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THE

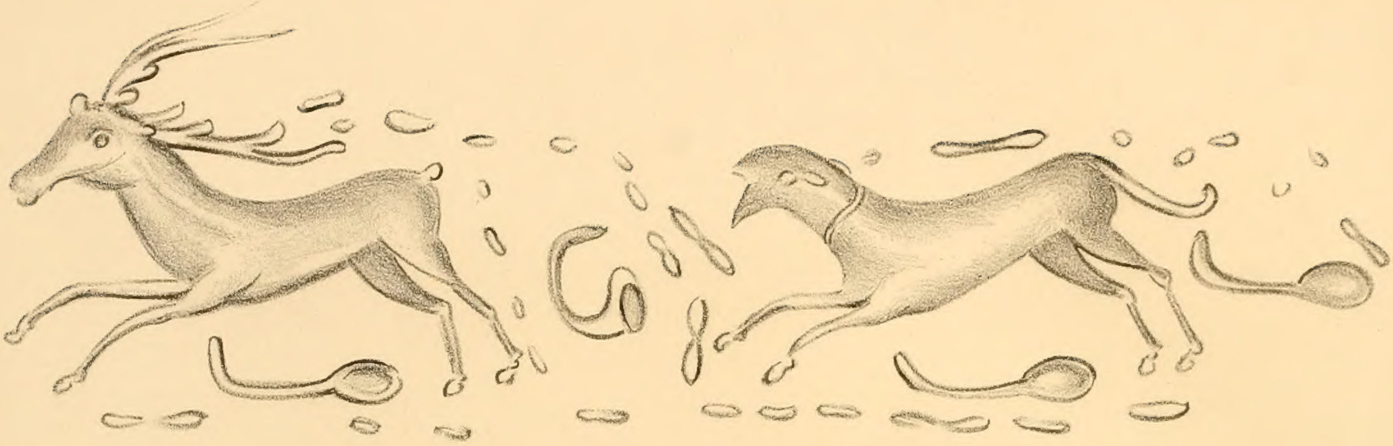
GEOLOGY AND FOSSILS

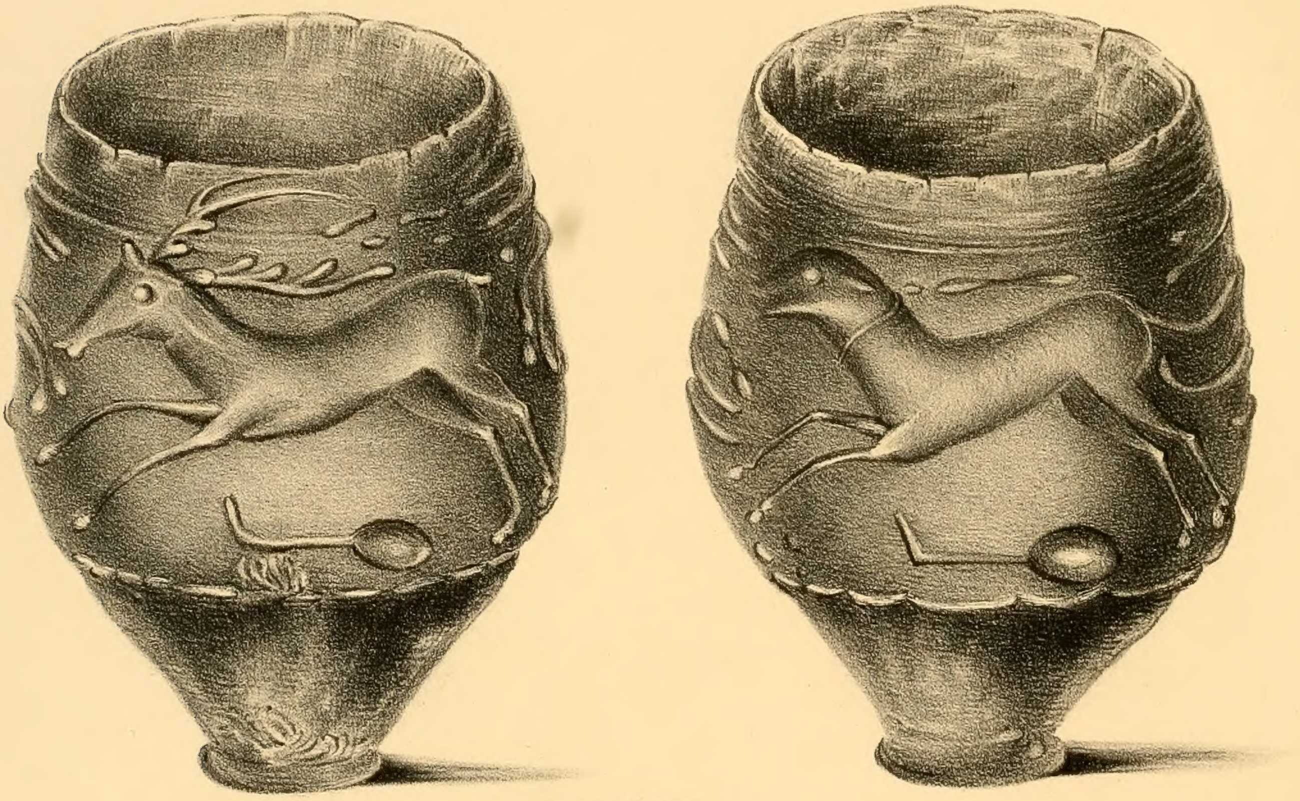
OF

THE TERTIARY AND CRETACEOUS FORMATIONS

OF

SUSSEX.





Drawn on Stone by Maria Dixon

Day & Son, Lith^{rs} to the Queen.

FUNEREAL VESSELS,

The same size as the original, found at Worthing in 1845, in cutting for the Railroad.

1, Ornaments continued round N^{o} 2. 3. Glass Vessel.

THE

GEOLOGY AND FOSSILS

OF THE

TERTIARY AND CRETACEOUS FORMATIONS

OF

SUSSEX.

BY

FREDERICK DIXON, ESQ., F.G.S.

"In the present state of Geological knowledge, Facts are more wanted than Speculations."—BAKEWELL.

LONDON:
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Sm 1850.

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TO

HIS GRACE THE DUKE OF NORFOLK,

HEREDITARY EARL-MARSHAL OF ENGLAND, K.G., ETC.,

THIS WORK,

CONTRIBUTARY TO THE SCIENTIFIC HISTORY

OF THE COUNTY WHICH OWES SO MUCH TO ITS RELATIONS WITH THE

HOUSE OF HOWARD,

IS,

WITH HIS GRACE'S PERMISSION,

AND AGREEABLY WITH THE EXPRESSED WISHES OF THE AUTHOR,

MOST RESPECTFULLY DEDICATED.

EDITOR'S ADVERTISEMENT.

When my esteemed and lamented friend, the Author of the present Work, was removed from the scene of his useful and benevolent labours, he had made considerable progress towards its completion.

Most of the plates had been engraved or lithographed, and nearly two-thirds of the letter-press was printed. There remained principally the fossils of the Chalk formation, in the preparation of which, for the press, the present Editor has to acknowledge the prompt and friendly contributions, by William Lonsdale, Esq., F.G.S., of the descriptions of the Corals; by Professor Edward Forbes, F.R.S., of the Echinoderms; by Professor Thomas Bell, Sec.R.S., of the Crustaceans; by James De Carle Sowerby, Esq., F.G.S., of the Mollusks; and the kind assistance rendered by Sir Philip de Malpas Grey Egerton, Bart., F.R.S., in revising the Author's notes on the extinct fishes of the Chalk, and in describing the plates illustrative of that class of the Cretaceous fossils.

