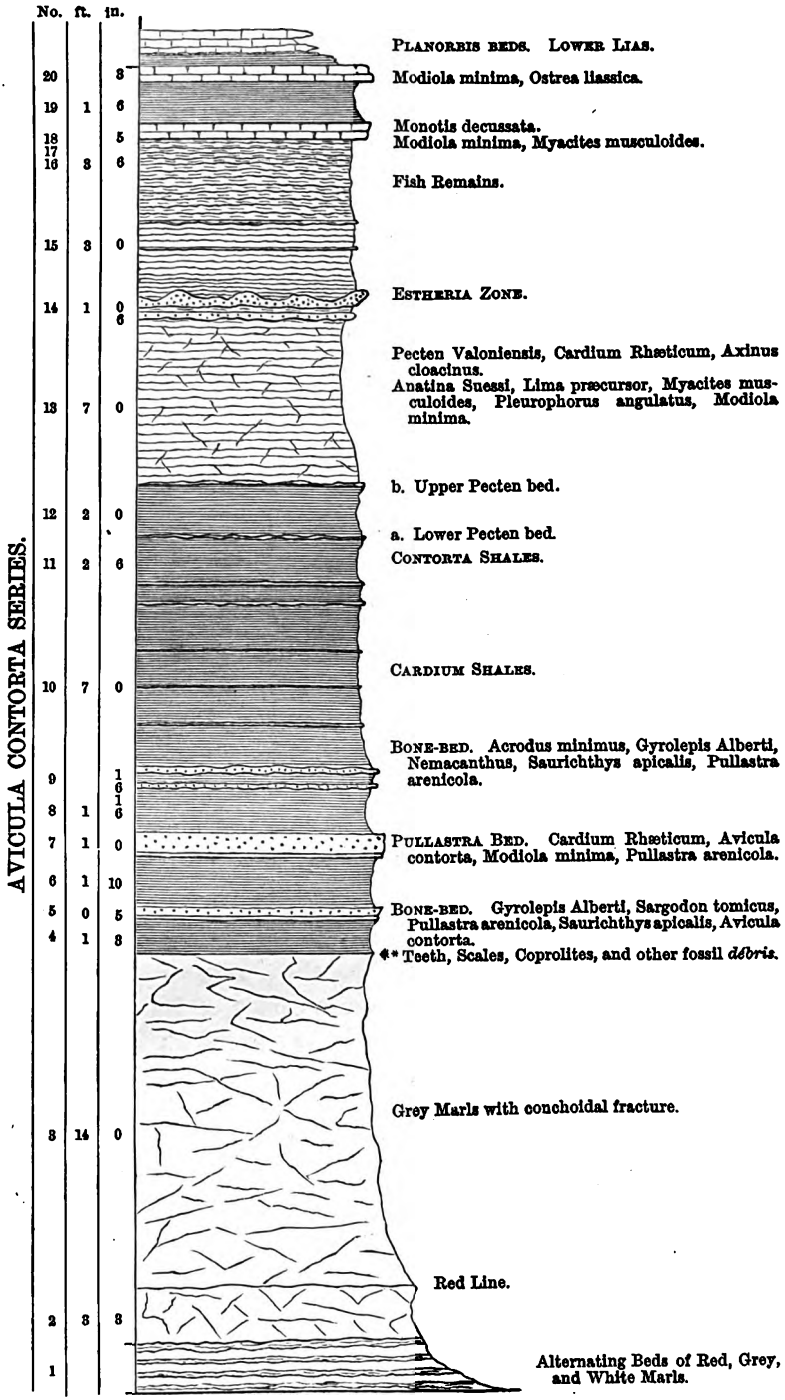
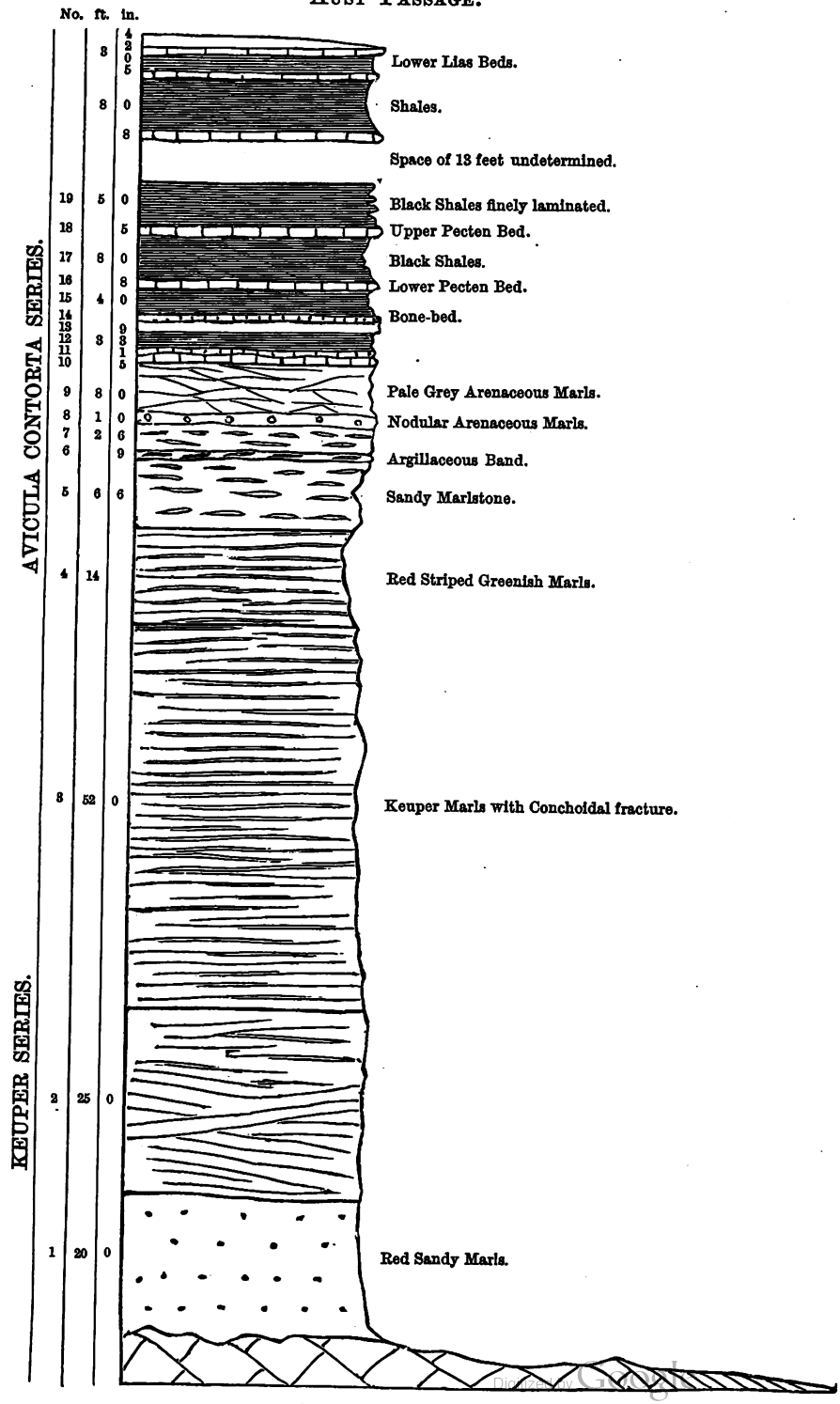


FIG. III. SECTION OF AUST CLIFF, ON THE SEVERN, NEAR AUST PASSAGE.



This section was measured by Mr. ETHERIDGE, and drawn by him to illustrate an address read by our esteemed President, Sir WILLIAM GUISE, Bart., F.L.S., at the Annual Meeting of the Club held at Elmore Court, 21st March, 1866.

AUST CLIFF.—If we proceed from Garden Cliff down the Severn, the next section of the *Avicula contorta* beds is met with at Aust Cliff, so long famous for its Bone-bed, and the large number of *Ceratodus* teeth which, from time to time, have been collected therefrom. My friend WILLIAM SANDERS, Esq., F.R.S., of Bristol, many years ago carefully measured this section, a matter of much difficulty from the mural character of the escarpment, and the result of his labors were published by Sir HENRY DE LA BECHE, in his valuable Memoir on the Geology of the south-west of England. * BUCKLAND and CONYBEARE having previously published a section of this cliff in their Memoir on the south-western coal district of England.†

In the upper part of the section are found about 3 feet of grey argillaceous Lias Limestone, containing *Ammonites angulatus*, Schloth., *Lima gigantea*, Sow., *Lima antiquata*, Sow., and *Modiola Hillana*, Sow., representing the lower beds of the Lima series. Below these are nine beds consisting of grey marls and argillaceous Limestones, representing the zone of *Ammonites planorbis*. The lowest Limestone bed of the series contains scales of fishes, elytra of insects, with Modiola and Terebratula; this rests upon 8 feet of grey, light-colored marls, with nodular Limestone, the equivalent of the white Lias series, or the beds numbered from fourteen to nineteen, inclusive, in the detailed section of Garden Cliff. The Cotham Marble caps the marly beds; this well-known singular band forming the base of the Ostrea series. The gap in the section is intended to represent a space of 13 feet which could not be satisfactorily examined. Below this space, 5 feet of thinly laminated black shales are exposed; and beneath a five-inch band of hard grey Limestone, containing scales of fish, *Pecten Valoniensis*, *Placunopsis alpina*, *Pleurophorus elongatus*, representing the

* Memoirs of the Geological Survey of Great Britain. Vol. i., p. 253: 1846.
† Geological Transactions, 2nd Series. Vol. i., p. 37.

upper Pecten bed of the Garden Cliff section, &c., this band rests upon another bed of black shales, 8 feet in thickness, containing seams of shells. Here are found *Avicula contorta, Cardium Rhæticum, Pullastra arenicola, Axinus, Anomia,* &c. The fossils are very numerous, but much compressed, and determined with difficulty. The Contorta shales rest upon a second, or lower, Pecten bed, consisting of a hard grey shelly Limestone, 8 inches thick, containing *Avicula contorta, Cardium Rhæticum, Pullastra, Axinus, Anomia,* &c., in fact, all the same shells that are found in the black shales above. Beneath the Limestone band is another bed of black shales, 4 feet thick, intersected by thin, inconstant, indurated bands, containing fishes' scales, &c. The shales rest upon the true Bone-bed, which is here a most remarkable band of dark grey, crystalline, calcareo-siliceous rock, containing nodules of marl, masses of dark coprolitic matter, bones of saurians, teeth of ceratodi and other fishes, in fine preservation. Its thickness varies from 2 to 8 inches; and it rests upon a thin band of dark shales, to which succeeds a yard of grey sandy marls, containing hard concretionary nodules; beneath are bands of hard sandy marl, resting upon 8 feet of pale grey arenaceous marls, having at their base a nodular band of similar marls, passing into a thick bed of sandy Marlstone, 6 feet 6 inches thick, and forming the base of the *Avicula contorta* series, which rests upon nodular greenish marls, thick bedded and red striped, fourteen feet thick, and next a thick mass of marls, having a conchoidal fracture, 52 feet thick; then follow the gypsiferous series, containing fibrous gypsum, in string-like lines, 25 feet 6 inches, having at the base 20 feet of red sandy marls,—the whole resting upon highly inclined strata of the lower portion of the carboniferous Limestone, which here forms the bed of the Severn.

The special character of this section consists in the great development of its Bone-bed, and the number of large teeth belonging to the genus *Ceratodus* that have been obtained here. Mr. Higgins, of Birkenhead, who has made the largest collection therefrom, reckons that he has found at Aust 140 different forms of teeth belonging to this singular genus.

I.—The Lias.

M. Martin divides the Lias into four stages—1st, *Hettangien* ou Infra-Lias. 2nd, *Sinémurien* ou Lias inférieur. 3rd, *Liasien* ou Lias moyen. 4th. *Toarcien* ou Lias superieur.

The Hettangien ou Infra-Lias { Calcaire marneux à *Ammonites angulatus*, et *Ammonites liasicus*. Lumachelles à *Ammonites planorbis*, *A. tortilis*, et *A. Burgundiæ*.

The Lumachelles, *zone à Ammonites Burgundiæ*, Mart., evidently represent the beds I have described as the zone of *Ammonites planorbis*, which rests upon the *Saurian* beds with *Ostrea liassica;* in the sections I have given in my memoir on "the *Avicula contorta* and Lower Lias of the south of England."* M. Martin's Ammonites are almost identical with forms of *A. planorbis* and *A. tortilis*, collected from beds of the same horizon in England, in the localities given in that memoir. Associated with the Ammonites are one or two species of *Hemipedina*, nearly allied to the small Urchins, collected from this zone near Pinhay Bay, Dorsetshire, and the Guinea Bed at Binton, Warwickshire. Corals, likewise, are found in the Lumachelles, nearly allied to the species of *Septastræa*, *Isastræa*, *Stylastræa*, and *Montlivaltia*, discovered in this and the next zone in England. The general facies of the fauna cannot be mistaken, for similar forms of the same genera appear for the first time in these basement beds of the Lias formation, many of them identical with, and when different from, nearly allied to the common type.

"Calcaire marneux à *Ammonites angulatus* et *Am. liasicus;* un des horizons paléontologiques les mieux caractérsés qu'il y ait dans le Département de la Côte-d'Or, et les plus riches en fossiles variés, est certainement la zone à *Ammonites Moreanus*. Limité à deux ou trois mètres de puissance au maximum, ce dépôt parait correspondre à une période d'animalization d'une admirable fécondité. C'est au sein de ses assises qu'a été recuillie la charmante faune que nous avons signalée, l'an dernier, et qui a de si intimes rapports avec la faune hettangienne, dont on doit la connaissance aux travaux de M. O. Terquem.†

* *Quarterly Journal of the Geological Society*. Vol. xvi., p. 389: 1860.

† Paléontologie stratigr. de l'Infra-lias, p. 38: 1860.

From this zone M. Martin has collected a total of 176 species, of which 58 species are found in the underlying stages, 98 species are special to the zone, and 47 pass upwards into the overlying calcaire à Gryphites arquées, or *Am. Bucklandi* beds. Among the fauna enumerated are 1 *Ichthyosaurus*, 1 *Ichthyodorulite*, 10 sp. of *Cephalopoda*, 63 *Gasteropoda*, 77 *Conchifera*, 5 *Brachiopoda*, 4 *Echinodermata*, 10 *Anthozoa*, 3 *Annelida* and *débris* of *Crustacea*.

This zone is found in Gloucestershire with a limited fauna; in the Harbury cutting of the Great Western Railway, Warwickshire; and in the coast section near Lyme Regis, with a numerous fauna. It is found, likewise, in the north of Ireland, and in the remarkable Lias district near Portrush. The Ammonites that characterize this zone have been figured and described by M. d'Orbigny, under the names *Am. Moreanus*, *Am. catenatus*, and *Am. Charmassei*, which are all so many different varieties of *Am. angulatus*, Schloth.; the typical forms of these are collected from the English beds, together with a very rich fauna of small Gasteropoda and Conchifera, many of which are identical with those so beautifully figured by M. Martin, from the zone in the Côte-d'Or, and by MM. O. Terquem et Ed. Piette au Lias inférieur de l'est de la France from strata of the same age.

It is clear, therefore, from this analysis, that the *Hettangien ou Infra-Lias* of M. Martin consists of the two lowest stages of the true Lias, namely, the "*zone of Ammonites angulatus*" and the "*zone of Ammonites planorbis*," the latter resting upon the Grès et Marnes à *Avicula contorta* and Bone-bed; in all their essential phases these two stages being the true equivalents of the bed so well known by these names to the members of the Cotteswold Club.

II.—Sinémurien ou Lias Inférieur

Consists of—*a*. Calcaire marneux bleuâtre à *Am. oxynotus*, *Am. stellaris*, *Am. Birchii*, &c. *b*. Marnes et calcaire marneux à *Ammon. bisulcatus*, cal. marneux à *Am. Scipionianus*, et *Am. rotiformis*.

Following these beds in an ascending order, the marnes et calcaire marneux à *Am. bisulcatus* are clearly the true equivalent of the "*zone of Ammonites Bucklandi*," of which *Am. bisulcatus*, Brug., = *Am. multicostata*, Sow., is the dominant species in France, and the form that appears to prevail in the Côte-d'Or. I saw several specimens of this species, which were identical with our own, from the same zone in Gloucestershire, Warwickshire, and Dorsetshire. The bed with *Am. Scipionianus*, d'Orb., likewise occurs in the vale of Gloucester, as I have a beautiful example of this Ammonite obtained near Bredon, from the deep cutting made in the formation of the Midland Railway.

The bed with *Am. rotiformis*, Sow., was exposed in excavating the Lower Lias Shales at Cold Pool, in the construction of the Cheltenham and Gloucester Railway; it is found likewise at Saltford, near Bristol, and at Lyme Regis, Dorsetshire. The bed with *Am. stellaris*, Sow., and *Am. Birchii*, Sow., occupies a higher position, and forms a portion of the *zone of Ammonites obtusus*, Sow.; most of the specimens of *Am. stellaris*, Sow., in M. Martin's collection are, in fact, true examples of *Am. obtusus*, Sow., and from the same localities were obtained *Am. Sauzeanus*, d'Orb., and *Am. Dudressieri*, d'Orb. *Am. Oxynotus*, Quenst., is grouped with these species, but in Gloucestershire this Ammonite occupies a higher position and characterizes a considerable zone, consisting of beds of dark clay, largely charged with the peroxide of iron; from these, many years ago, I collected a very large number of type specimens identical with the German forms. Swindon, near Cheltenham, and the excavations for the New Docks, Gloucester, may be mentioned as localities from whence they were largely obtained.

III.—"Liassien ou Lias Moyen"

Consists of the following sub-divisions:—

- *a* Marnes et calcaire marneux à *Ostrea gigantea.*
- *b* Marnes feuilletées et micacées.
- *c* Marnes et calcaires argileuse bleuâtres à *Am. Davœi et Am. Bechei.*

This division, or the Lias Moyen, attains a considerable development at Semur (Côte-d'Or). The under beds consist of

marls, containing *Am. Jamesoni*, *Am. Ibex*, *Am. Davœi*, with the lower portion of the beds containing *Am. margaritatus*, whilst above the marls are brown crumbling Limestones, with *Am. margaritatus*, *Am. spinatus*, and numerous specimens of *Gryphœa cymbium*. We shall find this to be the same condition of things prevailing in the vicinity of Cheltenham; in the many exposures of the Middle Lias beds along the western escarpment of the Cotteswold Hills; and in the magnificent sections along the Yorkshire coast in the north, and Dorsetshire in the south. In Gloucestershire the Middle Lias admits of a sub-division into five zones of life: these are in ascending order—1st, *zone of Ammonites Jamesoni;* 2nd, *zone of Am. Ibex;* 3rd, *zone of Am. capricornus;* 4th, *zone of Am. margaritatus;* 5th, *zone of Am. spinatus.*

1.—*The zone of Am. Jamesoni* is known to me only in a few localities in Gloucestershire. One of these (an old pit sunk deep for brick earth in the environs of Cheltenham,) has furnished fragments of a large *Am. Jamesoni*, Sow., and many of the young forms of the same species, known as *Am. Bronnii*, Röm., with *Rhynchonella rimosa*, von Buch. *Am. Jamesoni*, Sow., is found in Robin Hood's Bay, on the coast of Yorkshire, where it is associated with *Gryphœa obliquata*, Sow.; *Pholadomya decorata*, Ag.; *Pinna folium*, and *Am. Taylori*, Sow. This zone is likewise well developed in the Island of Pabba, near Skye, in the Hebrides, if I may judge from the suite of fossils collected therefrom by my friend Arch. Geikie, Esq., F.R.S., Director of the Geological Survey of Scotland, who sent these specimens to me for determination. The original type *Ammonites Jamesoni*, Sow., came from the brown micaceous sandstone of Pabba which represents these beds.

2.—*The zone of Ammonites Ibex* is likewise found in the neighbourhood of Cheltenham reposing on the preceding. The bed consists of a yellowish coloured clay in which numerous hard calcareous nodules are imbedded; in these we find *Am. Ibex*, Quenst., *Am. Maugenesti*, d'Orb, *Am. Henleyi*, Sow., *Am. bipunctatus*, Röm., with several conchifera as *Cœnatula ventricosa*, Sow., *Mytilus scalprum*, Sow., *Arca elongata*, Quenst.,

Pinna folium, Young and Bird, *Cardinia attenuata*, Buck., &c. This zone is well developed in Northamptonshire, as I have examined fine specimens of *Am. Ibex.*, Quenst., and *Am. bipunctata*, Röm., collected near Watford.

3.—*The zone of Ammonites capricornus* is well developed in England, and wherever the Middle Lias is fully exposed the laminated micaceous clays, often richly charged with the peroxide of iron, representing this zone are found; in the western escarpment of the Cotteswolds, as at Hewlitt's Hill, near Cheltenham, at Witcombe Park, near Birdlip, and at Mickelton Tunnel, near Evesham, it was at one time admirably exposed, and where it contained a very rich fauna. On the coast of Yorkshire, as at Staithes, and Boulby Cliff, this zone attains a great thickness and yields a long list of organic remains.

Fossils from the zone of Ammonites capricornus in Gloucestershire.

Cephalopoda.

Belemnites umbilicatus, *d'Blain.*
" elongatus, *Mill.*
" paxillosus, *Schloth.*
Nautilus striatus, *Sow.*
Ammonites Henleyi, *Sow.*
" capricornus, *Schloth.*
" fimbriatus, *Sow.*
" Davœi, *Sow.*

Gasteropoda.

Chemnitzia capricorni, *Wr.*
Cylindrites capricorni, *Wr.*
Trochus imbricatus, *Sow.*
Pleurotomaria Anglica, *Sow.*
" expansa, *Sow.*
" undosus, *Schübl.*

Conchifera.

Pholadomya ambigua, *Sow.*
" decorata, *Hartm.*
Pleuromya unioides, *Röm.*
Leda rostralis, *Lamk.*
" complanata, *Röm.*
" acuminata, *Goldf.*
" inflexa, *Röm.*
Astarte capricorni, *Wr.*
Mytilus hippocampus, *Young & Bird.*
Cypricardia cucullata, *Goldf.*
Cardinia attenuata, *Stutch.*
Goniomya capricorni, *Wr.*
Cardium truncatum, *Phil.*
Unicardium Janthe, *d'Orb.*
Cucullæa Münsteri, *Ziet.*
Arca elongata, *Quenst.*
" truncata, *Buck.*
Modiola scalprum, *Sow.*

Limea acuticosta, *Goldf.*
Avicula longiaxis, *Buck.*
Monotis inæquivalvis, *Sow.*
Inoceramus ventricosus, *Sow.*
" substriatus, *Goldf.*
Pecten æquivalvis, *Sow.*
Pecten priscus, *Schloth.*
" diversus, *Buck.*
" liasinus, *Nyst.*
Gervillia lævis, *Buck.*
Plicatala spinosa, *Sow.*
Gryphæa cymbium, *Lamk.*

BRACHIOPODA.

Terebratula punctata, *Sow.*
Spirifera rostratus, *Schloth.*
Rhynchonella rimosa, *von Buch.*
Rhynchonella variabilis, *Schloth.*
Orbicula scaliforme, *Wr.*
Lingula Beanii, *Phil.*

ECHINODERMATA.