Much expense had been incurred by Mr. Dixon in the illustrations of his Work, and after his decease, it was apprehended that its further progress might be arrested pending the final arrangement of his affairs. But this source of delay was promptly removed by one who appreciated his worth as a neighbour and a friend. Mrs. Thwaytes, of Charman Dean near Worthing, as soon as she became aware of the circumstance, most liberally supplied Mrs. Dixon with the funds required for the completion of the Work.

The geologist who may find in its pages, or its beautiful and accurate plates, a helping guide in the course of his investigations, will cheerfully acknowledge his debt of gratitude to this benevolent Lady: and her name will ever be honourably associated with those of other munificent promoters of the progress of science in this country.

Amongst the manuscripts, with other materials of the Work, entrusted to the Editor by the disconsolate relatives of the Author, was the 'Preface,' which is characteristic of Mr. Dixon's estimable and devout disposition: it is without date, but appears, by the reference to the 'Palæontographical Society,' to have been written in the year 1848. With the Preface were some detached notes on the principal chalk-pits in the neighbourhood of Worthing, and a Sonnet, in which Mr. Dixon had commemorated a day, the pleasing recollection of which, by those who spent it with him, is saddened by the reflection that it was the last of the instructive and delightful excursions made with the amiable Author to the scenes which he loved and the localities from which he drew such rich stores for the illustration of their geological history.