Cidaris Edwardsi, *Wr.*
Acrosalenia, *Nov. Sp.*
Pedina, *Nov. Sp.*
Uraster Gaveyi, *Forb.*
Tropidaster pectinatus, *Forb.*
Ophioderma Gaveyi, *Wr.*
Acroura Brodiei, *Wr.*
Pentacrinus robustus, *Wr.*
" punctiferus, *Quenst.*
" subangularis, *Mill.*

On the coast of Yorkshire, as at Staithes, Boulby, and Skinningrave Bay, where the Middle Lias is largely developed and finely exposed in magnificent coast sections, the shales with *Am. capricornus* = *Am. maculatus*, form the base of the cliffs. From Skinningrave Bay, I have specimens of *Ophioderma Gaveyi*, and it was here that *Plumaster ophiuroides*, Wr., was found, and from the same zone in Robin Hood's Bay, *Luidia Murchisonæ*, Will., was collected. On the Dorsetshire coast, as near Charmouth, this zone forms the upper portion of the grey micaceous marls, or "Green Ammonite bed" of the local collectors. In this stratum a great number of very fine Ammonites, with the shell well preserved, are found as *Am. capricornus*, Schloth., *Am. Loscombi*, Sow., *Am. fimbriatus*, Sow., *Am. latæcosta*, Sow., *Am. Bechei*, Sow., *Am. Henleyi*, Sow.

4.—*The zone of Ammonites margaritatus* forms an important sub-division of the Lias formation; the Marlstone and Ironstone series of Yorkshire, and the Marlstone of the Midland Counties, being comprised in this and the following zone. In Gloucestershire the lower portion of the Marlstone consists of a series of yellowish, grey, and brown Sands, with thin bands of calcareous Limestone and ferruginous nodules; the upper of a

rock-bed of an impure Limestone, weathering brown, but blue in the interior. In the eastern part of the county it is highly ferruginous, and varies from 1 to 10 feet in thickness. The rock-bed forms the surface of several tabulated promontories, as at Gretton, Bredon, Churchdown, and Stinchcombe Hills; and which produce fine picturesque effects in the physiographical features of the western escarpment of the Cotteswold range.

5.—*The zone of Ammonites spinatus* forms the upper portion of the Marlstone in this district, and must be studied in connection therewith. At Leckhampton Hill the Marlstone series is 115 feet thick, and this is its estimated thickness in general around the western flanks of the Cotteswolds. It may be studied at Chipping Campden, Stow-on-the-Wold, and Ebrington Hill, which formed the northern promontory of the ancient coast line.

The Marlstone attains a great development in Yorkshire, and is fully exposed in the fine coast section near Staithes, and at Boulby Cliff; the grandeur of this section can only be realised by the pedestrian, who at ebb tide sets about its exploration, and examines at low water mark the vertical wall of rock, built up of so many courses or zones of the Lias beds. Many of the *Brachiopoda, Conchifera,* and *Gasteropoda,* from the underlying zones of the Middle Lias, lived in the ocean from whence the Marlstone was deposited; but besides these species other forms appear to be special to it, of which the following may be enumerated:—

Cephalopoda.

Ammonites margaritatus, *Montf.*
" Englehardti, *d'Orb.*
" Normanianus, *d'Orb.*
" fimbriatus, *Sow.*
Ammonites heterophyllus, *Quenst.*
" Amaltheus, *Schloth.*
" spinatus, *Brug.*
Belemnites breviformis, *Ziet.*

Echinodermata.

Hemipedina Jardinii, *Wr.*
Uraster carinatus, *Wr.*
Astropecten Hastingiæ, *Forb.*
Ophioderma Milleri, *Phil.*
Ophioderma Egertoni, *Brod.*
" carinata, *Wr.*
" tenuibrachiata, *Wr.*
Ophiolepis Murravii. *Forb.*

From an investigation of the fauna of the Middle Lias, it would appear that the Asteriadæ and Ophiuridæ are found in greater numbers in this division of the Lias than any others, a fact which, perhaps, may be accounted for on the supposition that these beds were littoral formations.

IV.—Toarcien ou Lias Supérieur.

When M. A. d'Orbigny substituted the phrase étage Toarcien for Upper Lias, he had in view the town of Thouars, *Toarcium* (Deux Sèvres,) in the vicinity of which he had seen one of the finest sections of this formation, and which he regarded as its best French type; and for that reason I shall give it in detail here.

Lias supérieur, Thouars, (Deux Sèvres)*

a Thick bed of very white argillaceous Limestone, containing Silex, with *Belemnites tripartitus.*

b Ferruginous Limestone and clay, with *Ammonites Jurensis,* Ziet. Alternate beds of blue clay and Limestone passing in the upper portion to a ferruginous clay, with *Ammonites insignis,* Schub., and *Belemnites irregularis.*

c Blue Clay with *Ammonites radians,* Schloth., *Am. variabilis,* d'Orb., *Belem. tripartitus.*

d Grey granular Limestone, with *Ammonites Thouarsensis,* d'Orb.

e Compact Limestone, without fossils.

f Thin band of ferruginous clay, with *Ammonites serpentinus,* Schloth.

g Thick bed of sandy Limestone, worked for building stone.

h Foliated saccharoid Limestone, with *Ammonites bifrons,* Brug.

i Thick bed of yellowish Limestone containing grains of Quartz, and forming the basement bed of the section.

In other departments of France the Toarcien attains a considerable development, as in Cher, Lozère, and Aveyron, where some of the sections have a thickness of nearly 500 feet.

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* Cours Elementaire de Paléontologie et Géologie Stratigraphique, tome II., p. 469.

In the Côte-d'Or, M. J. Martin recognises the following divisions :—

a Marnes jaunâtres à *Ammonites mucronatus*, d'Orb.
b " brunes à *Turbo subduplicatus*, d'Orb.
c " et calcaire marneux à *Ammonites complanatus*, Brug.
d Calcaire marneux et Marnes schisteuses à *Ammonites serpentinus*, Schloth.

M. Martin's cabinets contained a good collection of the Ammonites from these beds, among which I found *Am. bifrons, Am. serpentinus, Am. complanatus, Am. Holandrei*, representing the species found in beds *c* and *d;* and *Am. Thouarsensis, Am. radians, Am. insignis, Am. variabilis, Am. mucronatus*, the species belonging to beds *a* and *b*. Now this assemblage of Ammonites, and the stratigraphical distribution of the species in the beds, was of great interest to me, as I have long maintained, in papers and discussions in our Club, that if the Cotteswold Hill sections of Upper Lias were to be read correctly we must go to France to learn the true character of their Toarcien types. When examined palæontologically the Thouars section admits of a sub-division into two stages, the beds *a, b, c, d*, forming the upper, and the beds *e, f, g, h, i*, the lower zone; and this is precisely the condition which prevails in some of our most typical sections, as at Frocester Hill, (Fig. IV,) where I include all the marly, argillaceous, and arenaceous deposits found between the Marlstone and Inferior Oolite in the Upper Lias, and group these beds into two stages, each containing a special fauna. The lower is in general an argillaceous formation, with occasional and inconstant bands of calcareous nodules. The shells of this division are nearly all specifically distinct from those of the Marlstone on which it rests. The Ammonites of the group Capricorni, which formed so striking a feature in the life of the Middle Lias, are all absent from the Upper Lias beds, and in their stead have appeared great numbers of species belonging to the groups Falciferi and Planulati. In England one of the most dominant forms is *Ammonites communis*, Sow., from which I have derived the name of this zone.

The upper zone is mostly an arenaceous formation in Gloucestershire, and partly an argillaceous one in Yorkshire,

although it possesses some species in common with the zone of *Ammonites communis* below, and that of the *Ammonites Murchisonæ* of the Inferior Oolite above; still it contains a fauna sufficiently numerous in specific forms, that are special to it, to justify its separation from the lower zone. Most of the Ammonites found in the upper zone belong to the group FALCIFERI, and a few are common to both: the group LINEATI is represented by one remarkable species the *Am. Jurenses*, Ziet., which is special to the upper zone, and from whence its name is derived.

I.—*The zone of Ammonites communis* is seen in the escarpments of the Cotteswold Hills, and on the summits of Bredon, Alderton, Gretton, and Churchdown Hills, all outliers from the main chain; it consists of:—

1.—Brown marly clays of variable thickness according to the amount of erosion.

2.—Bands of nodular argillaceous Limestone from 6 to 8 inches in thickness, called the "Fish-bed," containing fine specimens of *Pachycormus*, *Leptolepis*, *Tetragonolepis*, &c., with the wings of Neuroptera, as *Libellula Brodiei*, and elytra of Coleoptera.

3.—Bluish mottled clay, more or less laminated, containing *Cerithium*, *Rostellaria*, *Trochus*, *Natica*, and of *Conchifera Arca*, *Leda*, *Posidonomya*.

4.—Brachiopoda bed, with *Leptæna*, *Spirifer*, *Terebratula*.

5.—Blue clay, with *Ammonites falcifer*, Sow., *Am. communis*, Sow., *Am. bifrons*, *Am. serpentinus*.

FAUNA OF THE AMMONITES COMMUNIS ZONE, GLOUCESTERSHIRE.

REPTILIA.

Teleosaurus.	Plesiosaurus.
Ichthyosaurus.	Pterodactylus (coracoid of).

FISHES.

Pachycormus latirostris, *Ag.*	Tetragonolepis discus, *Egerton.*
Leptolepis concentricus, *Egerton.*	Dapedius, *Sp.*

CRUSTACEA.

Colea, *Sp.*

Insecta.

Libellula Brodiei, *Buck.*
Agrion Buckmani, *Brod.*

Cephalopoda.

Belemnites tripartus, *Sow.*
" acuarius, *Schloth.*
" compressus, *Voltz.*
Nautilus latidorsatus, *d'Orb.*
Ammonites communis, *Sow.*
" serpentinus, *Reinecke.*
" bifrons, *Brug.*
Ammonites annulatus, *Sow.*
" falcifer, *Sow.*
" Lythensis, *Young & Bird.*
" Raquinianus, *d'Orb.*
" cornucopia, *Young & Bird.*
" heterophyllus, *Sow.*
Belemnosepia, ink-bag and osselets.

Gasteropoda.

Turbo capitaneus, *Münster.*
Trochus bisertus, *Phil.*
Rostellaria, *Sp.*
Pleurotomaria, subdecorata, *Münster.*
Cerithium.
Trochus, *Sp.*

Conchifera.

Astarte lurida, *Sow.*
Posidonomya Bronni, *Voltz.*
Nucula Hausmanni, *Roem.*
" ovum, *Sow.*
Lima, *Sp.*
Tancredia laviuscula, *Lyc.*
Placunopsis sparsicostatus, *Lyc.*
Inoceramus dubius, *Sow.*
Monotis substriata, *Goldf.*
Arca inœquivalvis, *Goldf.*
Cucullæa Münsteri, *Ziet.*

Brachiopoda.

Leptæna Moorei, *Dav.*
" liasina, *Bouch.*
" granulosa, *Dav.*
Thecidium rusticum, *Moore.*
" Bouchardii, *Dav.*
Lingula Beanii, *Phil.*
Spirifer Ilminsterensis, *Dav.*
" Münsteri, *Dav.*
Rhynchonella pygmœa, *Mor.*
Terbratula globulina, *Dav.*
" Lycetti, *Dav.*

Echinodermata.

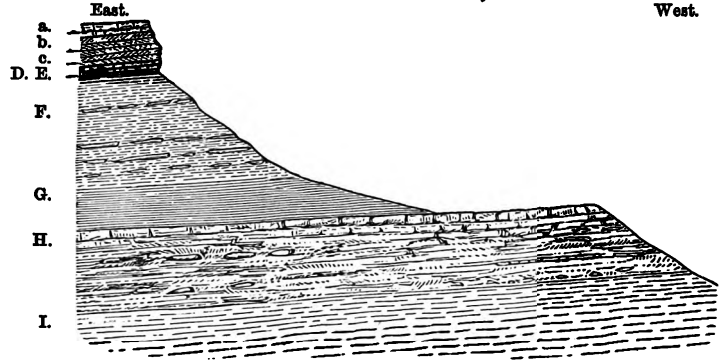
Acrosalenia crinifera, *Quenst.*
Pseudodiadema Moorei, *Wright.*
Pentacrinus, *Sp.*

II.—*The zone of Ammonites Jurensis* is well exposed in a few localities in Gloucestershire, as in the fine section at Frocester Hill, and in small exposures near Nailsworth and Brimscombe. It is seen likewise in Somerset and Dorset, and at Blue Wick, near Robin Hood's Bay, on the coast of Yorkshire. In all

these places it exhibits certain lithological characters, some of which are present in one locality and absent in another; but throughout the fauna is nearly identical.

The following section of Frocester Hill, near Stonehouse, affords the best type of the zone:—

FIG. IV. SECTION OF FROCESTER HILL, NEAR STONEHOUSE.



		ft.	
a, b, c.	Inferior Oolite	70	
D. E.	Calcareo-ferruginous sandstone, Cephalopoda bed, *Ammonites opalinus*...	6	Upper Lias Sands.
F.	Yellow and brown sands with inconstant and concretionary bands of calcareous sandstone = *Am. Jurensis zone*	150?	
G.	Upper Lias shale = *Am. communis zone* ...	80	
H.	Marlstone = *Am. margaritatus zone.* Hard calcareous sandstone resting on brown and grey sands, with bands and nodules of ferruginous sandstone...	150	
I.	Middle Lias shale = *Am. capricornus zone*...		

INFERIOR OOLITE.

		ft.	in.
a.	A fine grained oolitic Limestone, the upper beds obliquely bedded, the flaggy layers resting horizontally on inclined beds of Freestone	50	0
b.	A coarse cream coloured, gritty, crystalline Oolite, traversed at intervals by shelly layers; the rock consists chiefly of the *débris* of Shells, Echinidæ, and Crinoids, and glistens brilliantly when sunlit. It represents the "*calcaire à Entroques*" ...	10	0

		ft.	in.
c.	A hard, light brown, fine-grained, oolitic, sandy Limestone, containing fossils...	8	0

UPPER LIAS SANDS = JURENSIS ZONE.

D.	A coarse dark brown calcareo-siliceous rock, full of small dark grains of hydrate of iron. It contains an immense number of Ammonites, Nautili, and Belemnites	4	6
E.	A hard brown mudstone, with rows of irregular nodules, of micaceo-ferruginous sandstone ...	0	9
F.	Fine, brown, and yellowish micaceous sands, passing into greyish coloured micaceous sands, with inconstant bands of greyish calcareous sandstone, which are sometimes fossiliferous ...	150	0?

ZONE OF AMMONITES COMMUNIS.

G.	Blue clay and shale, with Ammonites	80	0

ZONE OF AMMONITES MARGARITATUS.

H.	Marlstone, a hard calcareous sandstone, resting on brown and grey sands, with bands and nodules of ferruginous sandstone	150	0

ZONE OF AMMONITES CAPRICORNUS.

I.	Dark shaly clays of the Middle Lias, forming the western slope of the hill		

In our comparison of the different zones of the Lias formation I have endeavoured to demonstrate the strict correlation of the different strata entering into its composition, and have shewn how closely the terrains in the Côte-d'Or agree with their equivalents in Gloucestershire. I now proceed to the examination of the great Jurassic series so well developed in France, Germany, and Switzerland; in this group of deposits, however, we shall find the study much more difficult, arising from a diversity of opinion among authors on the sub-division of the formations, and their true relation to the standard English type; the geologists of these different countries having formed opinions on the limits and development of certain subordinate

members of some Jurassic groups which do not always agree with the notions of English students on the same. It is but fair to remind the reader that Dr. WILLIAM SMITH* was the first geologist who described the English oolitic rocks, and prepared a classification of, and nomenclature for the same, and that his work has remained intact to our day. The labours of "the Father of English Geology" on these rocks having formed the foundation on which all subsequent students of Jurassic geology have built up their systems. By keeping these facts steadily in view, and taking Dr. SMITH's classification and limitation as the standard for comparison, we shall find that the apparent difference of opinion between English geologists and those of some foreign schools, consists more in a want of agreement about the definition and limitation of certain subordinate groups, rather than in any real difference about the rocks themselves.

OOLITHE INFÉRIEURE = INFERIOR OOLITE.

In the departments of the Côte-d'Or, Saone-et-Loire, and the Rhone, the Inferior Oolite, or Étage Bajocien, is well developed, and resembles in many respects the correlative divisions of this stage in the Cotteswold Hills. A very able "Mémoire sur le Groupe Oolitique Inférieur des environs de Mâcon Saone-et-Loire" was contributed by Mons. M. de FERRY to the "Mémoires de la Société Linnéene de Normandie."† From this we learn that l'étage Bajocien in that region rests upon the sands of the Upper Lias, and is overlaid by l'étage Bathonien, as shewn in the following diagram representing a generalized section of the Inferior Oolite in the Jura Maconnais. I am the more anxious to introduce this section to the knowledge of the members of the Cotteswold Club, as it shews how well the structure of their classic ground is repeated in the centre of France, and how truly the laws of stratigraphical geology are exemplified by a comparison of l'étage Bajocien, near Mâcon, with Cleeve Hill, near Cheltenham, (Fig. VI,) and Brown's Hill, near Stroud.

* Strata identified by organized Fossils: 1815.

† Tome xii: 1861.

Lithology.	Stages.	Leading Fossils.
Light coloured yellowish marls, readily becoming disintegrated.	*Étage Bathonien*, Calcaires marneux.	*Ammonites bullatus*, and *Ammonites arbustigerus.*
Brown ferruginous Oolite, with Shelly *débris.*	*Fuller's Earth?* Couche ferrugineuse.	Fragments of Shells.
Thin bedded Oolite, perforated by Lithodomi.	*Oolithe inférieure*, Lithophagous bank.	*Lithophaga Bajocensis.*
Ferruginous Limestone, with large Oolitic granules, and hydrate of iron.	Calcaires à Collyrites Ringens.	*Collyrites ringens* and *Ammonites Parkinsoni*, *Amm. Garantianus*, *Amm. subradiatus.*
Sandy marls, with Brachiopoda.	Calcaires à Terebratula Phillipsii.	*Terebratula Phillipsii*, *T. carinata*, *Ammonites Truellei*, *Amm. interruptus*, *A. Parkinsoni*, *Rhynchonella plicatella.*
Light coloured compact coralline Limestone, with calcareous spar.	Calcaire à Polypiers.	*Thecosmilia*, *Isastræa*, *Thamnastræa*, *Latomeandra* and other *Anthozoa*, with various species of *Polyzoa.*
Thick bedded, brownish compact saccharoid Limestone, traversed by very fossiliferous marly bands.	Calcaire à Entroques	*Ammonites Murchisonæ*, *Belemnites giganteus*, *Pholadomya fidicula*, *Trigonia striata*, *Myoconcha crassa*, *Hinnites tuberculosus*, *Terebratula plicata*, *T. carinata.*
Brown siliceous Limestone, enclosing large siliceous nodules (chailles) disposed in parallel beds.	Calcaire à Pecten personatus.	*Pecten personatus.*
Ferruginous sands, with Fucoids.	Couche à Fucoides.	*Ammonites opalinus*, Reinecke, = *Ammonites primordialis*, Schloth. *Chondrites scoparius.*

I shall now describe the several beds of the above section in detail:—

"L'étage Bajocien des environs de Mâcon repose toujours" says M. de FERRY "sur le Lias supérieur, ou plutôt sur la couche à *Fucoïdes* (*Chondrites scoparius* Thiolliére) avec Ammonites ramaniés (*Amm. primordialis*, Schloth.,) qui participant déjà aux caractères minéralogiques des calcaires à *Pecten personatus*, Goldf., base des formations de *l'oolithe inférieure.*" This bed is clearly the representative of the upper portion of the liassic sands of Frocester Hill, (see Fig. IV., p. 27,) and *Amm. primordialis*, Schloth., is certainly *Amm. opalinus*, Reinecke, which I have already shown to be one of the most characteristic fossils of this bed, (p. 27). Having determined the true place of the basement bed of the section, let us now proceed:—

Calcaires à Pecten personatus is a compact, sandy, yellowish Limestone, often tinted with blue and red stripes, and containing very large siliceous nodules, (chailles) disposed in beds parallel with the strata. The Lumachelles, with *Pecten personatus*, occupies the superior part; the lower portion is non-fossiliferous. The bed is about ten mètres in thickness; it is used for building, but is a bad material, as it readily breaks up when frozen.

Calcaire à Entroques is a thick bedded, compact, saccharoid Limestone, the colour of which varies from red (its usual tint) to white or blue. The whole is traversed by thin marly beds, full of Sponges, Polyzoa, and numerous fragments of the tests and spines of Echinides. The great abundance of the spathic *débris* of Crinoids, with plates and columns of Pentacrinites, contained therein has suggested the name by which it is generally known. It contains the following fossils:—

CEPHALOPODA.

Ammonites Murchisonæ, *Sow.*	Belemnites Berthandi, *Ferry.*
Belemnites giganteus, *Schloth.*	" curtus, *Berthauld.*

GASTEROPODA.

Pleurotomaria Ebrayana, *d'Orb.?* moulds supposed to belong to this sp.

CONCHIFERA.

Pholodomya fidicula, *Sow.*	Trigonia striata, *Sow.*
Ceromya, abducta, *d'Orb.*	Myoconcha crassa, *Sow.*
Astarte detrita, *Goldf.*	Mytilus Sowerbyanus, *d'Orb.*

Lima semi-circularis, *Goldf.*
" Berthandi, *Ferry.*
" Coquandi, *Ferry.*
Lima proboscidea, *Sow.*
Avicula digitata, *Desl.*
Trichites costatus, *Ferry.*
Pecten Silenus, *d'Orb.*
" personatus, *Goldf.*
" articulatus, *Goldf.*
Hinnites tuberculosus, *d'Orb.*
Ostrea subcrenata, *d'Orb.*
" sublobata, *Desh.*

Brachiopoda.

Rhynchonella quadriplicata, *d'Orb.*
" costata, *d'Orb.*
" Babeauana, *Desl.*
Terebratula Kleinii, *Lamk.*
Terebratula carinata, *Lamk.*
" plicata, *Buck.*
" globata, *Sow.*
Thecidea cristagalli, *Fer.*

Polyzoa.

Berenicea diluviana, *Lamx.*
" Archiaci, *Haime.*
Spiropora Deslongchampsii, *Ferry.*
" straminea, *Haime.*
Theonoa clathrata, *Lamx.*
Theonoa sulcata, *Ferry.*
Heteropora conifera, *Edw.*
" pustulosa, *Haime.*
" reticulata, *Haime.*
Neuropora Defrancei, *Haime.*

Echinodermata.

Cidaris Courteaudina, *Cott.*
Heterocidaris Trigeri, *Cott.*
" spinulosa, *Roem.*
Rabdocidaris maxima, *Desor.*
Pseudodiadema depressum, *Desor.*
Stomechinus serratus, *Desor.*
Pygaster Ferryi, *Cott.*
Galeropygus sulcatus, *Cott.*
" Ferryi, *Cott.*
Pentacrinus Bajocencis, *d'Orb.*
Stellaster Berthandi, *Wright.*
Nov. Sp.

Anthozoa et Spongia.

Trochocyathus Magnevillianus, *Edw. and Haime.*
Siphoneudea entrochorum, *Ferry.*
Discœlia glomerata, *Fer.*
Stenocœlia Ferryi, *E. de From.*
Monotheles Bajocencis, *Fer.*
Stellispongia Cotteaui, *Fer.*
Oculospongia Fromenteli, *Fer.*
Sparsispongia pustulosa, *Fer.*
Cupulochonia sub-helvelloides, *Fer.*
Actinofungia Matisconensis, *Fer.*

Calcaire à Polypiers forms vast reefs which are built upon the calcaire à Entroques and extend, north and south, the length of the massive of crystalline rocks that at the west limit the sedimentary terrains of the Mâconnais, and serve as their support.