R. O.

AUTHOR'S PREFACE.

In offering this Work to the Public, I must state that it was commenced, and most of the materials were collected for it some years ago, under the expectation that it would have been completed long before the present time. To those who have been cognizant of its progress, and may have expected its earlier appearance, I trust that the plea of professional duties, a residence in the country, and unexpected delays attendant on the engraving of many of the specimens, may be received as an excuse. If it should seem that I have been guided by the Horatian precept "nonum prematur in annum," it has been through compulsion of these concurrent circumstances of delay, which, however, I do not regret, since it has enabled me to add from time to time descriptions and figures of many new and important fossils, and to have had the advantage of comparing my own results with those given in some excellent recent English and foreign publications.

An apology may, perhaps, be expected for blending antiquarian notices with the description of a geological work. A few years ago there were no Archæological associations or journals; but a local geologist, whose immediate researches were into the antiquities of remoter epochs of his district, could hardly fail to have his interest excited by the analogous evidence of the past history of his own race. I was therefore led to add the facts that came to my notice, and so attempt to fill up the hiatus between the last geological change and the existing period. Now, I am glad to say, many counties have their Archæological meetings. Last year a new Society, called the Palæontographical, was formed for editing and describing the fossils of England: this shows an increasing interest in these pursuits, which is very gratifying. I have principally confined my observations to the fossils of Sussex. Some of the subjects of Professor Owen's descriptions, many of the Asteriadæ described by Professor Forbes, and a few Corals by Mr. Lonsdale, are, however, from the Chalk formation of Kent or neighbouring counties.

I have endeavoured to avoid as much as possible unnecessary technicalities, for many persons are deterred from reading scientific works through the fear of meeting what are called "hard words." The coining of names from the Greek and Latin languages in order to designate fossil species is, nevertheless, absolutely necessary; but the day, I hope, is long gone by when the dead languages were used to conceal truth and mystify the understanding. Every thought that can elevate the mind and improve the heart is capable of being expressed in our own language: even the advantage to the geologist of different countries, of Latin descriptions and names of fossils, decreases daily as the cultivation of the different living languages of Europe increases.

In the following pages I have entered into no speculative inquiry. Geology is not at variance with the sacred truths of Scripture; and it must be borne in mind that every fossil, as well as recent being, is the record of the will of God. Palæontological inquiry points out the wonderful power and wisdom of God at all periods of time; shows that in extinct beings the same law of excellent adaptation of means to ends regulated their structure in subservience to their welfare, as is now manifested in existing creation.

Professor Sedgwick, in his Discourse on the Studies of the University, at page 30, has the following beautiful sentence:—

"All nature is but the manifestation of a Supreme Intelligence, and to no being but him to whom is given the faculty of reason, can this truth be known. By this faculty he becomes the lord of created beings, and finds all matter, organic and inorganic, subservient to his happiness and working together for his good. A part of what is past he can comprehend; something even of the future he can anticipate; and on whatever side he looks, he sees proofs, not of wisdom and power only, but of goodness."

If I for one moment thought this volume contained a single sentence that would shake in the smallest degree the religious faith of any person, I should for ever condemn myself; but I am thoroughly convinced that scientific inquiry adds greatly to the happiness of thinking beings. I have now only to express my gratitude to those friends who have so kindly given me their valuable assistance, being perfectly satisfied that their sentiments accord with that devotional feeling, which assures us that all our endeavours, all our investigations are valueless, unless they tend to the honour and glory of God.

Worthing.

"The earth is the Lord's, and all that therein is: the compass of the world, and they that dwell therein.

"For he hath founded it upon the seas: and prepared it upon the floods."—*Psalm* xxiv.

SONNET,

Written at Houghton Chalk-pit, Sussex, on a visit with the Marquis of Northampton, Professor Owen, and John Edward Gray, Esq., June 15th, 1849.

Strangers or friends, who may in distant years
Be led by love of Nature to the spot
Where Houghton's cliff in awful grandeur rears
Its chalky head; once seen—and ne'er forgot.
There Time has cast his checker'd mantle round
Th' impending rocks, tinting with various hues
The scene: and rarest, sweetest flowers are found
Where Arun's stream its silent course pursues.
Or if by Science led you should behold
This ancient tomb of Lizards, Birds and Fish,
Such spoils, with smaller forms of every mould,
Their flinty shroud removed, will meet your wish.
These lines, to mark a happy day, were writ,
With wisdom's stores enrich'd, and keen Northampton's wit.