This formation is well characterized and extended, but is not always found between the "calcaire à Entroques" and the "calcaires à *Terebratula Phillipsii*," for like all true reef-like structures it is an inconstant member of a stratified series. The following may be considered to be the leading fossils of this bed:—

Cephalopoda.

Ammonites Sauzei, *d'Orb.*

Conchifera.

Pinna inornata, *Fer.*
Lithophaga Waterkeyni, *Chap.*
Lima semicircularis, *Goldf.*
Pecten articulatus, *Goldf.*
Ostrea subcrenata, *d'Orb.*

Brachiopoda.

Rhynchonella quadriplicata, *d'Orb.*
" costata
Rhynchonella parvula, *Desl.*
Thecidea triangularis, *d'Orb.*

Polyzoa.

Stromatopora dichotomoides? *Haime.*
Berenicea Archiaci, *Haime.*
Heteropora pustulosa, *Haime.*

Echinodermata.

Cidaris Courtandina, *Cott.*
Pygaster semisulcatus, *Phill.*

Anthozoa.

Thecosmilia ramosa, *d'Orb.*
Cladophyllia Babeauana *Edw. & Haime.*
Favia Fromenteli, *Fer.*
Confusastræa ornata, *de From.*
" consobrina, *d'Orb.*
Isastræa Bernardana, *Edw. & Haime.*
" variabilis, *Fer.*
" Lamartine, *Fer.*
" multistriata, *Fer.*
Latomeandra decipiens, *Fer.*
" Flemingi, *Edw. & Haime.*
Thamnastræa crenulata, *Edw. & Haime.*
" Mettenses, *Edw. & Haime.*
" Defranceana, *Ed. & Haime.*
" major, *Fer.*
Centrastræa Mc. Coyi, *Edw. & Haime.*
Goniocora prima, *de From.*
Microsolena dendroidea, *Fer.*

Calcaires à Terebratula Phillipsii.—Fine sandy marls cover up the surface of the ancient coral reefs, and these are succeeded by calcareous beds composed of the *débris* of crinoids, the plates

and spines of Echinidæ, fragments of shells, and other triturated organic remains. The most abundant fossils are the following:—

Cephalopoda.

Belemnites giganteus, *Schloth.*
" unicanaliculatus, *Hartm.*
Nautilus lineatus, *Sow.*
Ammonites Truellei, *d'Orb.*
" niortensis, *d'Orb.*
Ammonites interruptus, *Brug.*
" Martinsii, *d'Orb.*
" Humphriesianus, *Sow.*
" Garantianus, *d'Orb.*
" Ebrayi, *Fer.*

Conchifera.

Panopæa Jurassi, *d'Orb.*
Pholadomya fidicula, *Sow.*
Ceromya abducta, *d'Orb.*
Pinna ampla, *Sow.*
Mytilus reniformis, *d'Orb.*
Avicula digitata, *Desl.*
Hinnites tuberculosus, *d'Orb.*
Ostrea acuminata, *Sow.*

Brachiopoda.

Rhynchonella plicatella, *Sow.*
" quadriplicata, *d'Orb.*
" Garantiana, *d'Orb.*
" phaseolina, *Desl.*
Rhynchonella angulata, *Sow.*
Terebratula emarginata, *Sow.*
" carinata, *Lamk.*
" Phillipsii, *Mor.*

Polyzoa.

Berenicia diluviana, *Lamx.*
" Archiaci, *Haime.*
Proboscina Jacquoti, *Haime.*

Echinodermata.

Rabdocidaris crassissima, *Cott.*
Pseudodiadema depressum, *Desor.*
Acrosalenia aqualis, *Cott.*

Spongia.

Lymnoreotheles mamillata, *d'Orb.*

Calcaires à Collyrites ringens.—This is in reality a continuation of the preceding, although separated from it by some sterile beds. Its mineralogical facies is however different, for it is charged with ferruginous Oolites similar to those of Bayeux, and is likewise very fossiliferous. It is the highest bed of the Inferior Oolite series, and is capped by a small bank pierced by lithophagous mollusca. The fossils collected from the ferruginous Oolite are:—

Cephalopoda.

Belemnites giganteus, *Schloth.*
" unicanaliculatus, *Hartm.*
Nautilus lineatus, *Sow.*
" clausus, *d'Orb.*
Ammonites subradiatus, *Sow.*
" Parkinsoni, *Sow.*
" Garantianus, *d'Orb.*
" Martinsii, *d'Orb.*
" Humphriesianus, *Sow.*

Gasteropoda.

Chemnitzia procera, *Desl.*
Natica Bajocencis, *d'Orb.*
Eucyclus ornatus, *Desl.*
Pleurotomaria granulata, *d'Orb.*
" dentata, *Desl.*
Melania scalariformis, *Desl.*
Cerithium Piettei, *Fer.*

Conchifera.

Panopæa Jurassi, *d'Orb.*
" calceiformis, *d'Orb.*
" sinistra, *d'Orb.*
Pholadomya fidicula, *Sow.*
" angustata,
" Murchisonæ, *Ag.* non Sow.
" Heraulti, *Ag.*
Goniomya v. scripta, *Sow.*
Anatina pinguis, *Ag.*
Ceromya abducta, *d'Orb.*
Astarte trigona, *Desh.*
Trigonia costata, *Sow.*
" signata, *Ag.*
" clathrata, *Ag.*
Isocardia Bajocensis, *d'Orb.*
Arca oblonga, *Chap. et Dewal.*
Pinna ampla, *Sow.*
Pinna cuneata, *Phil.*
Mytilus reniformis, *d'Orb.*
Lithophaga Bajocensis, *Fer.*
Lima gibbosa, *Sow.*
" subduplicata, *Chap. et Dewal.*
Limea duplicata, *Goldf.*
Avicula digitata, *Desl.*
Gervillia Zieteni, *d'Orb.*
Pecten articulatus, *Goldf.*
" Saturnus, *d'Orb.*
" Silenus, *d'Orb.*
" subvagans, *Fer.*
" Hedonia, *d'Orb.*
Hinnites tuberculosus, *d'Orb.*
Ostrea acuminata, *Sow.*
" subcrenata, *d'Orb.*
" Phædra, *d'Orb.*
" sulcifera, *Phil.*

Brachiopoda.

Rhynchonella plicatella, *Sow.*
" varians, *Desl.*
" sub-obsoleta, *Dav.*
" spinosa, *Sow.*
" quadriplicata, *d'Orb.*
Terebratula Ferryi, *Desl.*
Terebratula Phillipsii, *Mor.*
" Eudesi, *Oppel.*
" perovalis, *Sow.*
" carinata, *Lamb.*
" emarginata, *Sow.*
" sphæroidalis. *Sow.*

Polyzoa.

Berenicea diluviana, *Lamx.*
Berenicea microstoma, *Haime.*
Stromatopora Terquemi, *Haime.*

Echinodermata.

Collyrites ovalis, *Leske.*
" ringens, *Ag.*
Clypeus Plotii, *Klein.*
Holectypus hemisphœricus, *Desor.*
Hyboclypus gibberulus, *Ag.*
Pseudodiadema depressum, *Desor.*
Magnosia Forbesii, *Wright.*
Cylocrinus rugosus, *d'Orb.*

In the Côte-d'Or the Inferior Oolite is essentially the same as in the preceding section, and is divisible, in descending order according to M. Martin, into—

1. Calcaire fissiles à Gervillies = to the Calcaires à *Collyrites ringens.*
2. Calcaire Polypiers.
3. Calcaire à Entroques, à *Pecten Bajocencis.*
4. Calcaire marbre inferieur, à *Ammonites Murchisonæ*, et *Pecten personatus.*
5. Feuillet grezeux, à *Chondrites scoparius.*

M. L. Guillebot de Nerville in his Légende explicative* groups the Inferior Oolite, under the general name Calcaire à Entroques, and divides it thus:—

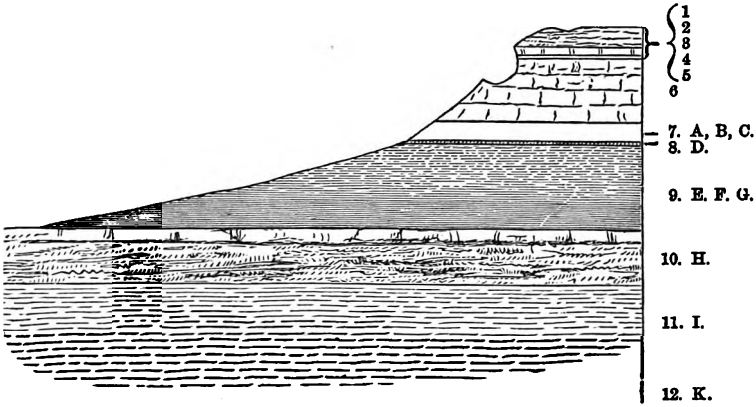
Calcaire à Entroques.
- Calcaire schistoïde silicieux.
- Bancs très riches en polypiers, quelques uns étant sub-oolithiques et s'enlevant par laves.
- Calcaire à Entroques proprement dit, compacte grisâtre ou bien ferrugineux et roussâtre.

Such being the case, I now proceed to correlate these divisions of the étage Bajocien of central France with the Inferior Oolites of Gloucestershire.

I have proposed to divide this formation in our district into three zones:—1st the Inferior, or zone of *Ammonites Murchisonæ*, in many cases resting upon the sands of Upper Lias, containing *Ammonites opalinus.* 2nd the Middle, or zone of *Ammonites Humphriesianus*, and 3rd the Upper, or zone of *Ammonites Parkinsoni* and *Collyrites ringens.* We shall see as we proceed how exactly these sub-divisions agree with those of M. Martin and M. de Ferry, already enumerated in detail.

* Légende explicative de la Carte Géologique du Département de la Côte-d'Or. 1853.

FIG. V. SECTION OF LECKHAMPTON HILL, NEAR CHELTENHAM.



1. Upper Trigonia bed.
2. Gryphæa grit.
3. Lower Trigonia bed.
4. Upper Flaggy Freestone.
5. Fimbria bed.
6. Lower thick-bedded Freestone.
7. A,B,C. Pea Grit and Ferruginous Oolite.
8. D. Lias Sands, with *Ammonites opalinus.*
9. E,F,G. Upper Lias Sands and Upper Lias Clay.
10. H. Marlstone, with *Ammonites spinatus.*
11. I. Middle Lias Clay, with *Ammonites capricornus.*

Leckhampton Hill, near Cheltenham, exhibits one of the best sections of the Inferior Oolite in Gloucestershire, and the following beds are well exposed and may be advantageously studied in that locality:—

No. 1.—Upper Trigonia Grit, consisting of thin-bedded brown oolitic ragstone, containing many fossils, chiefly as moulds and impressions of *Trigonia costata, T. formosa, T. signata, Rhynchonella spinosa, R. globata, Ammonites Parkinsoni, Amm. Martinsii, Clypeus Plotii.*

No. 2.—Gryphæa Grit is composed almost entirely of the valves of *Gryphæa sublobata,* imbedded in a fine hard calcareo-siliceous matrix. This ancient oyster-bank is found in many localities in the northern Cotteswolds, but is absent south of Rodborough Hill. Besides its dominant shell it contains *Pholadomya Heraulti, Terebratula Meriani, Gervillia tortuosa,* and *Hyboclypus caudatus.*

No. 3.—*Lower Trigonia bed*, light or brownish-coloured, thin bedded, oolitic ragstone, often iron-shot, containing in some localities many fossil shells in fine preservation. *Perna rugosa*, *Gervillia Hartmanni*, *Tancredia donaciformis*, *Lima gibbosa*, *Echinobrissus clunicularis*, *Pedina rotata*, *Holectypus depressus*, and *Magnotia Forbesii*, appear in this bank for the first time.

No. 4.—*Upper flaggy Freestone*, non-fossiliferous, 34 feet thick: it appears to be the equivalent of a bed at Cleeve Hill which contains a rich fauna.

No. 5.—*Fimbria bed*, or *Oolite Marl*, a cream-coloured mudstone resembling chalk marl, 8 feet thick. The dominant shell is *Terebratula fimbria;* it contains likewise *Terebratula carinata*, *Lucina Wrightii*, *Lima pontonis*, *Natica Leckhamptonenses*, *N. adducta*, *Mytilus pectinatus*, *Astarte elegans*, *Nerinæa*, *Chemnitzia*, and masses of coral *Thamnastræa Mettensis*, &c.

No. 6.—*Lower thick-bedded Freestone* a compact, light-coloured, fine-grained, oolitic limestone, extensively used for building purposes; it attains a thickness of 150 feet.

7, A.—*Pea Grit*, a brown, coarse, rubbly oolite, full of flattened concretions cemented together in a calcareous matrix. When the block weathers the concretions resemble flattened peas. It contains many fossils in fine preservation, as *Ammonites Murchisonæ*, *Pecten personatus*, *Pseudodiadema depressum*, *Pygaster semisulcatus*, *Galeropygus agariciformis*, *Stellaster obtusus*, *Acrosalenia Lycettii*, &c.

7, B.—A hard, cream-coloured, pisolitic limestone, composed of similar circular and flattened concretions.

7, C.—A coarse brown ferruginous rock, which readily breaks up and is reduced to mud by the frost, with few fossils. These three beds are upwards of 40 feet.

No. 8, D.—*Ammonite bed*, with *Ammonites opalinus* feebly represented here, but largely so in the southern Cotteswolds, as at Haresfield, Nailsworth, Frocester, &c.

No. 9, F.—*Upper Lias Sands*, very thin, about 20 feet; they thicken out in their course southwards, and attain a great thickness at Frocester Hill, Uley Bury, &c., resting on—

9, F.—Nodular band, with *Ammonites Walcotii*, *Am. communis*, 200 feet.

No. 9, G.—Blue shales of the Upper Lias, with *Ammonites radians, Am. serpentinus.*

No. 10, H.—*Marlstone*, with *Ammonites spinatus*, 115 feet.

No. 11, I.—*Clays of the Middle Lias*, forming the northern slope of the hill; they are well shewn in the brick-yards near the base, and contain *Ammonites capricornus, Am. Henleyi, Am. Ibex, Am. bipunctatus.*

No. 12, K.—*Jamesoni zone*, base of the Middle Lias.

1st.—Zone of Ammonites Murchisonæ.

Assuming that the "Feuillet grézeux à *Chondrites scoparius*, Thiollière," and other Fucoids, with the remains of *Ammonites opalinus*, is the equivalent of the Ammonite bed, capping the sands of the Upper Lias, we can have no difficulty in instituting a rigid comparison between the lower division of the Inferior Oolite, as given in M. de Ferry's section, and those exposed in the Cotteswold Hills.

The calcaire à Pecten personatus and calcaire à Entroques are, with us, represented by the Pea Grit and its underlying ferruginous bed, and in some localities, as at Frocester Hill, (Fig. IV., p. 27;) this zone is a light, cream-coloured, gritty, crystalline oolite, traversed at intervals by extremely crystalline shelly layers. A great portion of the rock is composed of the fragments and plates of Crinoidea, the plates and spines of Echinidæ, and comminuted fragments of the shells of Mollusca. This calcaire à Entroques at Frocester Hill has a most remarkable crystalline character, and, when lit by the sun's rays, glistens most brilliantly.

In the neighbourhood of Cheltenham (as at Cleeve, Dowdeswell, Leckhampton, Crickley, and Birdlip,) it is well developed; but in the southern Cotteswolds it becomes thinner, and at Dundry Hill, near Bristol, and in Somersetshire and Dorsetshire, a mere rudiment of this division is found. If we apply the Palæontological test to the physical correlations, we find additional evidence of their identity, for all the leading fossils collected by M. J. Martin, and enumerated in M. de Ferry's lists, are the characteristic species of our Murchisonæ zone. Thus we have:—

Cephalopoda.

Ammonites Murchisonæ, *Sow.*	Nautilus truncatus, *Sow.*
Belemnites giganteus, *Schloth.*	Belemnites spinatus, *Quenst.*

Conchifera.

Pholodomya fidicula, *Sow.*	Hinnites tuberculosus, *d'Orb.*
Ceromya concentrica, *Sow.*	Trichites nodosus, *Lyc.*
Trigonia striata, *Sow.*	Avicula digitata, *Desl.*
Pecten articulatus, *Goldf.*	Mytilus Sowerbyanus, *d'Orb.*
" proboscidea, *Sow.*	Myoconcha crassa, *Sow.*

Brachiopoda.

Terebratula simplex, *Buck.*	Rhynchonella Wrightii, *Davids.*
" plicata, *Buck.*	" decorata, *Davids.*
" carinata, *Lamk.*	" oolitica, *Davids.*

Echinodermata.

Cidaris Fowleri, *Wright.*	Pygaster semisulcatus, *Phill.*
Pseudodiadema depressum, *Desor.*	Galeropygus agariciformis, *Forb.*
Acrosalenia Lycetti, *Wright.*	Stellaster obtusus, *Wright.*
Stomechinus germinans, *Phill.*	Pentacrinus Desori, *Wr.* Nov. Sp.

My friend S. Sharp, Esq., F.G.S., discovered a magnificent Star-fish (*Stellaster Sharpii*, Wr.) in this zone, near Northampton; and Professor Berthand, of Mâcon, has found in the Calcaire à Entroques, near Mâcon, a nearly-allied species of the same genus. A mould of this Star-fish he has kindly communicated, and which I have described as *Stellaster Berthandi* in a note appended to Mr. Sharp's paper recently read before the Geological Society.

The *Calcaire à Polypiers*, composed of the ancient coral reefs in the Côte-d'Or and Saone-et-Loire, is likewise well represented in the Cotteswold Hills. Many years ago I discovered one of these reefs at Crickley Hill, near Cheltenham, and collected therefrom several species of corals appertaining thereto. At Brown's Hill, near Stroud, there is another fine section of the same reef. This coral bed, unfortunately, is largely used for road mending, and the size of the reef, which formed a complete bluff of coral rock, is now rapidly becoming smaller, and will soon disappear. It consists of large

masses of madreporic Limestone, embedded in a fine-grained cream-coloured mudstone. The corals are in a highly crystalline state, and their specific forms are determined with difficulty, unless the specimens have been long exposed to the air. The following section exhibits the true relation of this coral bed to the underlying and superincumbent strata.

SECTION OF CORAL REEFS IN THE LOWER DIVISION OF THE INFERIOR OOLITE, NEAR BROWN'S HILL, GLOUCESTERSHIRE.

LITHOLOGICAL CHARACTERS, and thickness.	BEDS.	ORGANIC REMAINS. LEADING FOSSILS.
	UPPER FREESTONES.	
Cream-coloured marl, with inconstant layers of mudstone, upper part passing into a loose friable freestone 20 feet thick.	Oolite Marl, Middle Coral bed.	*Thamnastræa, Isastræa, Axosmilia, Terebratula fimbria, T. carinata, T. maxillata, Rhynchonella Lycetti, Lucina Wrightii, Lima pontonis.*
Fine grained, thick bedded, oolitic Limestone, very white and emitting a metallic ring when struck with the hammer.	BUILDING FREESTONES.	Shelly fragments, indeterminable.
Coarse brown ferruginous Oolite.	LOWER RAGSTONES.	*Terebratula plicata.*
Nodular masses of Coralline Limestone embedded in a light-coloured mudstone, the corals highly crystalline.	LOWER CORAL REEF.	*Latomeandra, Thamnastræa, Isastræa, Axosmilia, Thecosmilia, Pecten Dewalquei, Trichites, Lucina Wrightii, Nerinæa.*
Brown ferruginous Oolite, pisolitic, the flattened concretions not much exposed.	PEA-GRIT.	*Lima sulcata, Hinnites abjectus, Ceromya Bajociana, Avicula complicata, Nerita costata, Trochotoma carinata Pygaster, Galeropygus, Cidaris, Acrosalenia, & Pseudodiadema.*

I think, therefore, there can be no doubt that the coral beds in the zone of *Ammonites Murchisonæ* in the Cotteswold Hills are the true equivalents of the Calcaire à Polypiers of the Côte-d'Or. Not only did the reef-building *Anthozoa* belong to the same genera, but several of them are the identical species. The corals in the lower reef are the following:—

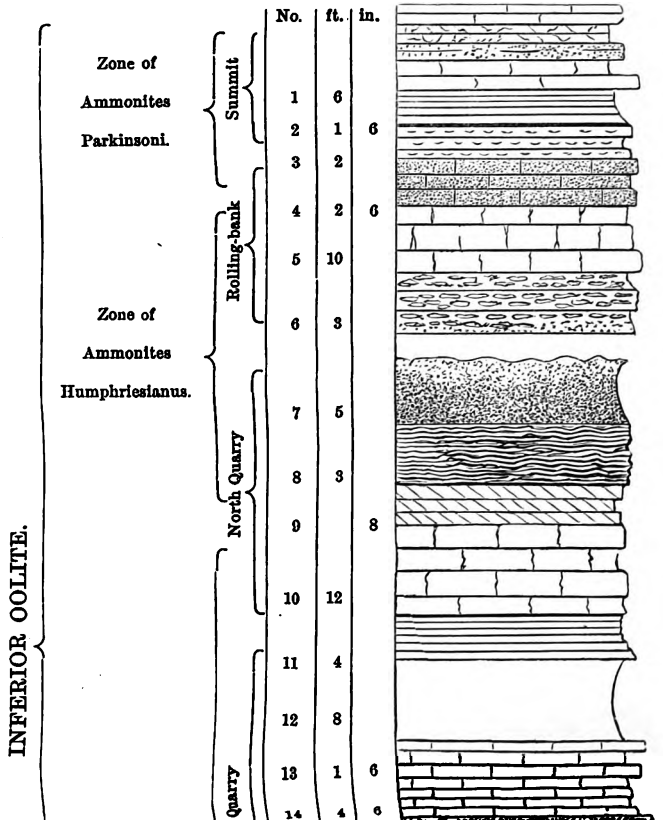
Montlivaltia Delabechii, *Ed. & Haime.*		Isastræa tenuistriata, *Ed. & Haime.*	
" tenuilamellosa	"	Thamnastræa Defranciana,	"
Axosmilia Wrightii	"	" Mettensis	"
Latomeandra Flemingii	"	" Mc Coyi	"

The middle coral bed is included in the oolite marl, which is interstratified between the lower and upper freestones. This bed at Frith, Leckhampton, Sheepscombe, Swift's Hill, and others, contains masses of *Thamnastræa, Isastræa,* and *Latomeandra,* and large numbers of *Terebratula fimbria, T. maxillata, T. carinata,* and *Rhynchonella Lycetti.* At Scar Hill, near Nailsworth, it is charged with *Nerinæa* and *Chemnitzia,* and forms a persistent stratum in the middle and northern Cotteswolds, extending across this portion of the plateau from the vales of Moreton and Bourton on the east, to the escarpment overlooking the Severn valley on the west, thinning out and disappearing in the southern part of the range.

The *Calcaires à Terebratula Phillipsii* are the representative of the middle division of the Inferior Oolite, or zone of *Ammonites Humphriesianus.* This zone forms, in some regions, a well marked sub-division, with a rich fauna special to it; in other localities it thins out or becomes blended with the higher beds. The best types of this zone are the ferruginous Oolites of Dundry, Yeovil, and Burton Bradstock, in England, and the lower half of the Oolithe ferrugineuse of Bayeux, in France. In the Cotteswold Hills it is well represented in the section at Cleeve Hill, a figure of which accompanied my paper on that subject, and which I have reproduced here to establish the correlation of the strata now under consideration.

This zone consists of the Brachiopoda, Roadstone, and Oyster beds, Nos. 4, 5, 6.

Fig. VI. SECTION OF THE INFERIOR OOLITE AT CLEEVE HILL.