NOTES ON THE PRINCIPAL CHALK-PITS OF SUSSEX.

Burpham Chalk-pit is celebrated for the remains of those rare fossils called "Marsupites," which Mr. Coombe has found in such perfect preservation. It is the "upper chalk," and is very free and white. In the centre of the pit there is a large fissure filled with reddish sand, probably of the same age as the elephant-bed.

Houghton Chalk-pit is one of the most magnificent chalk-quarries in Sussex; it is of great extent, and was worked at a very early period; the northern and southern extremities present a peculiarly picturesque appearance. Time has transformed the white chalk into various shades of colour. The projecting and rough rocks, covered in many places with drooping plants and foliage, the river winding its course through the valley, and the beautiful Downs of Arundel Park, all combine to make it a very beautiful and delightful spot.

The pit itself presents one of the best sections of the upper chalk formation, that is to say, chalk with flints; and the regular deposition of the flint nodules, varying from two to eight feet apart, is well displayed. Many of the scarcest and most interesting fossils are found in it—the bones of Saurians, of Birds, Fishes, Echinoderms, Testacea, &c. The flints occasionally contain drusic cavities of quartz and calcedony. I have procured from this pit very fine specimens of botryoidal and stalactitic calcedony, and cubic crystals of calcedony, which are very rare. Foraminifera are abundant on the exterior coatings of the flints; and fossil wood, which is rare in other cretaceous deposits, is here often found in the chalk, and sometimes attached to the flints.

The large quarry on the opposite side of the river Arun is called "Balcombe-pit," and is of the lower chalk formation, or that without flints. This is also a valuable pit to the Palæontologist. Those rare fossils called Sphærulites are here discovered; bones of turtles and fishes in very good preservation, particularly *Beryx ornatus* and *Macropoma Mantellii*; echinoderms and crustaceans, especially the *Astacus Leachii*. The nodules of sulphuret of iron here often contain a *Terebratula* or other small shell in the centre, which elsewhere is rare.

There are two or three more pits near the Windmill on the road to Amberley Mount, which are well worth examining; the *Beryx radians*, palatal teeth and very large vertebræ of fishes, and rare star-fishes, have been found in them.

From the Chalk-quarries at Steyning I have obtained Saurian vertebræ, remains of fishes, Belemnites, and Echinoderms, including *Ophiura* and other star-fishes.

Washington-pit is of the lower chalk formation, and from it I have procured specimens for the last forty years; some of my best shells, star-fishes, crustaceans, and remains of fishes, have been found in it.

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3. ——? dendrophylloïdes: *a*, portion magnified; *b*, surface magnified.

4. Dendrophyllia?: *a*, end view; *b*, portion magnified; *c*, variety.

5. Siderastrea Websteri, upon a pebble: *a*, young state magnified; *b*, full-grown star magnified; *c*, portion of full-grown star highly magnified; *d*, longitudinal section; *e*, portion of an old specimen.

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8*. —— radiata?: *a*, upper surface magnified; *b*, under surface magnified.

9. Eschara Brongniarti?: *a*, magnified.

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10. Cellepora petiolus: *a*, magnified; *b*, edge view magnified.

TAB. II.

Fig. 1. Solen obliquus.
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3. Tellina plagia.
4. —— tumescens.
5. Cytherea obliqua.
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6*a*. Cardilia læviuscula.

Fig. 7. Nucula similis.
8. Corbula longirostris?
9. Nucula serrata.
10. Corbula longirostris?
11. —— Gallica.
12. Panopæa corrugata.
13. Nucula bisulcata.

Fig. 14. Cardita planicosta.
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17. Clavagella coronata.
18. Cardita planicosta.
19. Clavagella coronata.
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21. Crassatella compressa, var. sulcata.

Fig. 22. Tellina canaliculata.
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24. Solenocurtus Parisiensis.
25. Pectunculus pulvinatus.
26. Chama Gigas, young.
27. Gastrochæna corallium.
28. Lithodomus Deshayesii.

TAB. III.

Fig. 1. Tellina textilis.
2. Cytherea trigonula.
3 & 3 *a*. Mactra compressa.
4. Tellina craticula.
5. —— plagia.
6. Cytherea lucida.
7. Lucina serrata.
8. 9. } Tellina donacialis.
10. Mactra semisulcata.
11. Tellina speciosa.
12. Diplodonta dilatata.
13. Cytherea nitidula.
14. Cardium alternatum.
15. Cardita elegans ?
16. Diplodonta dilatata.
17. Cardium ordinatum.