Trigonia-Grit. Ammonites Parkinsoni, and Corals.

Thecosmilia gregaria, Thamnastræa, Isastræa, &c.

Gryphæa sublobata, Lima proboscidea, Trigonia costata.

Chemnitzia-Grit. Chemnitzia procera.

Rubbly Oolite.

Brachiopoda-Bed. Terebratula Phillipsii, in clusters.

Road-Stone. Ammonites Humphriesianus, Chemnitzia Scemanni.

Oyster-Bed. Ostrea flabelloides, Lima Etheridgii.

Not known.

Yellow and Brown Sands, with lenticular nodules of Sandstone.

Hard wavy Sandstone. Serpula socialis, abundant.

Marly Oolite.

Upper Freestone, with old Terebratula fimbria.

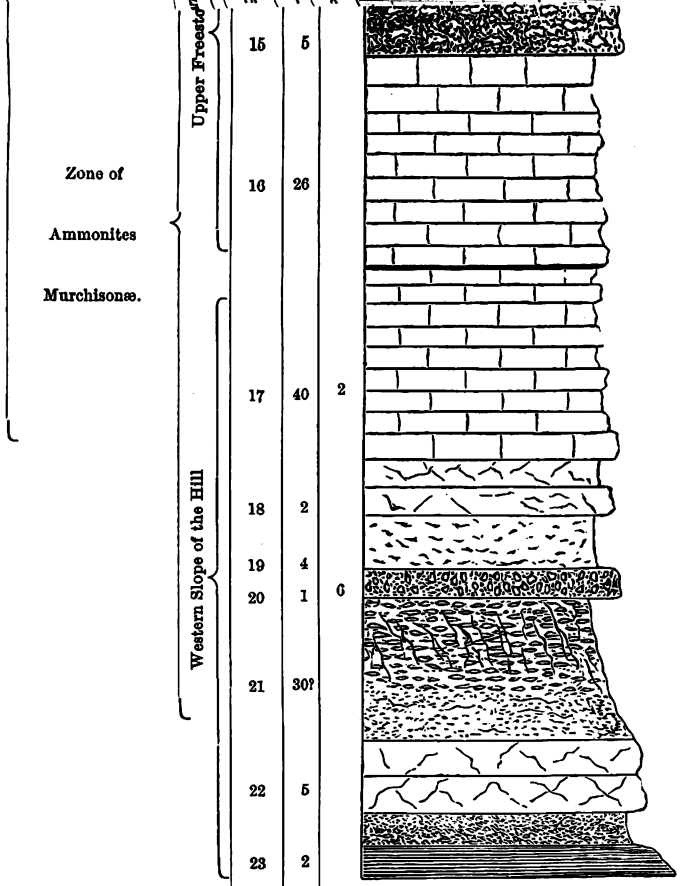
Thin flaggy Oolite.

Oolite Marl. Lucina Wrightii, Terebratula fimbria.

Thin hard bands of Limestone.

Thin beds of fine-grained Oolitic Limestone.

Hard rubbly Oolitic Marl in broken masses.



The Brachiopoda bed (No. 4 section) is a hard, compact, crystalline, buff-coloured Limestone, containing great numbers of *Terebratula Phillipsii*, Mor., which is the dominant fossil, with some specimens of—

Terebratula perovalis, *Sow.*
" carinata, *Lamk.*
" Buckmani, *David.*
Rhynchonella spinosa, *Scholth.*
" subtetrahedra, *David.*
" angulata, *Sow.*

The Roadstone (No. 5 section) is a hard, brown, ferruginous, oolitic Limestone, with a small assemblage of Mollusca; as—

CEPHALOPODA.

Ammonites Orbignianus, *Wright*
" Humphriesianus, *Sow.*
" Sowerbii, *Mill.*
Ammonites Brocchi, *Sow.*
" Braikenridgii, *Sow.*
Nautilus lineatus, *Sow.*

GASTEROPODA.

Chemnitzia Scemanni, *Oppel.*
" lineata, *Sow.*
Turbo lævigata, *Sow.*
Pleurotomaria fasciata, *Sow.*
" elongata, *Sow.*
" constricta, *Desl.*

CONCHIFERA.

Ostrea flabelloides, *Lamk.*
Hinnites tuberculosus, *Goldf.*
Lima proboscidea, *Sow.*
" Etheridgii, *Wright.*
" duplicata, *Sow.*
Trichites undulatus, *Lyc.*
Astarte excavata, *Sow.*
Cypricardia cordiformis, *Desh.*
Myacites calceiformis, *Sow.*
Gervillia consobrina, *d'Orb.*
Mytilus explanatus, *Mor.*
Pholadomya Heraulti, *Agass.*
Homomya crassiuscula, *Lyc.*
Myoconcha crassa, *Sow.*
Pteroperna plana, *Lyc.*
Trigonia costata, *Sow.*
" striata, *Sow.*
" decorata, *Agass.*
Modiola imbricata, *Sow.*
Pinna fissa, *Phil.*

The Oyster bed (No. 6 section) consists of a coarse, brown, ferruginous, sandy marl, with inconstant rocky bands, and contains the fossils in sandy seams; these are—

CONCHIFERA.

Ostrea flabelloides, *Lamk.*
" pyxiformis, *Wr.*
Pecten demissus, *Goldf.*
Lima proboscidea, *Sow.*
" Etheridgii, *Wr.*
Monotis tenuicostata, *Wr.*
Gresslya abducta, *Phil.*
Pleuromya tenuistriata, *Ag.*
Pholadomya Heraulti, *Ag.*
" ovulum, *Ag.*
" media, *Ag.*
" Dewalquei, *Lyc.*

ANNULOSA.

Serpula grandis, *Goldf.*	Serpula limax, *Goldf.*

ECHINODERMATA.

Clypeus Michelini, *Wr.*	Pseudodiadema depressum, *Deser.*
Stomechinus germinans, *Phil.*	Acrosalenia Lycetti, *Wright.*

In instituting a careful comparison between the Palæontology of this zone and that of the "*Calcaires à Terebratula Phillipsii,*" it is evident they are the true equivalents of each other; many of the fossil species are identical, and all present the general facies of the zone.

The "*Calcaires à Collyrites ringens,*" or "Calcaires fissiles à Gervillies," are represented in the counties of Gloucester, Somerset and Dorset by the zone of *Ammonites Parkinsoni*, (see section of Cleeve Hill, Fig. VI.) I am not aware that any Collyrites have been found in these strata in the Cotteswold Hills; but in Dorsetshire *Collyrites ringens* and *C. ovalis* are collected in considerable numbers, with *Ammonites Parkinsoni, Amm. Martinsii,* and other leading fossils of this stage, so that the true relative position of the beds is determined by these very characteristic urchins of the Inferior Oolite. This uppermost division, or zone of *Ammonites Parkinsoni*, consists of—1st, Upper Trigonia grit; 2nd, Gryphite grit; 3rd, Lower Trigonia grit; and 4th, Chemnitzia grit. It contains a very large assemblage of fossils, which are very characteristic of this stage; several of the species which appear for the first time in these beds extend throughout the Great Oolite, Forest Marble, and Cornbrash. I have already stated, in reference to this zone, that the fauna of the Lower Trigonia grit presents a remarkable contrast to that of the freestones on which it rests. Many species of Fish, Ammonites, Conchifera, Echinodermata, and Anthozoa, which now appear for the first time, lived through the subsequent stages and flourished in the Cornbrash, in which they all died out. It is a remarkable fact that the fauna of the Parkinsoni zone has many more palæontological characters in common with the Cornbrash than with the lower divisions of the Inferior Oolite.*

* *Quarterly Journal of the Geological Society.* Vol. xvi., p. 39.

The zone at Cleeve Hill contains several species of large corals, and in other localities coralline masses are found in the upper beds; in fact, this coral bed formed the upper reef of the Inferior Oolite, the lower reef resting on the Pea Grit, the middle on the Freestone, and the upper occupying the horizon of the Upper Trigonia Grit. The following section shews the true position of the upper coral bed:—

SECTION OF THE QUARRY AT WORGIN'S CORNER, NEAR SLAD VALLEY.

Masses of coralline Limestone, highly crystallized, 4 feet thick.	UPPER CORAL REEF.	*Thamnastræa, Isastræa, Thecosmilia, Magnotia Forbesii, Stomechinus intermedius, Trigonia costata, Latomeandra.*
Hard shelly Limestone, full of the shells of Brachiopoda, 5 feet thick.	BRACHIOPODA BED.	*Terebratula globata, Rhynchonella spinosa, Pholadomya fidicula, P. Heraulti, Gervillia, Ostrea, Trichites.*
Hard shelly sandy Oolite, full of the shells of Gryphæa, 6 feet thick.	GRYPHÆA BED.	*Gryphæa sublobata, Lima proboscidea, Gervillia tortuosa, Hybodypus caudatus.*

I have obtained the following fossils from this zone:—

CEPHALOPODA.

Belemnites canaliculatus, *Schloth.*
" giganteus, *Schloth.*
Nautilus lineatus, *Sow.*
" polygonalis, *Sow.*
" sinuatus, *Sow.*
Ammonites Parkinsoni, *Sow.*
" Garantianus, *d'Orb.*
" Martinsii, *d'Orb.*
" subradiatus, *Sow.*
" Truellei, *d'Orb.*

GASTEROPODA.

Chemnitzia procera, *Desl.*
Pleurotomaria fasciata, *Sow.*
Natica adducta, *Phil.*
Trochotoma carinata, *Lyc.*
Melania scaliformis, *Desl.*
Neritopsis Bajocencis, *d'Orb.*

CONCHIFERA.

Trigonia costata, *Sow.*
Pholadomya fidicula, *Sow.*
" Heraulti, *Agass.*
" ovulum, *Agass.*
Myopsis dilatata, *Phil.*
Goniomya angulifera, *Sow.*
Lima proboscidea, *Sow.*
" gibbosa, *Sow.*
" compressa, *Wr.*
Gervillia Hartmanni, *Goldf.*

Gervillia tortuosa, *Desl.*
Trichites undulatus, *Lyc.*
Opis cordiformis, *Lyc.*
Modiola Sowerbii, *d'Orb.*
Modiola bipartita, *Sow.*
" imbricata, *Sow.*
Ostrea acuminata, *Sow.*
Anatina pinguis, *Ag.*

ECHINODERMATA.

Stomechinus intermedius, *Agass.*
" bigranularis, *Lamk.*
Magnotia Forbesii, *Wr.*
Hyboclypus gibberulus, *Ag.*
" caudatus, *Wr.*
Holectypus hemisphericus, *Desor.*
" depressus, *Leske.*
Clypeus Plotii, *Leske.*
" Agassizii, *Wr.*
" altus, *Mc Coy.*
Collyrites ringens, *Desml.*
" ovalis, *Leske.*
Pedina rotata, *Wright.*
Pygurus Michelini, *Cott.*

ANTHOZOA.

Thecosmilia gregaria, *Edw. & Haime.*
Isastræa tenuistriata, " "
Thamnastræa Defranciana, "
Latomeandra Davidsonii, "
Montlivaltia Wrightii, " "
Montlivaltia Delabechii, *Ed. & Haime*
" trochoides, "
" Wrightii, "
Trococyathus Magnevillianus, *Mich.*
Discocyathus Eudesi, *Mich.*

BATHONIEN = GREAT OOLITE.

In the north of France l'étage Bathonien is composed of Terre à Foulon, Grande Oolithe, Calcaire de Caen, Oolithe de Caen, Calcaire de Ranville, and Calcaire à Polypiers. In the departments of the Côte-d'Or and Saone-et-Loire it admits of the following sub-division. M. J. MARTIN, for the Côte-d'Or, classifies the stages thus:—

Bathonien ou Grande Oolithe	Dalle nacrée et calcaire marneux inf. à *Prionastræa, Pentacrinus, Buvignieri,* et nombreux Bryozoaire. Calcaires en plaquettes à Bryozoaire. *Ostrea costata, Terebratula coarctata,* etc. Calcaires sub-oolithiques et marnes à *Terebratula, digona, obovata, ornithocephala et intermedia.* Calcaire gris sub-oolithique et marnes à *Terebratula cardium* et *hemispherica Apiocrinus Parkinsoni, Hemicidaris Luciensis, Heteropora pustulosa,* etc.
	Calcaires compactes ruiniformes à *Acrosalenia Lamarckii.*
	Oolithe blanche miliare à *Purpura glabra,* et *Purpura minax.*
	Calcaires marneux, à *Ammonites bullatus, Ammonites arbustigerus* et *Pholadomya Vezelayi.*
	Calcaires marneux inférieur à *Pholadomya bucardium.* Marnes à *Ostrea acuminata* et *Ammonites Parkinsoni.* Oolithe canabine à *Pholadomya gibbosa* et *Ostrea acuminata.*

In a paper,—"de l'étage Bathonien et de ses sub-divisions dans la Côte-d'Or,"* M. J. MARTIN has given many details, and a diagrammatic section of this stage, from which it appears that the Bathonien, considered stratigraphically, is divisible into six successive periods of deposits, separated from each other by an equal number "d'arrêts dans la sedimentation," and which constitute so many "*d'étages distincts.*" Studied in descending order we find beneath the "Callovien zone à *Ammonites athleta*" the following sub-divisions:—

1st,—The strata with *Pentacrinus Buvignieri*, d'Orb., and *Heteropora conifera*, Haime, of which the *débris* is found in all points of the massif, becoming extremely abundant at the last period of sedimentation.

2nd,—Beds with *Terebratula obovata*, Sow., and *Isastræa limitata*, Edw., which abound profusely in certain strata, and are sparse in others.

3rd,—Beds with *Terebratula cardium*, Sow., and *Apiocrinites Parkinsoni*, Schloth., these fossils characterizing a limited horizon comprised between the zone with *Terebratula obovata* above, and the Limestones with conchoidal fracture below.

4th,—The thick-bedded Limestones, with *Rhynchonella decorata*, d'Arch., which are considered by M. PAYEN to represent the Great Oolite, and by M. G. de NERVILLE and others as the Forest Marble.

5th,—The oolitic Limestones, containing *Pecten laminatus*, Sow., in abundance, a shell which is seldom found out of this zone.

6th,—The Marls, with *Ostrea acuminata*, Sow., which form the base of the stage. This small curved oyster is very abundant in the lower part of the zone and becomes rare in the upper.

In summing up his observations on these sub-divisions M. MARTIN observes,—"Il y a mieux, non-seulement chacune de ses périodes sédimentaires a vu se développer et pulluler durant sa formation une ou plusieurs espèces particulières, mais encore

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* Bulletin de la Soc. Geol. de France, 2e Série, t. xviii, p. 640: 1861.

ce développement et cette profusion numérique ont toujours exactement cöincidé avec le commencement des dépôts qui recèlent leurs dépouilles. Cela devait être en effet, car, ainsi qu'il arrive de nos jours au sein des mers actuelles, la faune de cette époque reculée, subissant dans son ensemble les influences de milieu, de profondeur, et de configuration orographique, n'a pu faire autrement que de se modifier à l'apparition de chacune des nouvelles phases de sédimentation. Telle espèce, trouvant à telle période des conditions de vie mieux appropriées à son genre d'organisation, s'y est extraordinairement multipliée, tandis que telle autre, par une raison inverse, y a chétivement vécu, ou n'y a même conservé que de rares représentants.

Contrairement à l'opinion reçue, il y a donc dans l'étage Bathonien de la Côte-d'Or six zones paléontologiques parfaitement distinctes. Ces zones, qui n'ont rien de l'arbitraire des sub-divisions admises jusqu'ici, sont naturelles et partout stratigraphiquement délimitées avec une admirable précision. Elles caractérisent chacune une des périodes de sédimentation que j'ai indiquées, et l'ensemble de leur faune suffit toujours à les faire reconnaître en l'absence de l'élément stratigraphique qui peut faire quelquefois défaut dans la pratique." *

Mons. M. H. de Ferry enumerates the following beds in l'étage Bathonien as developed in the environs of Mâcon, Saone-et-Loire, in descending order:—

L'étage Bathonien.
- Calcaires à Polypiers.
- " à Pholadomyes.
- " à Rhynchonelles.
- " à Échinodermes.
- " rugueux et perforés.
- " à Ammonites.

The Limestones at the base are marly and of a yellowish white colour, and contain *Amm. linguiferous*, *Amm. arbustigerus*, *Amm. planula*, and *Amm. bullatus*. They pass into the hard compact Limestones, having a rugose aspect, almost without fossils, and of which the superior part, when visible, presents

* Bulletin de la Soc. Geol. de France, 2e Série, t. xviii, p. 646: 1861.

perforated banks of a very characteristic aspect. This is the Great Oolite, properly so called, in the environs of Mâcon. It is replaced at Tournus by the *l'Oolithe blanche miliare*. This rock contains many fossils in the marly beds:—

Cephalopoda.

Ammonites bullatus, *d'Orb.*
" microstoma, *d'Orb.*
Ammonites discus, *Sow.*
" biflexuosus, *d'Orb.*

Conchifera.

Goniomya angulifera, *Sow.*
Pholadomya bellona, *d'Orb.*
Ceromya peregrina, *Ferry.*
Thracia viceliacensis, *d'Orb.*
Mytilus Sowerbyanus, *d'Orb.*
Lithophaga flabella, *Desl.*
Lima gibbosa, *Sow.*
" rigidula, *Phil.*
Lima hippia? *d'Orb.*
Avicula costata, *Smith.*
Gervillia acuta, *Sow.*
Pecten vagans, *Sow.*
" Luciensis *d'Orb.*
" rhetus, *d'Orb.*
" obscurus, *Sow.*
Plicatula cotyloides, *Desl.*

Brachiopoda.

Rhynchonella spinosa, *Sow.*
Terebratula globata, *Sow.*
Terebratula Buckmani, *Dav.*
Thecidea triangularis, *d'Orb.*

Polyzoa.

Stromatopora dichotoma, *Lamx.*
Berenicea diluviana. *Lamx.*
Disastopora Michelini, *Edwards.*
Spiropora cespitosa, *Lamx.*
" compressa, *Haime.*
Alecto dichotoma, *Lamx.*

Echinodermata.

Collyrites ovalis, *Leske.*
Echinobrissus clunicularis, *Llhwyd.*
Holectypus depressus, *Lamx.*
Hyboclypus gibberulus, *Agass.*
Pseudodiadema Wrightii, *Cotteau.*
" homostigma, *Ag.*

Collyrites ovalis is always very abundant, and with *Rhynchonella spinosa*, serves, according to M. de Ferry, to characterize this stratum in the environs of Mâcon.

The calcaires marneux à *Oursins* form a distinct bed persistent in its characters and fossils over an extended area.

The calcaires à *Rhynchonelles* are a marly bed, containing *Ostrea costata, Terebratula cardium, T. intermedia, Rhynchonella Boueti, Hemicidaris Luciensis, Acrosalenia spinosa*, etc.

The calcaires à *Pholadomyes* contain many of these molluscs embedded in fine marls in the normal position in which they lived,—as *Pholadomya Vezelayi, P. bucardium, Scalprum carinata? Ceromya striata, Anatina ægea, Terebratula coarctata, T. intermedia, Ammonites Bakeriæ, Amm. hecticus,* etc.; lastly, the series is terminated by compact Limestones, of which the upper part is perforated by lithophagous molluscs, covered by large oysters, and these beds serve to support the first ferruginous deposits of the *Callovien* stage.

M. G. de Nerville * classifies the Bathonien as follows:—

Groupe de la Grande Oolithe.

Cornbrash.—Calc. oolithique roux, à larges taches bleuâtres, à Oolithes miliaires bien égales. Cette assise renferme quatre à cinq petits bancs marneux.

Forest Marble.—Calc. compacte, par gros banc, de couleur blanc-grisâtre, à structure très-massive.

Grande Oolithe.—Calc. oolithique, blanc, à structure très-variable. *Terre à foulon et calcaire blanc jaunâtre marneux.*

Assise marneuse; à la base très-argileuse et même plastique, et passant à un calcaire jaunâtre marneux oolithique contenant beaucoup de fossiles, tels que *Ostrea acuminata.*

M. Ed. Piette has described the Étage Bathonien, in the department of the Meuse, as consisting of three groups which he thus characterizes:—

a.—*Calcaire marneux d'Etain* avec Rhynchonella concinna, Terebratula obovata, Ter. digona, Ter. cardium, Clypeus patella, Echinobrissus clunicularis. 15 mètres.

b.—*Marnes grises de Rouvres:* contenant, Pholadomya texta, Mytilus Sowerbyanus, Terebratula ornithocephala, Holectypus depressus, &c. 60 mètres.

c.—*Marnes et Calcaires à Ostrea acuminata de Montmédy* avec Ammonites Parkinsoni, Pholadomya Vezelayi, Ceromya rostrata, Lima gibbosa, Ostrea acuminata, Ostrea Marshii, Rhynchonella concinna, Rhyn. varians, &c. 80 mètres.

Group *a* appears to be synchronous with the Forest marble and Bradford clay; group *b* to represent the Fullers Earth of Box Tunnel, near Bath; and group *c*, in part at least, the zone of *Ammonites Parkinsoni*, Inferior Oolite, Gloucestershire.

* Légende explicative de Carte Géol. du Départ. de la Côte-d'Or.

A TABLE SHOWING THE CORRELATION OF THE SUB-DIVISIONS OF THE GREAT OOLITE GROUP IN FRANCE AND ENGLAND.

NORMANDY.	CÔTE-D'OR.	SAONE-ET-LOIRE.	ENGLAND.
Fossiles remaniés du Cornbrash.	*Pentacrinus Buvignieri* et *Heteropora conifera*	Calcaires compactes avec LITHOPHAGA ET OSTREA.	CORNBRASH.
Grande Oolithe supérieure ou Calcaire à Polypiers.	*Terebratula obovata* et *Isastræa limitata.*	Calcaires à POLYPIERS.	FOREST MARBLE.
			Bradford Clay.
	Terebratula cardium et *Apiocrinus Parkinsoni.*	Calcaires à RHYNCHONELLES.	FOREST MARBLE.
Grande Oolithe inférieure ou Oolithe miliare.	*Rhynchonella decorata.*	Calcaires à ÉCHINODERMES.	GREAT OOLITE.
			SHELLY FREESTONES.
	Pecten laminatus.	Calcaires rugueux et perforés.	STONESFIELD SLATE.
Calcaire marneux, Fullers Earth, Calcaire de Caen.	*Ostrea acuminata.*	Calcaires à AMMONITES, et COUCHE FERRUGINEUSE.	FULLERS EARTH.

In Gloucestershire the sub-divisions of the Great Oolite, which correspond to l'étage Bathonien, are arranged in stratigraphical order in the fourth column of the above table, and more fully explained in the following, in which, at the same time the most salient characters of the Lithology of the formations, and leading Fossils contained therein, are given.