Fig. 18. Cypricardia oblonga.
19. Limopsis granulatus.
20. Pectunculus globosus.
21. Byssoarca interrupta.
22. —— duplicata.
23. —— Branderi.
24. Lucina immersa.
25. Cypricardia carinata.
26. Chama Gigas.
27. Pecten reconditus.
28. —— plebeius ?
29. —— squamula.
30. 31. } —— 30-radiatus.
32. —— plebeius ? var.
33. —— 40-radiatus.
34. Lima expansa.

TAB. IV.

Fig. 1. Ostrea picta.
2. —— tenera, var. striata.
3. —— tenera.
4. —— longirostris.

Fig. 5. Ostrea Flabellula.
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7. Ostrea inflata.
8. Anomia tenuistriata.

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3. 4. } Cassidaria nodosa.
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Fig. 6. Turritella conoidea.
7. Fasciolaria biplicata.
8. Fusus rugosus.
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9. Sigaretus canaliculatus.

Fig. 10. Turritella conoidea, var. elongata.
11. Fasciolaria uniplicata.
12. Voluta labrella.
13. Murex minax.
14. Voluta labrella.
15. Triton expansus.
16. Voluta spinosa.
17. —— Cithara.

Fig. 18. Voluta recticosta. (Tab. VII. in text, p. 106.)
19. —— angusta.
20. —— muricina.
21. Rostellaria lucida.
22. Voluta crenulata.
23. —— nodosa.
24. —— costata.

Tab. VI.

Fig. 1. Bulla Edwardsii.
2. Solarium spectabile.
3 *a*. —— canaliculatum.
3 *b*. —— pulchrum.
4. Cerithium marginatum.
5. —— Cornu-copiæ.
6. —— marginatum.
7. —— calcitrapoides.
8. Turritella sulcata.
9. —— multisulcata.
10. Cerithium giganteum.
11. Pleurotoma attenuata.
12. 13. Strepsidura turgida.
14. Pleurotoma attenuata.
15. Cerithium cristatum.
16. Turritella marginata.
17. —— nexilis.
18. Cerithium incomptum.

Fig. 19. Turritella bicincta.
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21. Pleurotoma inarata.
22. Cassidaria coronata.
23. Pleurotoma plebeia.
24. —— dentata.
25. —— gentilis.
26. 27. Globulus labellatus.
28. Natica obovata.
29. Ampullina depressa.
30. Cassidaria coronata.
31. Ampullina pachycheila.
32. Globulus conoideus.
33. —— Willemettii.
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36. —— marginata.
37. —— bifrons.

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Fig. 1 & 3 *a*. Dentalium acuticosta.
2. Dentalium costatum.
3. —— nitens.
4. Cerithium unisulcatum.
5. Turritella fasciata.
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7. —— lanceolata: *b*, magnified.
8. —— uniplicata: *b*, magnified.
9. Fissurella Edwardsii.

Fig. 10. Solarium trochiforme?
11. Strepsidura armata.
12. Triton argutus.
13. Pseudoliva ovalis.
14. Scalaria interrupta.
15. —— acuta.
16. Dentalium acuticosta.
17. Pleurotoma curvicosta.
18. Bulla expansa.

Fig. 19. Pleurotoma obscurata.
20. 21. Mitra monodonta.
22. Globulus hybridus.
23. Delphinula Warnii.
24. Pleurotoma prisca.
25. Fusus unicarinatus.
26. Globulus scalariformis.
27. Littorina sulcata.
28. Voluta calva.
29. —— spinosa, var. platyspina.
30. Fusus parvirostrum.
31. —— errans.
32. —— incultus.
33. Buccinum stromboïdes.
Fig. 34. Fusus læviusculus.
35. Voluta Bulbula.
37. —— angusta.
38. Marginella ovulata.
39. Fusus undosus.
40. Cancellaria evulsa.
41. Melania costellata.
42. Turritella contracta.
43. Cassidaria nodosa.
44. —— ambigua.
45. 46. Voluta uniplicata.
47. Buccinum junceum ?
48. Eulima subulata.

TAB. VIII.

Fig. 1. 2. Cypræa Bowerbankii.
3. —— globosa.
4. 5. —— inflata.
6. —— Coombii.
7. 8. Pleurotoma amphiconus.
9. Conus deperditus.
10. —— diversiformis.
Fig. 11. Pseudoliva obtusa.
12. 13. Nummularia lævigata.
14. Ancillaria buccinoides.
15. —— obtusa.
16. —— fusiformis.
17. Conus velatus.
18. —— pyriformis.
19. Nautilus ziczac.