Lithology.	Formations.	Leading Fossils.
A rubbly thin bedded Limestone, with uneven surface, and occasional partings of marl and clay, containing fossils.	Cornbrash.	*Terebratula intermedia, T. obovata, Avicula echinata, Pygaster Morrisii, Echinobrissus orbicularis.*
A coarse fissile false-bedded Oolite, with bands of marl or clay interstratified therewith.	Forest Marble.	*Ostrea rugosa, O. acuminata, O. costata.*
Yellow clay, locally developed.	*Bradford Clay.*	*Terebratula digona, T. coarctata, T. maxillata, Apiocrinus Parkinsoni.*
Siliceous sands, sandy Limestone, and oolitic freestone.	Forest Marble.	*Ostrea rugosa, O. acuminata, O. costata.*
Shelly oolitic Limestone; thin bedded rubbly Oolite; hard brown oolitic Limestone, full of shells and oysters.	Great Oolite.	*Purpuroidea, Pteroceras, Alaria, Cerithium, Chemnitzia, Nerinœa, Clypeus Mulleri, Echinobrissus Woodwardii.*
A hard sandy fissile Oolite, capable of being split into roofing slates.	Stonesfield Slate.	*Trigonia impressa, Gervillia acuta,* Bones of Mammals and Pterodactyles, Palates of Fishes.
Brown or blue clay, sometimes breaking up into conchoidal fragments.	Fullers Earth.	*Pholadomya Vezelayi, Ceromya plicata, Pygurus Michelini, Acrosalenia spinosa.*

Fullers Earth.—Is a thick argillaceous deposit, separating the Inferior from the Great Oolite formations, and consisting of regularly bedded, blue, brown, and yellowish clay, shales and marls, with inconstant bands of nodular Limestone; at Box Tunnel, near Bath, it is about 150 feet thick, and in Sapperton Tunnel, Stroud Valley, 70 feet; near Amberley church there is a fine exposure of this rock, full of the small curved oyster, *Ostrea acuminata,* so abundant in this formation. At Symonds Hall Hill, the Fullers Earth is well seen in *situ.*

Fig. VII. Diagram shewing the Strata between Symonds Hall Hill and Wotton-under-Edge.

I am indebted to my old friend Professor Ramsay for the accompanying section, which he kindly made for me some years ago. The hill is capped by the Great Oolite, (7;) beneath this is the Fullers Earth, (6,) which here is 128 feet thick, and overlies the Limestone of the Inferior Oolite, (5,) which is 80 feet thick, resting on the hard sandy bands of the Upper Lias, (4,) with specks of the silicate of iron, containing Ammonites and Belemnites; to these succeed the soft sands of the Upper Lias, (4,) with lenticular concretions, having a thickness of 123 feet; these rest on the Upper Lias shale, (3,) and the latter on the Marlstone, (2,) which has a thickness of nearly 200 feet; the middle and Lower Lias shales and Limestones, (1,) stretching westward towards the vale.

Stonesfield Slate.—So well exposed on Sevenhampton Common, Eyeford, and Naunton, consists of sandy flags, slates, and blue Limestones which are often fissile and capable of being split into slates for roofing, disclosing in the sections *Trigonia impressa, Ostrea acuminata,* and *Avicula ovata, Lima cardiiformis, Pecten lens, P. vagans,* with very beautiful specimens of Star-fishes, *Astropecten Cotteswoldiæ,* and *Astropecten Wittsii.* The unique *Solaster Moretonis* was extracted by the workmen from a bed of rock in the Windrush Quarry, Gloucestershire, equivalent in age with the Stonesfield slate of the northern Cotteswolds.

Alternating with this marine fauna are certain shales which have been deposited in an estuary, for in them we find the remains of plants, the elytra of Coleoptera, and other parts of insects, belonging to the families Blapsidæ, Buprestidæ, Coccinellidæ, Pimpelliidæ, and Prioniidæ.

Many bones of *Pterodactyles*, teeth of *Megalosaurus*, and the palates of fishes are found in the slates at Eyeford. The fine state of preservation in which these fragile fossils lie, affords sufficient proof of the tranquil conditions that prevailed in the estuary where they were entombed. The Stonesfield slate is well exposed at Througham, two miles north of Bisley.

Great Oolite.—Many fine sections of this formation are seen in the county of Gloucester, as in the open cutting at Sapperton Tunnel, and Tetbury Road, Great Western Railway, Sherborne Park, Windrush Quarries, &c. The large quarries on Minchinhampton Common, that have been worked from ancient times, fully expose several of the strata of this formation; the lowest bed of the Great Quarry immediately overlies the Fullers Earth, and the vertical wall of rock, about 36 feet in height, admits of the following sub-divisions according to my friend, Dr. Lycett.*

A.—Planking consisting of several beds of a coarse shelly Limestone, the oolitic grains being sparsely distributed therein. Some of the beds separate into thin horizontal divisions or planks. *Purpuroidea*, *Pteroperna*, *Macrodon*, and other large shells are found here.

B.—Soft, pale, thin-bedded, rubbly Oolite, with occasional sandy partings, containing few shells and crystallized carbonate of lime, and therefore readily disintegrating on exposure to frost.

C.—Soft, yellowish, shelly Oolite, the testacea being arranged in layers which assume every kind of inclination within a short distance, and having numerous perforations bored by *Lithodomi*.

D.—Weatherstone in two or three beds, a brownish oolitic Limestone full of shells, crystalline carbonate of lime, and shelly *débris*, with oyster shells at the base.

E.—Basement bed consisting of a coarse, grey, or brown, and blue hard argillaceous Limestone, full of small oysters, *Ostrea acuminata*.

Upwards of 300 species of Mollusca have been collected from the Oolite in this locality, the greater number of these are found both in the lower and upper beds, and others abound at

* The Cotteswold Hills Hand-book, p. 93.

particular horizions. *Cephalopoda* are rare, but *Gasteropoda*, and *Conchifera* very numerous, the shells forming seams in the rock, which are often crowded to excess. In the following lists I have catalogued only the most abundant forms from the shelly Limestones :—

Gasteropoda.

Alaria armata, *Mor. & Lyc.*
" hamulus, *Desl.*
" paradoxa, *Desl.*
" trifida, *Phil.*
Cylindrites acutus, *Sow.*
" altus, *Mor. & Lyc.*
" cuspidatus, *Sow.*
Eulima communis, *Mor. & Lyc.*
Monodonta formosa, *Mor. & Lyc.*
" Lyellii, *d'Arch.*
" Labadyei, *d'Arch.*
Natica Michelini, *d'Arch.*
Nerinæa Voltzii, *Desl.*
" funiculus, *Desl.*
" Dufrenoyi, *d'Arch.*
Nerita rugosa, *Mor. & Lyc.*
" cancellata, *Mor. & Lyc.*
" hemisphærica, *Rœm.*
" minuta, *Sow.*
Ceritella acuta, *Mor. & Lyc.*
" unilineata, *Sow.*
Cerithium quadricinctum, *Goldf.*
Delphinula alta, *Mor. & Lyc.*
Patella Aubentonensis, *d'Arch.*
" inornata, *Mor. & Lyc.*
" rugosa, *Sow.*
Phasianella elegans, *Sow.*
" Leymerieri, *d'Arch.*
" conica, *Mor. & Lyc.*
Pileolus lœvis, *Sow.*
" plicatus, *Sow.*
Purpuroidea glabra, *Mor. & Lyc.*
" Morrisii, *Buvig.*
" nodulata, *Sow.*
Trochotoma obtusa, *Mor. & Lyc.*
" conuloides, *Desl.*
Trochus obsoletus, *Rœm.*
" spiratus, *d'Arch.*

Conchifera.

Arca æmula, *Phil.*
" Prattii, *Mor. and Lyc.*
" cucullata, *Roem.*
" Hirsonensis, *d'Arch.*
Astarte excavata, *Sow.*
" excentrica, *Mor. and Lyc.*
" rhomboidalis, *Phil.*
" squamula, *d'Arch.*
Avicula echinata, *Sow.*
" costatula, *Desl.*
Cardium Stricklandi, *Mor. and Lyc.*
Corbis Madridi, *d'Arch.*
" Bathonica, *Mor. and Lyc.*
Corbula involuta, *Goldf.*
Cypricardia cordiformis, *Desh.*
Cyprina Loweana, *Mor. and Lyc.*
" nuciformis, *Mor. and Lyc.*
" trapeziformis, *Goldf.*
Gervillia monotis, *Desl.*
" ovata, *Sow.*
" socialis, *Mor. and Lyc.*
Hinnites velatus, *Goldf.*
Lima cardiiformis, *Sow.*
" duplicata, *Sow.*
" impressa, *Mor. and Lyc.*
" ovalis, *Sow.*
Limopsis oolitica, *Desl.*
Lithodomus inclusus, *Desl.*

Lucina despecta, *Phil.*
" Bellona, *Mor. and Lyc.*
" rotundata, *Roem.*
Mytilus furcatus, *Goldf.*
" sublævis, *Sow.*
" imbricata, *Sow.*
Nucula variabilis, *Sow.*
Opis lunulatus, *Sow.*
" similis, *Sow.*
Ostrea acuminata, *Sow.*
" gregarea, *Sow.*
" rugulosa, *Mor. and Lyc.*
Pecten clathratus, *Roem.*
" lens, *Sow.*
" vagans, *Sow.*
Placunopsis Jurensis, *Roem.*
" socialis, *Mor. and Lyc.*
Tancredia axiniformis, *Phil.*
" brevis, *Lyc.*
" planata, *Lyc.*
Trigonia costata,, *Sow.*
" Goldfussii, *Münst.*
" Moretonis, *Mor. and Lyc.*

Brachiopoda.

Terebratula perovalis, *Sow.*
Rhynchonella concinna, *Sow.*

Echinodermata.

Acrosalenia hemicidaroides, *Wr.*
" spinosa, *Ag.*
Hemicidaris Luciensis, *d'Orb.*
Pseudodiadema depressum, *Desor.*
Nucleolites clunicularis, *Llhwyd.*
Hyboclypus caudatus, *Wr.*
Pygaster semisulcatus, *Phil.*
Clypeus Mülleri, *Wr.*

Dr. Lycett,* whose critical knowledge of the specific forms of this district is unsurpassed, states that the Great Oolite of Minchinhampton has produced:—

	Species.			Species.
Gasteropoda ...	165	of which are found in the Inferior Oolite	Gasteropoda ...	20
Conchifera ...	171		Conchifera ...	45
	336			65

So that twenty-two per cent. are common to both formations in the Cotteswolds generally. The 336 species represent eighty genera of Gasteropoda and Conchifera, and of this number only nine genera occur, which are not found also in the Inferior Oolite: we may say, therefore, in general terms that of the fossil Mollusca collected from the shelly beds of the Great Oolite at Minchinhampton, seventy-eight per centum are proper to that formation, and twenty-two, species common to it and the Inferior Oolite.

* The Cotteswold Hills Hand-book, p. 3.

Bradford Clay.—In the Minchinhampton district the soft upper beds of the Great Oolite are succeeded by a bed of very hard, white, or cream-coloured Limestone, eagerly sought out for the kiln, and raised for that purpose; this rock is remarkable for its hardness and the closeness of its texture. It is well seen in many places, as at Bussage, Cowcombe, near Cirencester, and in the open cutting of the Sapperton Tunnel; at Bussage and Cowcombe it contains a great many remarkable shells, the tests of which are preserved in the form of highly crystallized carbonate of lime, such as *Pachyrisma grande, Natica Michelini, N. grandis,* and *Purpura nodulata;* the hard white Limestone is considered as the uppermost member of the Great Oolite in this district. At the Tetbury Road Station of the Great Western Railway, a bed of yellowish clay is exposed, containing *Terebratula digona, T. orbicularis, T. maxillata, T. coarctata, T. cardium, Avicula echinata, Pecten hemicostatus, Cidaris Bradfordensis, Pseudodiadema homostigma.* These forms characterize the clay above the Great Oolite in Wiltshire, known as the Bradford clay; this rock is not a persistent stratum, but is frequently wanting, as near Bradford, where the Forest marble being visible is seen resting on the Great Oolite at Pickwick and Wormwood.* The Bradford clay ought not to be considered as an independant formation, separating the Great Oolite from the Forest marble, but rather as one of the inconstant argillaceous bands of the latter formation; this clay, above the upper Oolite, sometimes attains a thickness of from 40 to 60 feet at Farleigh; in other localities it is much thinner. Near Bradford, Wilts, it contained a great number of fine specimens of Crinoids, *Apiocrinus Parkinsoni,* and numerous Brachiopoda, *Terebratula digona, T. coarctata, T. cardium, &c.* When the Bradford clay is wanting, it is almost impossible to distinguish the upper beds of the Great Oolite, from those of the next formation.

Forest Marble.—This formation consists of a coarse fissile Oolite full of false bedding, and having interstratified therewith

* *Lonsdale,* the Oolitic district of Bath, Trans. Geol. Soc., 2nd Series. Vol. iii., p. 255.

bluish marls and shales, or bands of clay in yellow siliceous sands, containing large spherical blocks of sandy Limestone: a capital section through the Forest marble and Great Oolite at Crickley-Barrow, shows the lithological characters of these two formations:—

Forest Marble.	Shelly Oolite formed of organic *débris*, obliquely laminated in different directions.	Small oysters, Pectens, &c., in great profusion on the slabs.
Great Oolite.	Hard, white, sandy Limestone, thickly and regularly bedded.	Not very fossiliferous. Terebratula maxillata, numerous.

The organic remains in the Forest marble are abundant in individuals, but not numerous in species, and in this respect the formation presents a striking difference to the Hampton freestones; many of them are specifically identical with those of the Great Oolite, there being only a small minority which are not found in the basement beds of the Minchinhampton quarries.

Cornbrash.—Is a coarse thin-bedded Limestone, having bands of brown and grey marls alternating, and interstratified therewith. Near Chippenham, Wilts, it is well exposed and very fossiliferous, containing numerous *Brachiopoda* and *Anatinidæ*. I have collected all the fossils in the subjoined list from the Wiltshire Cornbrash:—

Conchifera.

Gresslya peregrina, *Phil.*	Avicula echinata, *Sow.*
Myacites securiformis, *Phil.*	Trigonia costata, *Sow.*
Homomya gibbosa, *Sow.*	Astarte excavata, *Sow.*
Myacites calceiformis, *Phil.*	Goniomya litterata, *Phil.*
Ceromya concentrica, *Sow.*	Gervillia crassicosta, *Mor. and Lyc.*
Pholadomya Heraulti, *Ag.*	Modiola bipartita, *Sow.*
Lima duplicata, *Sow.*	Avicula costata, *Sow.*
" cardiiformis, *Sow.*	Pecten lens, *Sow.*
" pecteniformis, *Schloth.*	" vagans, *Sow.*
Modiola Sowerbii, *d'Orb.*	" rigidus, *Sow.*

Brachiopoda.

Terebratula intermedia, *Sow.*	Terebratula obovata, *Sow.*
" maxillata, *Sow.*	Rhynchonella concinna, *Sow.*

ECHINODERMATA.

Clypeus Plotii, *Leske.*	Acrosalenia hemicidaroides, *Wright.*
Nucleolites clunicularis, *Llhywd.*	" spinosa, *Agass.*
" orbicularis, *Phil.*	Pseudodiadema depressum, *Desor.*
Holectypus depressus, *Lamk.*	Pygurus Michelini, *Cotteau.*

Nearly all the Conchifera in the above list are likewise found in the zone of *Ammonites Parkinsoni,* Inferior Oolite. They lived in the seas that deposited the Minchinhampton series, and passed into those of the Cornbrash. Several of the Brachiopoda are special to this formation, others have a wider range. All the Echinodermata made their appearance in the Parkinsoni zone of the Inferior Oolite, where they attained their most perfect development; some of the species became dwarfed in the Great Oolite seas, and again assumed their pristine condition in the Cornbrash; indeed, it would appear that the Parkinsoni zone of the Inferior Oolite and the Cornbrash had many conditions in common, as proved by the life-vigour of the same forms in both.

When studied, as a whole, we find very few species characteristic of the Great Oolite group, special to any of its sub-divisions, although the same species is found to assume certain varieties in the different beds in which it recurs; an evidence that the several members of the group were deposited under many changes of physical conditions.

The two sub-divisions of this series that have hitherto given rise to most discussion in our attempts to correlate these strata are the *Fullers Earth* and the *Bradford Clay,* which exhibit considerable variety as to presence, development, and fossils. These two deposits more properly belong to that class of beds which the Germans would call "einlager," or beds inconstantly interposed between others that are more permanent members of a group. In this sense these two clay beds would be "einlagers" of the upper division of the Lower Oolites. Thus *Ostrea acuminata, Ceromya plicata, Avicula echinata, Pholadomya Heraulti, Pecten vagans,* and *Pygurus Michelini,* found in the *Fullers Earth,* occur in all the other beds of the group. The *Stonesfield Slate* is not a constant member of the series, and

when present is often found to contain a special flora; jaws of Mammalia, belonging to the genera *Amphitherium* and *Phascolotherium*, and the bones and teeth of *Megalosaurus* and *Pterodactyles*, which were entombed in these slates, are likewise special to them; but the Mollusca and Echinidæ of the same beds are found in other members of the series. The *Great Oolite of Minchinhampton* contains a very rich fauna, many of the Molluscs extending through all the sub-divisions of the group, whilst others, as *Purpuroidea*, *Alaria*, *Pterocera*, *Pachyrisma*, &c., are special to it, and constitute exceptions to the general facies of the fauna which has a much more extended range through other formations. The *Bradford Clay*, with *Apiocrinus Parkinsoni*, *Terebratula digona*, *T. corarcta*, and *T. cardium*, is not always present; and even when present exhibits many phases of development, and appears to belong to one of the inlying argillaceous bands of the *Forest Marble*. This formation forms an important division of the group, and, although very fossiliferous, contains no species of mollusc, urchin, or coral, which can be said to characterize it, although the thinness of its beds and the amount of false bedding and oblique lamination its sections disclose, show that it was formed under very different conditions to the regular strata of thick-bedded Limestones, which preceded and followed this remarkably disturbed deposit. The *Cornbrash*, especially the development of this formation in Yorkshire, contains some species that as yet appear to be special to it; an examination of the list I have given of the fossils from the Cornbrash of the Yorkshire coast, contained in the cabinet of my old worthy friend John Leckenby, Esq., F.G.S.,* by whose assiduous collecting habits they have been accumulated, and by whose liberality they were communicated for publication, will satisfy the student of this fact. This list is the more important, as in making it out I had the advantage of my friend's most accurate critical knowledge in guiding me in determining the true character of all the species.

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* *Quarterly Journal of the Geological Society.* Vol. xvi., p. 27: 1860.

Oxfordien = Oxford Clay.

Oxfordien or Oxford Clay.

I.—*Marnes supérieures* à grandes *Ammonites plicatilis*, et *Pholodomya parcicosta*.

II.—*Calcaires pseudo-lithographiques* à *Pholadomya ampla*, *Ammonites Babeanus*.

III.—*Marnes Oxfordiennes inférieures* grises, et calcaires gris cendrés à Spongiares et *Ammonites biplex*, and *Amm. plicatilis*.

IV.—*Marnes ferrugineuses oolithiques* à *Ammonites cordatus*, *Amm. perarmatus*, *Amm. oculatus*.

V.—*Marnes Calloviennes* et calcaires marneux à *Ammonites athleta*, *Amm. lunula*, *Amm. Duncani*, *Pholadomya lineata*, *Poladomya decussata*, *Collyrites elliptica*.

I.—The marnes calloviennes et calcaires marneux, which represent the Kelloway rock at the base of the Middle Oolites of England, consist of marls and limestones of variable hardness and with an earthy fracture. The terrain has a rusty yellowish colour above, and is bluish, greyish, or blackish below, having a large quantity of oolitic iron disseminated throughout. Judging from the number of specimens in M. Martin's cabinets it must be a highly fossiliferous formation. The following is a list of the more common forms noted by me :—

Cephalopoda.

Ammonites calloviensis, *Sow.*
" macrocephalus, *Schloth.*
" anceps, *Reinecke.*
" Bakeriæ, *Sow.*
" modiolaris, *Llwhyd.*
Belemnites hastatus, *Blain.*
Nautilus hexagonus, *Sow.*
Ammonites Duncani, *Sow.*
" lunula, *Ziet.*
" athleta, *Phil.*
" coronatus, *Brug.*
" bipartitus, *Ziet.*

Conchifera.

Gryphæa dilatata, *Sow.*
Ostrea Marshii, *Sow.*
" gregarea, *Sow.*
Pecten fibrosus, *Sow.*
" vagans, *Sow.*
Isocardia tenera, *Phil.*

Brachiopoda.

Terebratula bicanaliculata, *d'Orb.*
" lagenalis, *Schloth.*
" Smithii, *Oppel.*
Terebratula calloviensis, *d'Orb.*
" pala, *von Buch.*
Rhynchonella Royeriana, *d'Orb.*

ECHINODERMATA.

Collyrites elliptica, *Ag.*	Pseudodiadema complanatum, *Ag.*
Pygurus Marmonti, *Ag.*	" superbum, *Ag.*
Holectypus striatus, *d'Orb.*	" calloviensis, *d'Orb.*
Polycyphus textilis, *Ag.*	Millericrinus Beaumontianus, *o'Orb.*
Pedina Gervillii, *Ag.*	" nodotianus, *d'Orb.*
Stomechinus calloviensis, *Cott.*	" sub-echinatus, *d'Orb.*
Acrosalenia radians, *Desor.*	" aculeatus, *d'Orb.*

II.—The marnes ferrugineuses oolithiques, à *Ammonites cordatus, Am. perarmatus, Am. oculatus,* &c., appear to correspond with some of the inferior beds in our lower calcareous grit.

III.—The marnes grises et calcaires gris cendrés avec couches de Spongiaires, consist of calcareous nodules in a similar matrix a few feet thick, containing many *Anthozoa* and *Spongia* of large dimensions. The fossils are very numerous and well preserved, they consist of *Ceriopora striata,* Goldf., *C. angulosa,* Goldf., *Scyphia obliqua,* Goldf., *S. pertusa,* Goldf., *S. paradoxa,* Münst., *Asterias scutata,* Münst., *Cidaris Blumenbachii,* Münst., *C. marginatus,* Goldf., *C. coronatus,* Goldf., *Trigonia clavellata,* Sow., *Pecten subtextorius,* Münst., *Terebratula bucculenta,* Sow., *T. pectunculus,* Schloth., *T. tetragona,* Roem., *Ammonites canaliculatus,* Münst., *Am. Henrici,* d'Orb., *Am. Eucharis,* d'Orb., *Belemnites Royerianus,* d'Orb., &c., &c.

IV.—The calcaires pseudo-lithographiques, à *Pholadomya ampla,* pass into—

V.—The highest terrains which extend throughout the northern part of the arrondissement, and are composed of the marnes supérieures à grandes *Amm. plicatilis,* et *Pholadomya parcicosta.* According to M. BEAUDOUIN* this zone is nearly 100 mètres = 328 feet in thickness, and contains some beautiful crystals of the metastatique carbonate of lime, balls of calcareous marls, very analogous to the chailles of the Franche-Comté, and probably on the horizon of those of l'Yonne. The fossils are not numerous, and those which retain their test have passed into a siliceous condition. The leading specimens are *Gryphæa dilatata,* Sow., *Pholadomya parcicostata,* Ag., *Trigonia clavellata,* Sow., *Melania striata,* Sow., *Ammonites plicatilis,* Sow.

* Bulletin de la Soc. Geol. de France, 1re Série, t. xiv, p. 155: 1842.

M. G. de Nerville* divides his group of "*Marnes Oxfordiennes et calcaire marneux Oxfordien*" into six beds which, in descending order, are:—

Marnes Oxfordiennes et Calcaire marneux Oxfordien.

6.—Marne jaunâtre, argileuse, assez coquillière, donnant du ciment hydraulique, *ciment de Molesmes*. 10 mètres.
5.—Une assise d'un *calcaire marneux*, gris de fumée, alternant avec des lits marneux. 30 mètres.
4.—Calcaire marno-compacte Oxfordien. Cette assise présente souvent, vers sa base, des cherts (*chailles*) siliceux bien distincts de ceux qu'on rencontre aussi accidentellement plus bas à la base du Groupe Corallien. 30 mètres.
3.—Marnes mélangées d'un grande nombre de bancs lenticulaires et de *rognons* de calcaire marno-compacte d'un gris bleuâtre. 15 mètres.
2.—Assise purement marneuse, des *marnes Oxfordiennes* proprement dites; composée de marnes bleuâtres, très-coquillières, à fossiles souvent pyriteux. 15 mètres.
1.—Couche de *Minerai de fer* hydroxidé à Oolithes miliares, à gangue calcaire et marneuse. Horizon geognostique d'une sûreté absolue. 3 mètres.