TAB. IX.

Fig. 1. Lycopodites squamatus.
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3. 4. Pinites Dixoni.
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5. —— fusiformis: *b*, magnified.
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7. Nummularia radiata.
8. Quinqueloculina Hauerina.
9. Triloculina Cor-anguinum.
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10. Belosepia Blainvillii ?
11. —— Cuvieri.
12. —— longispina.
13. —— Oweni.
14. —— brevispina.
15. —— longirostris.
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21. Serpula ornata.
22. Cerithium cancellatum.
23. Orbis patellatus.
24. Idmonea Coronopus.
25. Stylophora emarciata.
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28. Dendrophyllia?
29. Echinus?
30. Dendrophyllia?
31. Emarginula obtusa.

Tab. X.

Fig. 1 & 2. Dental plate of the Myliobates Dixoni.
3, 4 & 5. Dental plate of the Myliobates toliapicus.
6, 7 & 8. Dental plate of the Ætobates irregularis.
10. Base of the serrated spine of a Myliobates.
11 & 12. The left lower maxillary bone and teeth of Elasmodus Hunteri.
13. Periodus Kœnigii.
14–17. Portions of the prolonged premaxillaries or 'sword' of a Xiphioid fish (Cœlorhynchus).
18. The upper maxillaries and teeth of Edaphodon eurygnathus.
19. The right premaxillary of Edaphodon eurygnathus.
20. The right upper maxillary of Edaphodon Bucklandi.
21. The inner side view of Edaphodon Bucklandi.
22. A fragment of a Chimæroid tooth.
23. Platylæmus Colei.
24–27. Vertebræ of Fossil Fishes.
28–31. Teeth of Lamna elegans.
32–35. Teeth of Otodus obliquus.

Tab. XI.

Fig. 1. Part of the lower dental plate of a recent Sting-ray, Myliobates.
2–4. Ætobates irregularis.
5. —— convexus.
6. —— subconvexus.
7. A single tooth of Ætobates.
8. Ætobates rectus.
9. Lower jaw and teeth of a recent Ætobates.
10. Section of upper and lower jaw of Ætobates.
11–13. Defensive spines of a Siluroid fish.
14. Myliobates Dixoni.
15. —— irregularis.
16. —— Edwardsi.

Fig. 17. Myliobates contractus.
18. A tooth of the Gavialis Dixoni.
19. A tooth of the Carcharodon heterodon.
20 & 21. Two views of a tooth of the Otodus lanceolatus.
22 & 23. Teeth of the Galeocerdo latidens.
24 & 25. Teeth of Fossil Fishes.
26. Prolonged premaxillaries or 'sword' of a fossil Sword-fish (Cœlorhynchus).
27. Molar tooth of a Pachydermal quadruped (Lophiodon minimus).
27 *a.* & 27 *b.* Premolar tooth and part of jaw of the same quadruped.

Tab. XII.

Fig. 1. Ætobates marginalis.
2. Myliobates striatus.
3. —— Dixoni.
4. —— toliapicus.
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6 & 7. Teeth of a Saw-fish, Pristis.
8. Portion of fossil skin of a Placoid fish.
9 & 10. Pristis contortus.
11, 12 & 13. Dental plates of Platylæmus.
14. A vertebra of Palæophis typhæus.
15. The eighth costal plate of the right side of the carapace of a Soft-Turtle, Trionyx.
16. A costal plate of the carapace of a Turtle (Chelone).
17. A neural plate of Chelone.
18. The head of the humerus of a Chelonian.
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Tab. XIII.

Fig. 1, 2 & 3. Skull of the Chelone convexa.
4. Skull of Chelone trigoniceps.
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11. Side view of mandibular symphysis, Chelone trigoniceps.
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9. The mandibular symphysis of a smaller individual of the same species.
12, 14 & 16. A sacral vertebra of a fossil Trionyx.
13, 15 & 17. A sacral vertebra of a recent Trionyx.

TAB. XIV.