M. Jules Marcou† has shewn that Nos. 4, 5, 6, of M. de Nerville's section are synchronous with his *Argovien;* Nos. 2 and 3 with his Marnes Oxfordiennes; and No. 1 with the Fer de Clucy in the Jura franc-comtois.

The Oxfordien is well developed in the adjoining department of the Haute-Marne, where, according to M. E. Royer,‡ it is divisible into—

1.—*Marnes Oxfordiennes supérieures.*
2.—*Marnes Oxfordiennes moyennes.*
3.—*Marnes Oxfordiennes inférieures*, ou marnes bleues avec *Ammonites biplex* et autres petites Ammonites pyriteuses.
4.—*Marnes Oxfordiennes ferrugineuses*, ou terrain *Kellovien*, which contains a great number of fossils of this stage.

The Jura of Haute-Saône has been most carefully described, bed by bed, by M. Thirria.§ In the lower portion are—1st, brownish marls, very rich in "minérai de fer hydroxidé oolithique," with *Ammonites macrocephalus*. 2nd, blackish grey marls, with *Ammonites Lamberti, Am. Mariæ, Am. dentatus, Am. coronatus, Rhynchonella Thurmanni, Pentacrinus pentagonalis*, &c. 3rd, argiles avec chailles, or yellowish clay, representing the upper portion of the Oxford Clay, or the *couches d'Argovie* ou *Argovien* of M. Marcou.

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* Légende explicative. † Lettres sur les Roches du Jura, p. 163.
‡ Bull. Geol. Soc. France, tome viii, p. 582: 1851.
" " tome viii, 2me Séries, p. 600.
§ Statistique géolog. de la Haute-Saône: 1833.

M. J. Thurmann, * in his admirable essay, "sur les soulèvemens Jurassiques du Porrentruy," has described the Oxfordien group in the Jura as it exists in Mont-Terrible. The division and palæontology of these beds agree substantially with the condition of things existing in the departments of France, just described.

M. Jules Marcou † has contributed a most valuable memoir on the Jura salinois, in which he has described the physical and biological contents of the Jurassic rocks in the Franche-Comté. The same learned author has, likewise, in a later publication, a series of letters to my late friend Professor Oppel, compared the synchronism of the middle and upper Jura franc-comtois with corresponding formations described in the memoirs on the Haute-Saône, by M. Thirria; the Côte-d'Or, by M. de Nerville; the Haute-Marne, by M. E. Royer; the Meuse, by M. Ed. Piette; the Moselle, by MM. Terquem and Piette; the Ardennes, by M. Piette; the Cévennes by MM. Em. Dumas and Paul de Rouville; and the lower Jura with the works of different English authors,—Professor Phillips, Mr. Edward Hull, and Dr. Wright.

Dr. William Smith long ago divided his Clunch, or Oxford Clay, into the argillaceous strata, or Oxford Clay proper, forming the great mass of the formation and including subordinate beds of yellow sandy Limestone, which he first found at Kelloway Mill, Wilts, and which he called Kelloway rock. Subsequent discoveries have proved that the distinction was correct, and that a classification of the upper beds of the group may be made by a critical study of their organic remains. Keeping steadily in hand the key that has helped us to unlock the sub-divisions of the Lias and Lower Oolites, let us proceed with the beds of the middle oolitic formations.

Many years ago, during the construction of the Great Western Railway between Chippenham and Trowbridge, the lower beds of the Oxford Clay down to the Cornbrash were cut through, and an immense number of Ammonites and other

* Mémoires de la Soc. d'Hist. Naturelle, de Strasbourg: 1832.

† Recherches géol. sur le Jura salinois, Mem. Soc. géol. de France: 1846.

shells were obtained therefrom. The laminated clays of Christian Malford were likewise extensively worked for fossils, and from these various sources of knowledge we learn that the Oxford Clay of Wilts may be thus divided into three zones, taking the dominant Ammonite in each zone as characteristic of it. The following table explains the sequence of the beds in the Trowbridge railway cutting:—*

	Lithology.	Zones.	Leading Fossils.
		Coralline Oolite.	
Calcareous Grit.	Soft variegated siliceous sands alternating with calcareous grits and bands of siliceous sandstone containing shelly fragments; the beds full of oblique lamination, near Calne.	Ammonites Perarmatus.	Ammonites perarmatus, Amm. cordatus, Amm. Lamberti, Amm. Sutherlandiæ, Amm. Crenatus.
Oxford Clay.	Dark bituminous slaty clay containing septaria and veins of stone with large Ammonites; the laminated clays have the shells of Ammonites and other Molluscs well preserved, but much compressed as at Christian Malford.	Ammonites Jason.	Ammonites Jason, Amm. lunula, Amm. Reginaldi, Amm. Comptoni, Belemnites Puzosianus, B. abbreviatus, Acanthoteuthis antiquus, Sepia, Loligo, Alaria armigera, Turritella muricata, Trigonia clavellata, Nucula Phillipsii, Ostrea deltoidea.
Kelloway Rock.	Rusty, yellow-coloured, sandy Limestone, passing into grey, Kelloway Mill and railway cuttings. Wilts. Scarboro', Yorkshire.	Ammonites Calloviensis.	Amm. calloviensis, Am. Gowerianus, Am. modiolaris, Am. Königii, Ancyloceras callovicense, Isocardia tenera.
Kelloway Shales.	Dark, drab, or bluish clay containing many nodules, having Ammonites for a nucleus, railway cutting, near Trowbridge.	Ammonites Macrocephalus.	Am. macrocephalus, Amm. modiolaris, Am. Gowerianus, Am. Chamusseti, Am. funiferus.
		Cornbrash.	

* A very good section of the Trowbridge cutting, carefully measured and accurately described by Reginald Mantell, Esq., C.E., was published in the *Quarterly Journal of the Geological Society*, Vol. xvi, p. 310: 1850. The lists of fossils and description of new species by Professor Morris, F.G.S.

I.—*Zone of Ammonites macrocephalus.* Beneath the Kelloway Rock, in Wiltshire, there is a bed of dark blue clay containing many Ammonites and argillaceous nodules, having chiefly young Ammonites and other molluscs for their nuclei; this bed was well exposed in the railway cutting near Trowbridge, and I fortunately possess a very complete suite of the fossils collected therefrom. The clay was especially rich in Cephalopoda, as the following list shews:—

CEPHALOPODA.

Ammonites macrocephalus, *Schloth.*	Ammonites Gowerianus, *Sow.*
" modiolaris, *Llhwyd.*	" Königii, *Sow.*
" Chamusseti, *d'Orb.*	Belemnites abbreviatus, *Mill.*

CONCHIFERA.

Trigonia clavellata, *Sow.*	Modiola bipartita, *Sow.*
Avicula expansa, *Phil.*	Nucula Phillipsii, *Mor.*

On the Yorkshire coast the Kelloway rock is largely developed and separated from the Cornbrash by a bed of dark-bluish clay, more or less laminated, varying in thickness from four inches to six feet: this, the so-called "clay of the Cornbrash," appears to represent the zone of *Am. macrocephalus*, as it contains several species of shells which are rarely, if ever, met with in the Cornbrash, as *Ammonites macrocephalus*, Schloth., *Sanguinolaria parvula*, Bean., *Cardium latum*, Bean., *Opis triangularis*, Bean., *Belemnitis tornatilis*, Phil.* The claws and carapaces of two crustacea, *Glyphœa rostrata*, Phil., *G. Birdii*, Bean., occur in round argillaceous nodules in this clay at Cayton Bay, with *Hemipedina Woodwardii*, Wr., collected therefrom, and given to me by the late Dr. MURRAY.

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* *Sanguinolaria parvula* and *Cardium latum*:—These very doubtful species, founded on solitary examples, are really unworthy of being continued in any list of Cornbrash fossils. The first is no true Sanguinolaria. *Opis triangularis*, Bean, is hardly even a variety of *Isocardia nitida*, Phillips; it is not an Opis; and I have struck it out of my list of Cornbrash fossils. *Ammonites macrocephalus*, Schloth., is not peculiar to the clay, but is found much more abundantly in the true Cornbrash below. The only characteristic fossil, therefore, is the species referred to, *Belemnites tornatilis*, Phillips; but I cannot refer it to any of the varieties of *B. Oweni* in which Prof. PHILLIPS now includes *B. tornatilis*—it comes nearer to *B. abbreviatus*. Note by J. LECKENBY, Esq.

II.—*The zone of Ammonites calloviensis*, or Kelloway Rock, was first discovered by Dr. William Smith, at Kelloway Mill, Wiltshire, and afterwards *in situ* in the Castle Hill, Scarborough. This is the true correlative formation to the *Marnes calloviennes* and *Calcaires marneux*, of Mr. Martin. From this stone, in Wiltshire, I have collected:—

Cephalopoda.

Belemnites tornatilis, *Phil.*
Ammonites calloviensis, *Sow.*
" Gowerianus, *Sow.*
" Lamberti, *Sow.*
" Hecticus, *Hart.*
" Guillelmi, *Sow.*
Ammonites Duncani, *Sow.*
" athleta, *Phil.*
" modiolaris, *Llhwyd.*
" Königii, *Sow.*
" sublævis, *Sow.*
Ancyloceras callovicense, *Mor.*

Gasteropoda.

Alaria bispinosa, *Phil.*
Littorina punctura, *Sow.*
Turbo elaboratus, *Lyc. and Mor.*
Pleurotomaria granulata, *Sow.*

Conchifera.

Pholadomya acuticosta, *Sow.*
Astarte minima, *Phil.*
" carinata, *Phil.*
Isocardia tumida, *Phil.*
" tenera, *Phil.*
Nucula lachryma, *Sow.*
Goniomya v. scripta, *Sow.*
Trigonia clavellata, *Sow.*
" costata, v. pulla, *Sow.*
Myacites recurvus, *Phil.*
" decussatus, *Phil.*
" calceiformis, *Phil.*
Gresslya perigrina, *Phil.*
Unicardium depressum, *Phil.*
Cardium cognatum, *Phil.*
" striatulum, *Phil.*
Lucina lirata, *Phil.*
Cucullæa minima, *Leck.*

Brachiopoda.

Terebratula ornithocephala, *Sow.*
Rhynchonella varians, *Schloth.*

My old esteemed friend, J. Leckenby, Esq., F.G.S., of Scarborough, has contributed a valuable paper on the Kelloway Rock of the Yorkshire coast,* and which I quote here as an important addition to my very imperfect notes on this formation in Wiltshire. It is seen in the cliff to the south of Gristhorp Bay, the projecting point of Red Cliff, and at the Castle Hill,

* *Quarterly Journal of the Geological Society.* Vol. xv, p. 4: 1859.

Scarborough, where a fine section near the pier may be easily and advantageously examined. It consists of the following:—

		ft.	in.
A.	Moderately compact irony sandstone 1½ feet thick, traversed by darkened veins of the same metallic character; it contains *Am. Königii, Am. flexicostatus.* Special to the bed *Bel. tornatilis*	1	6
B.	Loose friable sandstones, without fossils	4	0
C.	Similar to A, but richer in organic remains, containing, besides those enumerated, *Am. modiolaris, A. Gowerianus, A. Chamusseti, Pholadomya acuticosta, Modiola pulchra,* and *Gryphœa dilatata.* It is a more nodular cherty bed than A	1	6
D.	Compact almost unfossiliferous sandstone, sometimes an Ammonite or a Belemnite in the large blocks ...	20	0

The following is a catalogue of the fossils collected by J. Leckenby, Esq., from Kelloway Rock, of Yorkshire, with descriptions of some new, or imperfectly understood species.*

Cephalopoda.

Ammonites sublævis, *Sow.*
" ordinarius, *Bean*, MS.
" rugosus, *Leck.*
" Gowerianus, *Sow.*
" reversus, *Simp.*, MS.
" vertumnus, *Bean*, MS.
" poculum, *Bean*, MS.
" Chauvinianus, *d'Orb.*
" alligatus, *Bean*, MS.
" Arduennensis, *d'Orb.*
" binatus, *Bean*, MS.
" Königii, *Sow.*
" athleta, *Phil.*
" gemmatus, *Phil.*
" Guillelmi, *Sow.*
" Murrayanus, *Simp.*, MS.
" placenta, *Bean*, MS.
" Lamberti, *Sow.*
Ammonites putealis, *Bean*, MS.
" turgidus *Bean*, MS.
" gregarius? *Bean*, MS.
" lunula, *Zieten.*
" Chamusseti, *d'Orb.*
" lenticularia, *Phil.*
" funiferus, *Phil.*
" hyperbolicus, *Simp.* MS.
" glabellus, *Bean*, MS.
" conterminus, *Bean*, MS.
" bipartitus, *Zieten.*
" Baugieri, *d'Orb.*
" flexicostatus, *Phil.*
Belemnites tornatilis, *Phil.*
" Puzosianus, *d'Orb.*
a. " hastatus, *Blain.*
a. " gracilis, *Phil.*
c. Nautilus hexagonus, *Sow.* (*b*) 2.

Note.—Of the foregoing list of *Ammonites,* one species *Am. alligatus* ascends to the Calcareous Grit above. All the others (except *Am. binatus,* of which a dwarfed variety is found in the Oxford clay,) are peculiar to the Kelloway Rock.

(*b*) 2 Two species named above are found in the Calcareous Grit; and to the above list should be added *Am. perarmatus* and *Am. hexicostatus.* The former also ascends to the Calcareous Grit. *Am. putealis* is a variety of *Am. Hecticus.* Note by J. Leckenby, Esq.

* *Quarterly Journal of the Geological Society.* Vol. xvi., p. 4: 1859.

Gasteropoda.

a. Alaria bispinosa, *Phil.*
(*d*)4. Natica, (a cast)
b. Chemnitzia vittata (?) *Phil.*
(imperfect casts.)
Cerithium abbreviatum (NS.)
" Culleni (NS.)
b. Littorina punctura, *Bean*, MS.
b. " ornata, *Sow.*
Turbo sulcostomus, *Phil.*
b. Turbo elaboratus, *Lyc. and Mor.*
Pleurotomaria guttata, *Phil.*
" arenosa, *Bean*, MS. (*a i*)
b. " granulata, *Sow.*
a. " depressa, *Phil.*
" striata, *Bean*, MS.
Patella ? graphica, *Bean*, MS.
a. Actæon retusus, *Phil.*
c. Dentalium annulatum, *Bean*, MS.

Brachiopoda.

(*e*)5 *b.* Terebratula ornithocephala, *Sow.*
c. Rhynchonella varians, *Schloth.*
Lingula lævis, MS.
Discina (Orbicula) centralis, MS.

Mr. Bean's Collection.

Conchifera.

b. Gryphæa bullata, *Sow.*
c. " dilatata, *Sow.*
c. Anomia inæquivalvis, *Phil.*
Ostrea canaliculata, *Bean*, MS.
" procerula, *Bean*, MS.
" A peculiarly elongated smooth species approaching *Vulsella.*
" striata, *Bean*, MS.
c. Pecten demissus, *Phil.*
b. " fibrosus, *Phil.*
c. " vagans, *Sow.*
c. " abjectus, *Phil.*
c. " arcuatus, *Sow.*
b. Lima duplicata, *Sow.*
" Phillipsii, *d'Orb.*
" notata, *Goldf.*
c. Avicula inæquivalvis, *Sow.*
a. " ovalis, *Phil.*
c. " Brammburiensis, *Phil.*
" clathrata, *Bean*, MS.
b. " rugosa, *Goldf.*
a. Pinna mitis, *Phil.*
c. Modiola bipartita, *Sow.*
c. " cuneata, *Sow.*
" pulcra, *Phil.*
a. Cucullæa æmula, *Phil.*
b. " elongata, *Sow.*
b. " clathrata, (NS.)
" minima, (NS.)
Solemya Woodwardiana, (NS.)
c. Nucula lacryma, *Sow.*
c. Trigonia costata, v. pulla, *Sow.*
c. " elongata, *Sow.*

(*a i*) *Pleurotomaria arenosa* is merely the well-preserved condition of *P. guttata.* The test in the type of the latter has perished except the thick nodular portion upon the sutures, from whence its name. In the well-preserved *arenosa* the guttæ appear less prominent by comparison with the highly ornamented diameter of the other parts of the shell. Note by J. Leckenby, Esq.

(*d*) 4 Natica Guerrei, *Deslongch.* Note by J. Leckenby, Esq.

(*e*) 5 Terebratula Buckmani, *Davidson.* Note by J. Leckenby, Esq.

(c)3. Trigonia clavellatta, *Park.*
c. " variety much less produced posteriorly, and with the tubercles crowded on the anterior margin.
Ostrea undosa, *Bean*, MS.
Ostrea archetypa, *Phil.*
c. " Marshii, *Sow.*
b. Cardium cognatum, *Phil.*
b. " citrinoideum, *Phil.*
" subdissimile (?) *d'Orb.*
a. " Crawfordii, (NS.)
Lucina lirata, *Phil.*
b. " crassa, *Sow.*
Corbis ovalis, *Phil.*
" lævis, *Sow.*
b. Astarte lurida, *Sow.*
b. " minima, *Phil.*
b. Astarte politula, *Bean*, MS.
b. Unicardium depressum, *Phil.*
b. " sulcatum, *Bean*, MS.
c. Isocardia tumida, *Phil.*
b. " minima? *Sow.*
b. " nitida, *Phil.*
" ? clarissima, *Bean*, MS.
c. Anatina undulata, *Sow.*
" versicostata, *Buvig.*
b. Pholadomya acuticosta, *Sow.*
b. " ovalis, *Sow.*
" carinata? *Goldf.*
b. Myacites calceiformis, *Phil.*
b. " decussatus, *Phil.*
b. " securiformis, *Phil.*
a. " recurvus, *Phil.*
c. Goniomya, v. scripta, *Sow.*
c. Gresslya peregrina, *Phil.*

CRUSTACEA, ANNELIDA, &c.

c. Glyphæa rostrata, *Phil.*
c. Serpula intestinalis, *Phil.*
Cidaris, imperfect fragments.
Encrinital stems.

Note.—The species marked *a*, in the above list, occur also in the bed above, or the Oxford clay; the letter *b* indicates that the species is found in the bed below, or the Cornbrash; *c*, that it is common to all the three deposits.

The Zone of Ammonites Jason.—Dark-coloured slaty shales of the Oxford Clay, in parts unctuous and bituminous, and emitting a gas which burns with brilliancy when lighted. It contains many Belemnites and compressed Ammonites, with their white calcareous shell well preserved; here, likewise, was found *Acanthoteuthis antiquus*, *Sepia*, and *Loligo*, with ink-bags attached. This is the division of the Oxford Clay which was so long successfully worked by the late Mr. WILLIAM BUY, at Christian Malford, and from whence all the fine specimens that he distributed throughout the country were obtained.

(c) 3 *Trigonia clavellata* should not be inserted, as I have lately added three new species of clavellated Trigonia, including the form thus noted, which will be described and figured by Dr. LYCETT in his forthcoming work on the genus *Trigonia*. One of these is from a seam only quite lately explored and which has yielded *Tancredia curtansata*, *Mya modria*, (dwarfs,) *Gervillia acuta*, not hitherto found in the Kelloway rock. Note by J. LECKENBY, Esq.

CEPHALOPODA.

Ammonites Jason, *Reinecke.*
" Guillelmi, *Sow.*
" Comptoni, *Pratt.*
" Lonsdalii, *Pratt.*
" Brightii, *Pratt.*
" Reginaldi, *Mor.*
Ammonites fluctuosus, *Pratt.*
" cordatus, *Sow.*
" modiolaris, *Llhwyd.*
Belemnites Puzosianus, *d'Orb.*
" hastatus, *d'Blain.*
Acanthoteuthis antiquus, *Pearce.*

GASTEROPODA.

Turritella muricata, *Sow.*
Alaria composita, *Sow.*
Alaria bispinosa, *Phil.*
" trifida, *Phil.*

CONCHIFERA.

Gryphæa dilatata, *Sow.*
Ostrea gregaria, *Sow.*
Avicula inæquivalvis, *Sow.*
" ovalis, *Phil.*
Modiola bipartita, *Sow.*
Pholadomya deltoidea, *Sow.*
Nucula Phillipsii, *Mor. and Lyc.*
" elliptica, *Phil.*

The Zone of Ammonites perarmatus,—or lower Calcareous Grit, is the equivalent of the "marnes ferrugineuses oolithiques à *Am. cordatus, Am. perarmatus, Am. oculatus*, &c.," of M. MARTIN. This formation is by most English geologists "considered a subordinate member of the Coral Rag, though containing some fossils peculiar to itself, and being principally an arenaceous instead of a calcareous rock." With some continental authors it is the upper member of the Oxfordian stage, as having greater palæontological affinities with the other divisions of this group than with the coralline Oolite which rests upon it.

It consists of a series of soft, variegated, siliceous sands, alternating with calcareous grits, and bands of siliceous Limestone, with fossils. The beds of Calcareous Grit are very irregular, and frequently present the phenomena of oblique lamination or current-bedding.* It varies in thickness from 20 to 80 feet. In the bands of calcareous sandstone, fossils are plentiful, though generally fragmentary. This zone is well developed near Calne, Wilts; Headington Hill, near Oxford;

* Memoirs of the Geol. Survey, Expl. of Sheet 13, p. 5, by Messrs. HULL and WHITAKER.

Abingdon and Marcham, Berks; Weymouth, Dorset; &c. The following are the leading fossils I have collected from the first of these localities:—

CEPHALOPODA.

Ammonites perarmatus, *Sow.*	Ammonites Lamberti, *Sow.*
" cordatus, *Sow.*	" Arduennensis, *d'Orb.*
" Sutherlandiæ, *Sow.*	" crenatus, *Brug.*

Without making a special study of the Calcareous Grit it would be impossible to give a correct table of its conchifera, as our lists have for the most part been made from the Coral rag and Calcareous Grit taken together. Although the Ammonites I have named are found in the upper part of the Oxfordian, still I think that portion of the bed more properly belongs to the zone of *Am. perarmatus*, than to the slaty bituminous shales of the true Oxford Clay on which it rests.

CORALLIEN = CORALLINE OOLITE.

The Corallien in the Côte-d'Or consists, according to M. MARTIN, of the following sub-divisions:—

A. Oolithe corallienne à Diceras et calcaire compacte.
B. Calcaire fissile sub-oolithique et calcaire blanc à Polypiers.
C. Calcaire grumeleux compacte, calcaire à chailles et marnes inferieures à *Glypticus hierogliphicus*, *Cidaris florigemma*, &c.