Fig. 1. Teredo ante-nautæ.
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3 *a.* Vermetus Bognoriensis.
3 *b.* }
4. } Xiphidium quadratum.
5 & 5 *a.* Teredo personata.
6. Cultellus affinis.
7. Pectunculus decussatus.
8. Cyprina? nana.
9. Panopæa intermedia.
10. Pholas Pechellii.
11. Cyprina planata.
12. Cardita quadrata.
13. Modiola elegans.
14. Panopæa Puella.
15. Nautilus Sowerbii.
16. Modiola simplex.
17. Anomia tenuistriata.
18. Lingula tenuis.
19. Ampullina patula §.
20. Solarium bistriatum.
21. Aporrhais Sowerbii.
22. Buccinum? internal cast.
23. Littorina sulcata.
24. Natica microstoma.
25. Acteon simulatus?
Fig. 26. Pseudoliva semicostata.
27. Infundibulum trochiforme.
28. Nautilus centralis.
29. Fusus tuberosus.
30. Pleurotoma prisca? internal cast.
31. Pholadomya virgulosa.
32. Pectunculus brevirostris.
33. Cardita Brongniarti.
34. Represents a portion of a large mass composed of oval grains, rather smaller than rice, collected into clusters of an elongated form, nearly an inch long, sometimes cylindrical, sometimes fusiform or flattened, piled upon one another either irregularly or in a radiating manner. Similar masses occur of various sizes, some consisting of only a few clusters, others of considerable numbers, covering a surface of 5 or more inches square. Similar bodies have long been observed by Mr. Wetherell in the Highgate clay. Can they be Coprolites?
35. Probably the remains of a Coral, or the cast of a Worm's tube?

TAB. XV.

Fig. 1. Crocodilus Spenceri.
2. The first caudal vertebra of ditto.
3. }
4. } Astacus Bellii.
5. Cancer Leachii.
6 & 6*a.* Pyrula Smithii.
Fig. 7. Voluta denudata.
8. Cassidaria nodosa.
9. —— ambigua.
10. Turritella scalarioides.
11. A tooth of the Otodus obliquus.

§ This and *A. sigaretina* are erroneously referred to *Globulus* in the list. *Globulus labellatus* is correct, p. 118.

Tab. XVI.

Magnified sections of various kinds of Fossil Woods, chiefly of Palms; forming Agates, from the Sussex coast. (See p. 234.)

Tab. XVII.

Polished sections of Choanites, Corals, and Fossil Sponges; forming Agates, from the Sussex coast. (See p. 67 and 68, which refers by mistake to Tab. XIII.)

Tab. XVIII.

Fig. 1–10. Monocarya centralis.
11 & 12. —— cultrata.
13. —— uncertain species.
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29–33. Axogaster cretacea.
Fig. 34. Axogaster cretacea var.?
35†, 36 & 37. Epiphaxum auloporoides.
35*. Diastopora ramosa?
35‡, 40 & 41. Alecto ramea.
38 & 39. Spinopora Dixoni.

Tab. XVIII. A.

Fig. 1. Alecto gracilis.
2. Diastopora Sowerbii.
3. —— ramosa?
4. Clypeina tubæformis.
5. Idmonea cretacea.
Fig. 6. Desmeopora semicylindrica.
7. Petalopora pulchella.
8. —— pustulosa.
9. Holostoma contingens.

Tab. XVIII. B.

Fig. 1. Diastopora ramosa.
2. Siphoniotyphlus plumatus.
3-5. Homœosolen ramulosus.
6. Atagma papularium.
Fig. 7. Marginaria Rœmeri.
8. Escharina intricata.
9–11. Flustra inelegans.
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Fig. 1. Pentacrinus caput-Medusæ, recent. (From the Collection of W. J. Broderip, Esq., F.R.S., F.G.S.)
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Tab. XX.

Fig. 1–3, 6, 7. Portions of Chalk Pentacrini.
4 & 5. Marsupites Milleri.
8. —— lævigatus.
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11–38. Portions of Chalk Apiocrini.

TAB. XXI.

Fig. 1. Goniaster Hunteri.
2 & 2*. Goniaster rugatus.
3. Goniaster.
4. Goniaster uncatus, dorsal or upper surface.
5. —— ——, under surface.
6. Oreaster Boysii.
7, 7 *a–e*. Oreaster coronatus.
Fig. 8. Fragment of Goniaster uncatus.
9. Fragment of a Goniaster.
10 & 11. Goniaster Parkinsoni.
12. Oreaster obtusus.
13. —— ocellatus.
14. Oreaster.
15. Fragments of Oreaster pistilliferus.
16. Fragments of an Oreaster.

TAB. XXII.

Fig. 1. Goniaster Smithii.
2.
2 *a*. } —— ——.
3. —— compactus.
4. —— Bowerbankii.
Fig. 5. Goniaster.
6. —— Coombii, dorsal surface.
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8. Stellaster Comptoni.
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TAB. XXIII.