The Coral Rag and Pisolite of Dr. WILLIAM SMITH is, in part only, the equivalent of this stage, which is so well developed in Wiltshire, Berkshire, Oxfordshire, Buckinghamshire, Dorsetshire, and Yorkshire, and forms such an important feature in the sedimentation of the Middle Oolites. During the Oxfordian age, Ammonites, numerous in species and multitudinous in individuals, crowded the seas from which were deposited the middle Jurassic formations from the macrocephalus to the perarmatus zones of life; but with the commencement of the coralline stage, on the study of which we now enter, a great change in the physical conditions of the bed of that sea seems to have taken place; the comparative shallow water in which the Oxfordian Cephalopoda disported, was now changed into

a deep ocean in a slowly subsiding area,—a condition of things, probably analogous to the coral sea within 30° of each side of the equator in our day. The Jurassic waters were then studded with coral reefs, extending over an area equal to a great portion of modern Europe, as shown by the geographical distribution of the coralline formations, which stretch through England in a diagonal line from Yorkshire to Dorsetshire; through France, from the coast of Normandy to the shores of the Mediterranean, forming besides a chain extending obliquely through its central portion from the department of the Ardennes in the north, to Charente Inférieure in the south, including Savoy, the Hautes-Alpes, and Basses-Alpes; the Jura of the Haute-Saône, and the Jura franc-comtois, and the Swiss Jura chain throughout its entire length; from Schaffhausen on the Rhine, to Coburg in Saxony, and along the range of the Swabian Alps, and the Franconian Jura. The corallian, was, therefore, a widely extended formation, and appears to have been formed under conditions similar both in their physical and biological relations.

The Ammonites that have hitherto helped us to determine the limits of the Jurassic formations are unfortunately rare in the corallian strata, and we must seek among the leading fossils of these beds for other genera, whereby to ascertain their correlations; fortunately we find excellent substitutes in the *Corals*, *Echinidæ*, and certain genera of *Mollusca* so abundant in the different stages thereof. Examined by this test the corallian terrains in France, Germany, and Switzerland admit of a division into three zones, which, in descending order, may be thus defined:—The upper zone consists of fine white earthy or siliceous limestones like chalk, with numerous species of *Nerinæa*, and *Diceras arietina*, which characterize it. The second zone is remarkable for the large number of corals it contains, and which form a Madreporic Limestone; in fact, the fossil reefs of a coral sea. The third zone contains many Echinoderms, among which *Cidaris florigemma* and *Glypticus hieroglyphicus* are conspicuous; the spines of *Cidaris florigemma* alone forming an excellent leading fossil when the test is absent.

Lithology.	Zones of the Coralline Oolite.	Leading Fossils.
Calcaires à Astartes. Calcaires à Nérinées. Calcaires à Diceras.	I. Nerinæan Zone.	*Astarte minima, Exogyra Bruntrutana, Nerinœa Bruntrutana, N. Calypso, Diceras arietina.*
Calcaires compactes et sub-oolithiques avec calcaire à Polypiers.	II. Coral Zone.	*Thecosmilia annularis, Stylina tubulifera, Montlivaltia dispar, Isastræa explanata, Thamnastræa arachnoides, T. concinna, Cosmoseris irradians.*
Calcaires grumeleux compactes. Terrain à Chailles. Marnes inférieures.	III. Echinidian Zone.	*Cidaris florigemma, C. Blumenbachii, Hemicidaris crenularis, C. coronata, Echinus perlatus, Glypticus hieroglyphicus, Millericrinus echinatus.*

Of these three zones we can correlate the Coralline Oolite, Coral Rag, and Pisolite of Smith with II. and III., but the Superior, or Nerinæan, zone is absent in England.

M. G. de Nerville* divides his groupe Corallien of the Côte-d'Or into eight formations, which, in descending order, are as follows:—

Groupe Corallien.

8.—*Calcaire à Ptérocères.* Calcaire jaune, a points verts, sableux, renfermant quelques minces bancs de marnes sableuses. Caracterisé par le *Pterocera Oceani.*
7.—*Calcaire à Astartes.* A la base se trouve un banc marneux.
6.—*Calcaire à Nérinées.* Calcaire blanc mat, à pâte fine, crayeuse, oolithique, renfermant beaucoup de Nérinées.
5.—*Oolite corallienne*, formée de gros grains oolithiques, et pisolites oblongues, soudées par un ciment calcaire très-solide.
4.—*Calcaire compacte et piqueté corallien.* Calcaire compacte, à pâte fine, à fond blanc grisâtre piqueté de petites taches rondes roussâtres.
3.—*Calcaires fissiles et sub-oolithiques coralliens.*
2.—*Calcaire Madreporique.* Calcaire blanc-grisâtre composé en grande partie de coraux.
1.—*Calcaire compacte inférieur grumeleux corallien.* Tres-fossilifère, riche surtout en *débris* de grasses Apiocrinites et d'Oursins. Renfermant en quelques points de nombreux cherts (*chailles*) siliceux.

This classification differs from that of M. Martin, (p. 3.) The *Calcaire à Ptérocèren* (8) is grouped with his Kimméridien;

* Legende explicative de la carte géolog. du Depart. de la Côte-d'Or: 1853.

the *Calcaire à Astartes*, (7) and *Calcaire à Nérinées* (6) forming his Séquanien, and the stages (5, 4, 3, 2, 1) constituting his Corallien. The facts are the same, the grouping alone being different.

M. Thirria † has given an admirable description of the petrography and stratigraphical relations of the Jurassic Rocks in the Haute-Saône, which adjoins the Côte-d'Or, and from his memoir we learn some important details on the Corallien of that department, and which I quote.

Calcaires à Astartes.

a. Calcaire un peu marneux, grisâtre, avec *Astarte minima.*
b. Marne grise.
c. Calcaire un peu marneux, schisteux et grisâtre, avec *Astarte minima, Exogyra Bruntrutana.*
d. Marne grise.
e. Calcaire un peu marneux, schisteux et grisâtre, avec *Astarte minima, Trigonia suprajurensis.*
f. Calcaire grisâtre, compacte, avec *Astarte, Ostrea, Apiocrinus.*

Calcaire à Nérinées.

a. Calcaire compacte, grisâtre, avec Oolites miliares et *Nerinea* et *Crinoids.*
b. Calcaire blanchâtre, oolithique.

Oolithe Corallienne.

c.—Calcaire dit *Vergenne* ou pierre blanche, avec Oolites cannabines avec *Nerinea Bruntrutana, Diceras arietina, Calamophyllia, Isastræa.*
d.—Calcaire jaunâtre, avec grasses Oolites.

Calc. compactes et sub-oolithiques avec fossiles siliceux.

a.—Calcaire compacte.
b.—Calcaire compacte, très-oolithique, avec coraux siliceux.
c.—Calcaire compacte, grisâtre, avec entroques et coraux.
d.—Calcaire compacte, alternant avec des couches de calcaires marneux, avec entroques et coraux. *Serpula grandis, Thecosmilia annularis, Stylina tubulifera, Montlivaltia dispar, Isastræa explanata, Thamnastræa arachnoides.*

Argile avec Chailles, pars.

a.—Argile jaune, siliceuse, avec chailles géodiques et *Hemicidaris crenularis, Pedina sublœvis, Cidaris Blumenbachii, C. Parandieri, C. florigemma, C. coronata, Echinus perlatus, Glypticus hieroglyphicus, Apiocrinus Roissyanus, Millericrinus Milleri, M. rosaceus, &c.*

† Statistique géologie de la Haute-Saône: 1833.

From these sections we observe that the three zones already described, are present in the departments of the Côte-d'Or and Haute-Saône, and extend into those of the Doubs and Jura, as shewn in M. Marcou's memoir on the Jura salinois; the upper zone attaining a considerable development in that region. M. Martin's cabinets contain a very fine series of fossils from all the three divisions. Many of those from the Echinidian and Coral zones were forms well known to me, from their specific identity with some of the Echinidæ and Anthozoa of our own Coralline Oolite. I was not unfamiliar with the large Nerinæas and Diceras from the upper zone, as M. Etallon had, several years ago, sent me a very fine series of Mollusca and Polypifera from the Dicératien zone of the environs of St. Claude in the Haut-Jura.

Coralline Oolite.—This important member of the English Oolitic system was described by Dr. William Smith as "Coral Rag and Pisolite," and by Conybeare and Phillips as "the Superior or Oxford Oolite with Calcareous Grit and Sand, forming the lowest beds." It comprises a series of strata from one to two hundred feet in thickness, ranging obliquely north and south from Weymouth, in Dorset, and passing through the counties of Wilts, Oxon, Berks, and Bucks to Yorkshire, where it is well developed and exposed. Near Calne, Wilts, it consists of—1st, Calcareo-siliceous or Upper Calcareous Grit, underlaid by a band of 10 feet thick of ferruginous clay; 2nd, Coral Rag composed of thick-bedded oolitic freestones and rubbly Oolite, about 80 feet, resting upon irregular beds of rubbly Oolite, 40 feet thick, containing corals; 3rd, Clay and fissile Oolite, 40 feet, containing the tests and spines of numerous Echinidæ, as *Cidaris florigemma, Hemicidaris intermedia, Pseudodiadema versipora,* &c.; and, 4th, Lower Calcareous Grit, consisting of sand, with beds of calcareous grit and impure Limestone, containing large *Ammonites perarmatus*, and Star-fishes, *Astropecten rectus*,—this formation passing into and resting upon the Oxford Clay. The Coral Rag freestones, representing the middle zone, are well seen at Calne: the corals, at Steeple Ashton, and the beds with Echinoderms, representing the

lower zone, near Calne and Lynham. Everywhere the coral rag or middle zone has the character of being an ancient coralline sea-bed, interposed between two arenaceous deposits, (the upper and lower calcareous grits,) and is remarkable for the vast assemblage of reef-building polypifera, and the tests, spines and *débris* of Echinidæ it contains compared with the small proportion of Mollusca found with them.

Steeple Ashton, Wilts, was long a famous locality for corals. The surface of the fossiliferous beds of the Coral Rag were there exposed in many fields, and the corals annually turned out by the plough were exposed to the air and weathered. I have collected the following species from this locality :—

CORALS FROM STEEPLE ASHTON.

Stylina tubulifera, *Phil.*
" Delabechii, *Edw. & Haime.*
Thecosmilia annularis, *Keferstein.*
Calamophyllia Stokesii, *Edw. & Haime.*
Cladophyllia Conybearii, *Ed. & Haime.*
Goniocora socialis, *Röem.*
Isastræa explanata, *Goldf.*
Thamnastræa arachnoides, *Park.*
" concinna, *Goldf.*
Comoseris irradians, *Edw. & Haime.*

The Coral Rag at Farringdon, Berks, consists of irregularly bedded coralline Limestone, with beds of clay intercalated therewith; the corals are, for the most part, species of *Thamnastræa, Thecosmilia,* and *Isastræa,* &c., lying in the position in which they grew in the lagoon of the coral sea. At Marcham, Garford, Fyfield, and Bradley, near Cumner, there are several quarries of this rock. At Headington, a good section of the whole series is obtained. "The formation here divides itself into a lower and upper series. The lower beds are of the more usual description, and are well shewn in a quarry 100 yards south of the Windmill, near Workhouse Farm. They are formed of enormous quantities of fragmentary corals, besides *Conchifera,* in great abundance. The corals are of the genera *Thecosmilia* and *Isastræa,* &c., and are generally imbedded in thin coatings of clay. In this section the thickness of the rock is 12 feet, and at the base we find the soft brown sands of the lower calcareous grit. Further to the north-east we find the higher beds of the coralline Oolite well

exposed in quarries at the base of the Kimmeridge clay; they consist of coarse oolitic Freestone, yielding large blocks of building stone, which has been extensively used at Oxford for buildings later than the fifteenth century. This Freestone is 12 feet thick, which gives a total of 25 feet for the Coral Rag in this locality." *

The coralline Oolite is well developed and admirably exposed near Malton, Yorkshire, where large quarries of compact thick-bedded freestones are worked, near the town, and yield a rich harvest of organic remains. A beautiful fine-grained building stone, containing much siliceous matter, is extensively quarried near Hildenley, for church decoration, from which Sir C. Strickland, Bart., whose property it is, has collected a very fine series of fossils. At Hackness, Ayton, and Seamer, near Scarborough, there are many exposures, from whence the madreporic beds of this formation are extensively raised for road material; they consist of old coral reefs, in beds of from 10 to 15 feet in thickness, composed of layers of crystallized coral rock from 18 to 24 inches in thickness, largely consisting of *Thamnastræa concinna*, Goldf., and other Anthozoa; each layer being separated from the others by rubbly clay and mud. The largest quarry is near Ayton, another is near Seamer, and others are in the neighbourhood of Wykeham and Brompton. The Ayton quarry, which may be considered as the type, contains large nodulated masses of madreporic Limestone, the beds composing it having an irregular undulating surface. The corals appear to have grown in areas of depression in the coralline sea, for the rock consists of large masses of a very hard and highly crystalline madreporic Limestone, forming nodulated eminences and concave curves in beds of from 12 to 18 inches in thickness, a stratum of yellowish clay filling up the hollows, and forming a horizontal line in the stratification of the bed. A stratum of nodulated crystalline Limestone is covered by a layer of clay, and thus the rock is made up just

* Memoirs of the Geol. Surv. The Geology of parts of Oxfordshire and Berkshire, (Sheet 13,) by Edward Hull, B.A., and William Whitaker, B.A.: 1861.

as modern reefs are filled in by the erosion and fracture of the outer walls of the reef; the accumulation of the *débris* being ground down to mud and sand and washed into the interstices, and plates, and branches of the polypes that are building other parts of the living mass. The Ayton reef is exposed to about 10 feet in section, and rests upon another reef forming the floor of the quarry, and which descends many feet deeper. The corals are perforated by boring shells *Gastrochæna,* and numerous Molluscs that nestled in the creeks and crannies of the lagoon are here entombed as they died. Of these *Phasianella striata,* Sow., *Pecten vemineus,* Sow., *Pecten lens,* Sow., *Turbo muricata,* Sow., are most conspicuous; besides numerous other shells as *Chemnitzia, Nerinæa,* and other genera of the family *Pyramidalidæ,* that had their home in the lagoons of the coral sea. The following species collected from the coralline Oolite of Yorkshire, are preserved in the Museums of York, Scarborough, and Whitby, and likewise in the cabinet of J. Leckenby, Esq.:—

Anthozoa from the Coralline Oolite.

Montlivaltia dispar, *Phil.*	Stylina tubulifera, *Phil.*
Rhabdophyllia Phillipsii, *Ed. & Haime.*	Isastræa explanata, *Goldf.*
Thecosmilia annularis, *Flem.*	Cosmoseris irradians, *Edw. & Haime.*
Thamnastræa concinna, *Goldf.*	Isastræa inæqualis, *Phil.*
" arachnoides, *Park.*	Cladophyllia Conybearii, *Edw.*

The following list of Cephalopoda has been made for this paper by my excellent friend John Leckenby, Esq., F.G.S., whose accurate critical knowledge of the Palæontology of the Yorkshire Oolites is unsurpassed. He has likewise kindly added a list of the Mollusca found in the Coral Reefs around Scarborough:—

Cephalopoda

Found in the Coralline Oolite of Yorkshire.

Belemnites abbreviatus, *Mill.*	Ammonites Goliathus, *d'Orb.*
Nautilus hexagonus *Sow.*	" perarmatus, *Sow.*
Ammonites plicatilis,* *Sow.*	" cordatus, } *Sow.*
" Williamsoni, *Phil.*	" var. excavatus }
" (syn.) Arduennensis, *d'Orb.*	

* Not found in the calcareous grit below.

Cephalopoda

Obtained in the Calcareous Grit of Yorkshire.

Belemnites hastatus, *de Blain.*
" abbreviatus, *Mil.*
Nautilus hexagonus, *Sow.*
Ammonites Williamsoni, *Phil.*
" (syn.) Arduennensis, *d'Orb.*
" Vernoni, *Phil.*
" Bakeri, *Sow.*
" convolutus ornati, *Quenst.*
" " parabolis, "
" Goliathus, *d'Orb.*
Ammonites perarmatus, *Sow.*
" " var.
" athleta, *Phil.*
" cordatus, *Sow.*
" " v. excavatus, *Sw.*
" " v. vertebralis "
" " v. Scarburgensis, [*Y. and B.*
" canaliculatus, *Munst.*

Ammonites solaris, p. 4, Fig. 29, *Phillips'* Geo. of Yorkshire, must have found its way into the collection of the Scarborough Philosophical Society by accident. It is from the Lower Lias of the south of England, and may still be seen in the Society's Museum.

Am. Williamsoni, Phil., = *Am. Arduennensis*, d'Orb., is found from 1 inch to 16 inches in diameter, and the same observation applies to *Am. cordatus*, Sow.

List of Mollusca in the Coral Reefs.

Gasteropoda.

Turbo funiculatus, *Phil.*
Trochotoma ternata, *Phil.*
Littorina muricata, *Sow.*
Phasianella striata, *Sow.*
Natica Clymenia, *d'Orb.*
Nerita lævigata, *Sow.*
Nerita bellulata, *Bean.*
Neritopsis Guerrei, *Desl.*
Cerithium limæformis, *Roem.*
Nerinæa fasciata, *Voltz.*
" fusiformis, *d'Orb.*
Trochus tornatilis, *Phil.*

Conchifera.

Exogyra mima, *Phil.*
Placunopsis inæqualis, *Phil.*
Pecten vagans, v. sub-fibrosus, *Sow.*
Myoconcha texta, *Buvig.*
Modiola Lycetti, *Whit.*
" inclusa, *Phil.*
Arca quadrisulcata, *Sow.*
" æmula, *Phil.*
Cucullæa pectinata, *Phil.*
Astarte rhomboidalis, *Phil.*
Sowerbia triangularis, *Phil.*
Gastrochæna Moreana, *Buvig.*

The beds of clay, with Echinidæ forming the *Zone of Cidaris florigemma* occur at Calne and Lynham, Wilts, and at one

time yielded a large number of beautiful specimens; the clay in which the Urchins were found formed the bottom of the quarry; unfortunately this rich mine has become flooded, and the fossiliferous beds are now under water. The following species were collected many years ago from this zone near Calne.

ECHINODERMATA.

Cidaris florigemma, *Phil.*
" Smithii, *Wright.*
Hemicidaris intermedia, *Flem.*
Pseudodiadema hemisphæricum, *Ag.*
" versipora, *Phil.*
" radiatum, *Wright.*
" mammillanum, *Roem.*
Hemipedina corallina, *Wright.*
" tuberculosa, *Wright.*
Glypticus hieroglyphicus, *Goldf.*
Stomechinus gyratus, *Ag.*
Acrosalenia decorata, *Haime.*
Holectypus oblongus, *Wright.*
Pygaster umbrella, *Lamarck.*
Echinobrissus dimidiatus, *Phil.*
" scutatus, *Lamarck.*
Clypeus subulatus, *Young and Bird.*
Collyrites bicordata, *Leske.*
Pygurus pentagonalis, *Phil.*
" Phillipsii, *Wright.*
" Blumenbachii, *Koch & Dunke*
" Hausmanni, "
Millericrinus echinatus, *Schloth.*

The *Coral rag*, and beds with *Cidaris florigemma*, and *Glypitcus hieroglyphicus*, constitute the two divisions of the Coralline Oolite in England, and represent the two zones into which M. MARTIN divides the Corallien of the Côte-d'Or. The upper zone, included in M. de NERVILLE'S section of groupe corallien, in descending order, includes calcaire à Nérinées, calcaire à Astartes, and calcaire à Ptérocères,—the two first form M. MARTIN'S

SÉQUANIEN.

This group is composed, according to our author, of—

SÉQUANIEN.
- Calcaires marno-compactes à *Astarte minima.*
- Calcaires marneux à *Terebratula humeralis.*
- Calcaires durs ou blancs crayeux à *Nerinœa Bruntrutana.*
- Calcaires blanchâtres à *Ostrea solitaria* et *Hemicidaris diademata.*

These terrains are considered by some to belong to the upper division of the Corallian, and by others to constitute a distinct formation intermediate between the Oxfordian and Kimmeridge stages. The Séquanien is largely developed in several departments of France, especially in the Franche-Compté, comprising

the Haute-Saône, Doubs and Jura. As this region was formerly inhabited by a powerful Celtic race, the Séquani, their name has been given to the group. M. Thurmann * described these beds as they are seen at Mont-Terrible,—1st, as *Calcaires à Astartes*, Calcaires compactes, à cassure conchoïde, avec *Astarte minima* et très-peu de fossiles, 20 mètres in thickness; 2nd, *Calcaires à Nérinées*, Calcaires blancs, compactes-conchoïdes, ou crayeux, avec Nérinées, 20 mètres; 3rd, *Oolithe Corallienne*, Calcaire oolithique, cannabines ou pisaire inégal, souvent sub-crétacé; relief superficiel de la décomposition des oolithes presentant fréquemment une concentricité remarquable, avec *Nerinœa Bruntrutana*, *Diceras arietina*, &c., 5½ mètres. This author erroneously considered them to be synchronous with the English coral rag.

M. Thirria † in his description of the Jura of the Haute-Saône followed a like division of the Séquanien, as may be seen in his section given at p. 75. M. Jules Marcou ‡ has described these strata in his groupe "Séquanien, Kimméridien et Portlandien" and establishes the synchronism of the Séquanien or Groupe de Besançon with the Calcaire à Astartes of the Haute-Marne, the Meuse, the Côte-d'Or, and Haute-Saône, in his Roches du Jura. §

M. Etallon || divides the Terrain Jurassique Supérieur into two stages,—1st, *Calcaire Corallien*. 2nd, *Dicératien*. The first are the rocks that belong to the coral rag, and have been already described: the second represent that portion of the Séquanien which is characterized by *Nérinées* and *Diceras*. "Les *Diceras* se trouvent en immense quantité; c'est de beaucoup le fossile le plus abondant, et parmi eux domine le *Diceras Münsteri*, Goldf. *Diceras speciosa*, Goldf., est aussi très-commun, mais sa grande

* Essai sur les Soulèvemens Jurassiques du Porrentruy: 1832.

† Statistique géolog. de la Haute-Saône: 1833.

‡ Recherches sur les Jura salinois, p. 116: 1846.

§ Les Roches du Jura, p. 174: 1860.

|| Esquisse géol. du Haut-Jura, p. 47: 1857. Statistique géolog. du Départ. de la Meuse: 1852.

taille ne permet de l'obtenir que rarement entier. L'oolithe n'étant pas spéciale à cette sub-division, j'ai cru devoir adopter le nom de Dicératien."

M. Buvignier, in 1852, and M. Ed. Piette, in 1857, have made important works on the department of the Meuse, the "*Calcaire à Astartes de Verdun*" formé à la partie supérieure de calcaires blancs crayeux, quelquefois gris marno-compactes; et à la partie inférieure d'argiles grises ou jaunâtres assez passantes, avec *Ostrea Bruntrutana, Astarte minima, Melania striata, Ceromya inflata, Cardium Buvigineri.* This formation attains here a thickness of 130 mètres and rests upon the coral rag de St. Mihel, consisting of white chalky Limestones of great purity, containing *Nerinæa Bruntrutana, N. nodosa,* and *Diceras arietina* in its upper portions; *Ostrea gregaria, Cidaris Blumenbachii, Hemicidaris crenularis, Thamnastræa affinis, Calamophyllia flabellum,* and *Cal. articulosa* in its lower division. The coral rag attains a thickness of 130 mètres = 400 feet.

Séquanien.

The *Séquanien or Nerinæn zone,* which forms so important a member of the Corallian series in France and Switzerland, is not represented in England. The fine white Limestones, for the most part, composing these rocks are formed of the *débris* of coral-reefs that played so important a part in the seas of the upper Jurassic epoch; and if strata synchronous with those forming this stage ever existed in our area they have been eroded and subsequently removed from English soil by denudation. This fact affords a good illustration of an observation previously made in reference to the existence and development of different zones of the Lias and Lower Oolites. In some localities, for example, we find certain terrains largely thickened and containing few characteristic fossils; in others the zone may be absent, or present and feebly developed, and the thin rudimentary beds composing it may be largely charged with their leading shells; so that in studying the Jurassic formations, with a view to establish their synchronism, it is on the palæontology

of each stage, more than on its lithological character and physical development, that we must depend for a true determination of its age and correlation.

Kimméridien = Kimmeridge Clay.

The upper Jurassic rocks present a greater diversity of character in different regions than the members of the middle and lower divisions, and the difficulty of establishing the synchronism of their several stages increases in our ascent from the Coral Rag to the summit of the Purbeck series; several reasons may be given for this, but our chief obstacle is the want of a better classification, and more detailed study of the Kimmeridge clay and Portland formations of England, and this is the reason for my reticence regarding the correlation of some of these deposits. M. Martin defines l'étage Kimméridien thus:—

Kimmêridien.	{ Marnes et calcaires marno-compactes à *Ostrea virgula*. { Calcaires à Ptérocèren avec quelques *Ostrea virgula*.

M. G. de Nerville* includes the calcaire à Ptérocèren in his groupe corallien of which it forms the uppermost terrain, and thus defines it "*Calcaire à Ptérocères.* Calcaire jaune, à points verts, sableux, renfermant quelques minces bancs de marnes sableuses, caractérisés par le *Pterocera Oceani.*" The marnes à *Ostrea virgula* he makes the base of his groupe Kimméridien et Portlandien, and describes as "marnes blanchâtres renfermant une grande quantité de Gryphées virgules, *Terre à fours.*" In the Haute-Saône M. Thirria unites the two in one group, as "calcaires et marnes à Gryphées virgules," and describes as marne grisâtre, divisée en plusieurs assises par de minces bancs de calc. marn. avec *Ammonites gigas, Nautilus giganteus, Pterocera Oceani, Pholadomya protei, Ceromya excentrica, Ceromya inflata, Exogyra virgula, Exogyra Bruntrutana, Ostrea solitaria, Nerinæa grandis, Nerinæa cylindrica,* &c. These beds form the groupe de Porrentruy of M. Marcou in his Jura salinois, and they are les argiles à *Ostrea virgula* de Loxeville, of M. E. Piette, in the department of the Meuse, and are

* Légende explicative de la carte géolog. du Départ. de la Côte-d'Or: 1853.

defined as "argiles composées d'alternances de marnes grises ou bleues avec intercallations de calcaires blancs grisâtres ou jaunâtres avec *Ostrea virgula, Ostrea spiralis, Pterocera ponti, Ammonites nucleus, Trigonia supra-jurensis,* &c." These strata have a thickness of about 80 mètres.

M. Thurmann makes this group his second division, or *marnes Kimméridiennes,* and which he defines as "marnes jaunâtres et calcaires marno-compactes, grumeleux, avec exogyres et nombreux fossiles, à l'état de moule intérieur," and in his later letters on the Jura considers the thickness of these marnes to be 35 mètres.

During the formation of the Great Western Railway by Wotton Bassett a section of the Kimmeridge clay was made, and from this I obtained some of its characteristic fossils, as *Ammonites decipiens, Amm. mutabilis, Pleurotomaria reticulata, Ostrea virgula, Ostrea deltoidea,* &c. This formation is, however, feebly exposed in Wiltshire. Near Farringdon, Berks, it consists of a dark blue or olive-coloured clay, with sandy or calcareous bands containing fossils, and is overlain by the Sponge gravel beds of the Lower Greensand; and at Culham by the blue laminated clay of the Gault, containing *Ammonites interruptus.* At Headington Hill it is seen in position resting upon the Coralline Oolite, and here contains *Exogyra virgula, Ostrea deltoidea, Rhynchonella inconstans, Ammonites biplex,* with large bones of Dinosaurians belonging to the genera *Pliosaurus, Ichthyosaurus* and *Steneosaurus.*

The fine section on the Dorset coast, between St. Alban's Head on the east, and Gad Cliff on the west, embracing its type locality—Kimmeridge Bay, affords a magnificent exposure of this formation, which is best seen by sailing along the coast; near the shore it forms the lower portion of the cliffs, and consists of dark blue bituminous clay, overlain at Swyre Head by Portland sand and stone.

Portlandien = Portland Oolite.

M. Martin defines these terrains as—

Portlandien. { *a* Calcaires marneux et marno-compactes à *Trigonia Boloniensis* et *Pinna supra-jurensis.*
b Calcaires marno-compactes à *Amm. gigas.*

M. G. de Nerville* likewise divides this groupe Portlandien into—

a Calcaires jaunâtres, compactes, bréchiforms en bancs épais perforés d'une infinité de trous sinueux et lisses ... ... 30 mètres.

b Calcaire marno-compacte, de couleur jaune nankin, criblé de dendrites noirâtres par petits bancs ... 20 "

M. Marcou† includes these two bancs in his Calcaires de Salins, and M. Thirria‡ enumerates the following beds in his Calcaires Portlandiens in the Jura de la Haute-Saône:—

Calcaires Portlandiens.

a	Calcaire compacte, gris-jaunâtre	1 , 50
b	Calc. lumachelle	0 , 18
c	Calc. avec *Nerinea*	0 , 20
d	Calc. grisâtre	0 , 10
e	Calc. avec *Nerinea*	0 , 16
f	Calc. grisâtre en plaquettes	1 , 30
h	Calcaire marno-compacte, gris-blanchâtre en bancs peu épais, séparés par petites couches de marne grisâtre avec *Exogyra virgula*, *Trigonia concentrica*, *Terebratula*	10 , 00
i	Calc. avec fragments de *Trichites*	0 , 15
k	Calc. compacte non-fossilifère...	5 , 00
l	Calc. blanc-grisâtre avec *Nerinea*	3 , 00

In the department of the Meuse the Portlandien is well developed, and has been described in detail by M. Buvignier in his Statistique géologique; and, subsequently, by M. Ed. Piette, from whose memoir we learn that the Portland terrains are described as "*Oolite du Barrois*," and appear to resemble, in physical and palæontological characters, the Portland Oolite of England. The group is divided thus:—

a *Sous-groupe supérieur des calcaires de Brillon*, formé de calcaires compactes, d'un gris verdâtre, avec intercallations de bancs d'Oolithe vacuolaire et de calcaires lumachelliques appelés roches fromtelles; et aussi contenant des bancs de calcaires sub-compactes dolomitiques; avec *Anomya supra-jurensis*, *Pholadomya Barrensis*, *Trigonia gibbosa*, *Melania crenulata*, *Delphinula vivauxea*, *Cerithium Dammariense*, &c. ... ... 40 , 00

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* Légende explicative: 1853.

† Roches du Jura, p. 162: 1860.

‡ Statistique géolog. de la Haute-Saône: 1833.

b *Sous-groupe moyen des calcaires de Ligny;* formé de calcaires très-dures, compactes, criblés de cavités irregulières et appelé calcaires cariés, avec *Ammonites gigas, Cerithium supracostatum, Ostrea virgula* ... ... 95 , 00

c *Sous-groupe inférieur des calcaires blancs et argiles blanches d'Auberville;* formé d'alternance de bancs de calc. blanc, crayeux, gris ou meme jaunâtre, et d'argile de même couleur; avec *Ostrea virgula, Trigonia gibbosa, Lima argonnensis, Pholadomya acuticosta, Panopœa Voltzii, Ammonites gigas,* &c. ... 60 , 00

M. THURMANN* has described the *Calcaire Portlandien* in the coupe du Banné près Porrentruy, where it attains a thickness of 20 mètres, and consists of—

a Calcaires compactes, marno-compactes ou oolithiques. Cassure sub-conchoïdale. Cohesion moyenne. Couleurs claires très-variées.

b Structure en grand distincte et régulière. Dendrites, filets, nœuds spathiques.

c Fossiles assez nombreux à l'état de moule intérieur, excepté les genres *Terebratula, Pinna, Ostrea, Trichites,* etc. Test calcaire. Absence de fossiles siliceux.

d Calcaires compactes, sub-conchoïdaux, de couleur claire; de fines Oolithes que je n'ai jamais vu dépasser et rarement même atteindre la dimension miliare, et que, au contraire, sont souvent d'une ténuité remarquable. La présence des protos, des exogyres, et des grosses isocardes paraît aussi assez constante.

e Dans les parties inférieures, les alternances marno-compactes et marneuses se multiplient. Les fossiles deviennent plus nombreux, et la stratification plus obscure.

In the department of the Pas-de-Calais and in the coast section near Boulogne-sur-Mer the Portlandien is seen resting on the Kimmeridge clay at Crèche, Couple, Share, Falaise d'Alprecht, and Moulins de Ningle: it consists of a light-coloured sandy Limestone, full of crystallized carbonate, and in the upper stage contains many fossil shells identical with the Portland Oolite of England. Here are found—

* Les soulèvemens Jurassiques du Porrentruy, p. 11.

Pecten lamellosus, *Sow.*
Cardium dissimile, *Sow.*
Perna Suessi, *Oppel.*
Trigonia incurva, *Sow.*
Trigonia gibbosa, *Sow.*
Natica elegans, *Sow.*
Buccinum naticoides, *Sow.*
Ammonites giganteus, *Sow.*

ECHINODERMATA.

Cidaris Boloniensis, *Wright.*
Hemicidaris Davidsoni, *Wright.*
" Purbeckensis, *Forbes.*
Acrosalenia Kœnigii, *Desml.*
Echinobrissus Brodieii, *Wright.*
" Haimei, *Wright.*
Astropecten Loriolii, *Wright.*
Ophidiaster Davidsoni, *Wright.*
Pentacrinus Bouchardi, *Wright.*

My late friend, M. BOUCHARD-CHANTEREAUX, kindly sent me a series of all these specimens from the Portlandien of Boulogne, and which I have critically compared with those of the same species found in the Portland formation of the island of Portland, and from beds of the same age at Brill, Bucks; and Tisbury, and Swindon, Wilts.

In the department of the Pas-de-Calais, in the environs of Boulogne-sur-Mer, the Kimméridien and Portlandien stages are well exposed in the coast section between Cap Gris-Nez in the north, to Eguihen in the south. These terrains have been the subject of important studies made by Professor HEBERT, M. SÆMANN and others; and lately an admirable monograph has been published by my friend M. P. de LORIOL and M. E. PELLAT, in the "Mémoires de la Société de Physique et d'Histoire Naturelle, Genève."* As this important work gives a most accurate account of all the beds by M. PELLAT, and descriptions and figures of the fossils by M. de LORIOL, it forms an epoch in the natural history of the upper division of the Jurassic rocks of France, and a most valuable guide to a more detailed examination of their correlative formations in England. Having been long acquainted with the fossils of the Portlandien of Boulogne, from several communications of the same made to me by my late friend M. BOUCHARD-CHANTEREAUX, I can fully

* Monographie Paléontologique et Géologique de l'étage Portlandien des environs de Boulogne-sur-Mer. Genève: 1866.

appreciate the sterling value of this work, and commend it to all who wish to extend their knowledge of the formations on which it treats.

M. de Loriol gives the collective name terrain Kimméridien to all the deposits comprised between the "terrain Oxfordien, et les couches de Purbeck," and forms four sub-divisions in the terrain Kimméridien,—1° L'étage *Portlandien*. 2° L'étage *Virgulien*. 3° L'étage *Ptérocèrien* ou Strombien. 4° L'étage *Séquanien* ou Astartien. These four stages, taken together, correspond very nearly to the Superior Oolite of several authors, and to "l'étage des calcaires du Barrois" of Professor Hebert, and M. E. Piette.

L'étage Séquanien consists of a yellow Limestone, with *Nerinæa Goodhalli*, and the sandstones and clays of Wirvigne; the former rests upon a compact Limestone, with *Cidaris florigemma* and *Phasianella striata;* the Nerinæan Limestone contains a great abundance of *N. Goodhalli* and *Terebratula humeralis*. The Sandstone of Wirvigne contains a great number of Echinidæ, as *Pseudodiadema mamillanum* and *Pygurus Royerianus*. *Ostrea virgula* appears here for the first time.

L'étage Ptérocèrien consists of thin beds of argillaceous Limestones, having other coloured bands interstratified with them, and containing *Pholadomya hortulana*, *Ceromya*, and *Pinna granulata*.

L'étage Virgulien, with *L'étage Portlandien*, constitute the entire escarpment of the Jurassic cliffs of the Bas-Boulonais; the former consists of an intercalation of dark-coloured clays, limestones, sands, and sandstone, with *Ammonites longispinus*, *Trigonia variegata*, *Trigonia Rigauxiana*, *Ostrea virgula*, *Pholadomya acuticostata*, and has a thickness of 80 mètres.

L'étage Portlandien admits of a three-fold division,—the 1st, or *inferior stage*, from 15 to 20 mètres in thickness, consisting of sands and sandstones, with *Ammonites gigas*, *Natica Marcousana*, and *Perna rugosa;* they are all well exposed in the Cap de la Crèche and in the railway cutting at Terlincthun; the fossil shells are numerous, as *Trigonia Micheloti*, *Tr. Barrensis*, *Tr. Boloniensis*, *Mytilus Morrisii*, *Ostrea virgula*, *Astropecten Loriolii*, and *Hemicidaris Purbeckensis*.

The *middle stage*, or argiles glauconieuses à *Cardium Morinicum*, et *Ostrea expansa*, is 30 mètres in thickness and contains *Ammonites biplex, Cidaris Boloniensis, Acrosalenia Königii.*

The *upper stage*, or grès à *Trigonia gibbosa* and *Tr. incurva*, from 8 to 10 mètres thick, was identified by Dr. Fitton as the equivalent of the Portland stone of England; it contains, likewise, *Ammonites giganteus, Cardium Pellati, Serpula coacervata, Pecten lamellosus, Echinobrissus Brodieii, Echinobrissus Haimii, Natica Ceres, Astarte sociales.* This stage forms the summit of the cliff, where it is well exposed; likewise at Mont de Couple, Falaise d'Alprecht, and at la Butte de Ningle. I have endeavoured to epitomise the admirable section given by M. Pellat, in the following table:—

(See opposite page.)

Classification of the Upper Jurassic Rocks of Boulogne-sur-Mer.

Stages.	Formations.	Leading Fossils.
Wealden Clay and Hastings Sands.		Cyrena ferruginea.
Terrain Kimméridien. — Étage Portlandien.	Upper Portland, with Cardium dissimile.	*Cypris, Astarte socialis, Cardium dissimile, Natica Ceres, Trigonia gibbosa, T. incurva, Amm. giganteus, Card. Pellati.*
	Middle Portland, with Cardium Morini.	*Astarte Sœmmani, Acrosal. Königii, Ostrea expansa, Perna Bouchardi, Lima Boloniensis, Amm. biplex, Card. morinicum, Ostrea Bruntrutana.*
	Lower Portland, with Ammonites gigas.	*Pterocera Oceani, Natica Marcousana, Perna rugosa, Trigonia Micheloti, T. Pellati, T. variegata, Amm. gigas.*
Étage Virgulien.	Upper Clays, with Ostrea virgula.	*Amm. mutabilis, Thracia supra-jurensis, Pinna granulata, Gervillia Kimmeridiensis, Ostrea virgula, Ostrea deltoidea, Pygaster macrocyphus, Trigonia variegata.*
	Sandstone Ostr. virgula	
	Middle Clays, with Ostrea virgula.	*Amm. longispinus, Pholadomya acuticostata, Trigonia Rigauxiana, Gervillia Kimmerid., Ostrea virgula.*
	Sandstone Ostr. virgula	
	Lower Clays, with Ostrea virgula.	Fossils as in the upper beds
Ét. Ptérocèrien.	Limestone of Bréquerèque.	*Pholadomya hortulana.*
Ét. Séquanien?	Grès of Wirvigne.	*Ostrea virgula, Pygurus Royerianus.*
	Oolite, with Nerinæa.	*Nerinæa Goodhalli, Terebratula humeralis,*
Terrain Oxfordien.		*Cidaris florigemma.*

The Portland Oolite is well exposed at Swindon, Tisbury, Chicksgrove, and other places in the vale of Wardour, Wilts; at Shotover, Oxon; at Hartwell, near Aylesbury; at Brill and Stone, Bucks; and in the island of Portland and other localities in Dorset. It consists of Sands and Sandstones below, gradually becoming calcareous as we ascend, and passing into light-coloured Limestones above. Many of the beds contain layers of chert, alternating with them like flints in the upper cretaceous rocks. The Portland beds are divisible into—

a. Portland stone, consisting of fine white calcareo-siliceous Limestones with oolitic structure, and known locally as "Stonebrash" and "Roche" by the workmen; with these are interstratified layers of clay and masses of chert, 90 feet thick.

b. Portland sands, consisting of brown and yellow sands, and sandstone, the lower portion full of green grains of the silicate of iron, Glauconite, 80 feet.

c. Kimmeridge clay.

Several very fine sections are exposed in different quarries in the island of Portland, where the marine beds of the Portland Oolite are overlain by the estuarine series of Purbeck beds, consisting of clays and limestones crowded with freshwater mollusca, the soil of old land or "dirt beds," with the roots and stems of trees, *Cycadeæ* seen in the position in which they grew prior to their submergence beneath the Neocomian wave. A very interesting section of upper oolitic strata is seen in a hill near Hartwell, by Aylesbury, where the Portland, Purbeck, Wealden, and Neocomian strata are found in position resting on Kimmeridge clay, which is worked for brickmaking, and contains many fossils in fine preservation, as *Ammonites biplex*, *Belemnites Souichii*, *Astarte Hartwelliensis*, with the bones of *Pliosaurus*. My late friend, M. Sæmann of Paris, examined this locality and made a section of the beds in 1866, with the intention of correlating the English Portland beds with the Portlandien stage, which he had previously studied at Boulogne-sur-Mer. His notes and section have been published by my friend M. P. de Loriol and M. E. Pellat in their Monograph on l'étage Portlandien des environs de Boulogne-sur-Mer.

From the Hartwell brickyard, situated in the valley, consisting of a black sandy Kimmeridge clay, M. Sæmann collected *Ammonites biplex, Belemnites Souichii, Pleuromya Tellina, Thracia depressa, Cardium Morinicum, Perna Bouchardii, Mytilus Bolonensis, Pecten Morini, Lima Boloniensis, Ostrea expansa,* and many other shells in a fine state of preservation, of which only one—*Astarte Hartwelliensis,* Sow.—appears to have been figured. *Ammonites biplex* is very abundant, and sometimes it is most perfectly preserved in the clay, or enclosed in géodes. These fossils are found at Hartwell in the same proportion and abundance as at Boulogne, and their association proves undeniably the existence of the middle Portlandien of the Boulonais in England. The clays, with *Cardium Morinicum,* are overlain by sandy and argillaceous beds, some of which are fossiliferous, containing *Pleuromya, Unicardium,* and *Thracia angulare.* This bed likewise occurs at Shotover, where it contains Ammonites. The upper portion of the sand is concealed by vegetation, and above this is a quarry of Portland stone, with *Ammonites giganteus,* extensively worked at Hartwell; both the flat and inflated varieties of this shell occur; the flattened forms resembling the Ammonites of the Middle Portlandien of the Boulonais, with *Natica elegans, Natica Ceres, Cardium Pellati, Cardium dissimile, Trigonia incurva, Trigonia Pellati, Lima rustica, Pecten lamellosus, Ostrea expansa,* and *Serpula coacervata.* Numerous traces of this annelide are seen on the Ammonites. These Portland marine beds are overlain by the estuarine Purbeck strata, consisting of shales, clays, and marly limestones, full of freshwater organisms, as *Cyrenæ, Cyprides,* and fishes, with the remains of insects, and lacustrine plants. The Wealden beds are likewise represented in this instructive section, as we have *Cyrena, Unio,* and *Paludina,* with the Wealden plant *Endogenites erosa.* The hill is capped by Lower Greensand, or Neocomian strata, containing *Exogyra sinuata, Pecten obliquus, Ostrea macroptera,* &c. From this section it is inferred, 1st,—that the Lower Portlandien of the Boulonais, with *Perna rugosa* and *Pterocera Oceani,* is not represented here. 2nd,—that the dark sandy clays of Hartwell

are identical with the representative of the argiles glauconieuses of the Boulonais, or Middle Portlandien. The Portland sand of Fitton comprises the "sables glauconieux," which correspond to the "couches sableuses et glauconieuses" of the upper portion of the Middle Portlandien of the Boulonais; these sands contain, at Shotover, the same fossils as the sub-adjacent clay of Hartwell, and are related like the beds with *Astarte Sœmanni* of the Boulonais to the Middle Portlandien. The upper portion of the sands, without the silicate of iron, Glauconite, are destitute of fossils, these M. SÆMANN unites with the Portland stone, and groups as Upper Portlandien. The sands are overlain by a bed with *Cardium Pellati*, which contains at Swindon *Perna Bouchardi*, and at Hartwell *Pecten lamellosus* and *Ostrea expansa*. At Swindon this bed is covered by a hard blueish rock, containing *Ammonites giganteus;* above this are twenty feet of sands with inconstant layers of sandstone, and some beds containing Trigonias intercalated with them. The sands are overlain by a series of Limestones and marly sediments, in the lower portion of which we find *Cerithium Portlandicum*, corresponding to the great horizon of the Island of Portland, and in the upper portion *Lucina portlandica*, *Cyrena rugosa*, and *Neritoma sinuosa*.

If this reading of the Hartwell section is correct, the conclusion is—

1st,—That in England the *Lower Portlandien*, or the beds with *Perna rugosa* and *Pterocera Oceani*, is absent.

2nd,—That the *Middle Portlandien* is represented by the dark sandy clays of the brickyard at Hartwell, containing *Ammonites biplex*, *Cardium Morinicum*, and *Ostrea expansa*, &c. A portion likewise of the overlying fossiliferous sand, with green Glauconite grains, belongs to this group.

3rd,—The *Upper Portlandien*, so largely developed in England, has at its base the non-fossiliferous sands without Glauconite, and in its middle and upper portions the true calcareo-siliceous Limestones and other beds forming the Portland stone, and containing *Ammonites giganteus, Cerithium portlandicum, Natica elegans, Natica Ceres, Trigonia incurva, Trigonia gibbosa, Cardium dissimile, Pecten lamellosus*, &c.

The Kimmeridge clay so well exposed on the Dorsetshire coast, and traceable through Wiltshire, Buckinghamshire, Lincolnshire and Yorkshire, is everywhere characterized by *Ostrea deltoidea*. This formation is, comparatively speaking, a barren deposit in our island, and good fossiliferous beds have not yet been exposed. Our present knowledge of this great argillaceous deposit is most imperfect, and until a good series of its fossils is obtained it is impossible to correlate its beds with those of the "*Argiles Virguliennes*" of the Boulonais.

My observations have greatly exceeded the limits I had originally prescribed to this memoir, and I have to apologize for their unavoidable extension. I was anxious to place before my associates the notes I had made in France on a subject most interesting to all persons who study Jurassic Geology; and especially to those of our members who have taken a part in the discussions which, from time to time, have occupied our attention in our many meets among the charming Cotteswold Hills,—the miniature Jura of Gloucestershire. If these remarks should perchance awaken in any of my colleagues a taste for the study of Comparative Geology, my work will not have been in vain. Having been for many years an earnest student of Jurassic Palæontology, in connection with my large work on the Oolitic Echinodermata, I have become deeply impressed with the importance of this kind of knowledge, not only to those who, like myself, may take up special branches of investigation,—for to all such it is indispensable,—but to those also who desire to acquire larger views of natural phenomena, and who strive to emancipate their minds from the narrow ideas and insular prejudices that unconsciously entwine themselves around the observer who limits his investigations to particular localities, and excludes from his enquiry any knowledge of similar phenomenain other regions or other lands;—to all such persons Comparative Geology offers a vast field of investigation, replete with instruction, charming from associations and recollections, and affording materials for a more philosophical survey of nature, and a truer conception of the wonderful laws by which the fabric of our globe has grown, and been developed into its present condition.