Fig. 1. Arthraster Dixoni.
2. Disc of Ophiura serrata.
3, 3 *a*, 3 *b*. Portions of arms of Ophiura serrata: 3 *a*, magnified.
4, 5. Goniaster latus.
6. —— Coombii.
7. Oreaster squamatus.
Fig. 8. Goniaster, sp.?
9. —— lunatus.
10. —— angustatus.
11–12. —— Mantelli.
13–14. Portions of Goniaster uncatus.
15. A fragment of Goniaster rugatus.
16. Fragment of a Goniaster.

TAB. XXIV.

Figs. 1 & 2. Holaster subglobosus.
3 & 4. Micraster cor-bovis.
5 & 6. —— gibbus.
7, 8, 9. Holaster cor-avium.
10, 11, 12. —— pillula.
13, 14. Discoidea Dixoni.
15. Cidaris serrifera.
16. Outline of side view of sphere of Cidaris serrifera.
17. Magnified portion of sphere of Cidaris serrifera.
Fig. 18. Teeth of Cidaris serrifera.
19. Magnified base of a spine of Cidaris serrifera.
20. Cyphosoma spatulifera.
21. Magnified portion of sphere of Cyphosoma spatulifera.
22. Magnified base of spine of Cyphosoma spatulifera.
23 & 24. Spine of Cidaris.
25. Spine of Cidaris.
26. Goniaster mosaicus.

Fig. 27. Oreaster bulbiferus.
28. Sphere of a small or young Cyphosoma?
29. Sphere of a small or young Cyphosoma?
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31. Magnified portion of fig. 29.

TAB. XXV.

Fig. 1. Cidaris vesiculosa; 1 *a*, portion of spine, magnified.
2. Spine of Cidaris serrifera; 2 *a*, a portion magnified.
3. Spine of Cidaris sceptrifera.
4. Spine of Cidaris vesiculosa.
5. Cidaris sceptrifera.
6 & 7. Spines of Cidaris sceptrifera.
8. Cidaris perornata.
9. Section of a spine of Cidaris clavigera.
10, 11. Cidaris clavigera.
12. Portion of a Cidaris.
13. Portion of sphere of Cidaris vesiculosa.
14. Cidaris clavigera.
Fig. 15. Portion of a Cidaris.
16. Sphere of a Cidaris.
17. Cyphosoma Milleri.
18–20. Spines of Cidaris clavigera.
21. Portion of Cidaris vesiculosa.
22. Cidaris clavigera.
23–25. Salenia scutigera.
26, 27. Cyphosoma Milleri.
28. Spine and part of the head of Cidaris.
29. Cyphosoma variolaris.
30. Glypticus Koninckii.
31. Echinopsis pusillus.
32 & 33. Cidaris sulcata.

TAB. XXVI.

Figs. 1–5. Hippurites Mortoni.
4. Fragments found at Southeram chalk-pit, near Lewes.
5. Fragment from a chalk-pit in Kent, from the Collection of Mrs. Smith; it shows the surface of one of the diverging plates between the cellular tissue of which the mass of the shell is composed.
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TAB. XXVII.

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2. —— carinata, young.
3. Gryphæa globosa, var. depressa.
4. } Crania costata.
5. }
6. —— striata.
7. Exogyra Rauliniana; Ostrea, *D'Orbigny.*
Fig. 8. Hipponix, attached valves.
9. Orbicula Parisiensis: *a*, free valve; *b*, attached valve; *c*, interior of free valve.
10. Terebratula sex-radiata.
11. —— Bulla.
12. } Lituola nautiloïdea: *b*, magnified;
13. } *c*, highly magnified.
14. Lituola? (Rotalia): *b*, highly magnified.

Fig. 15.
16. Terebratulæ.
17.
18. Ammonites; a section to show the siphuncle preserved.
19. Cristellaria rotulata.
20. Emarginula affinis.
21. Terebratula striatula.
22. Ammonites Prosperianus.
23. Belemnites semicanaliculatus.
24. Baculites Faujasii.
25. Emarginula affinis; cast of exterior.
26. Turbo gemmatus.
Fig. 27. Pleurotomaria perspectiva.
28. Belemnites mucronata; a cast in flint.
29. Belemnites Baudouini.
30. Baculites Faujasii.
31. Aporrhais stenopterus.
32. Scalaria compacta.
33. Turbo gemmatus.
34. Avellana, species uncertain.
35. Natica Dupinii.
36. Aporrhais stenopterus.
37.
38. Scaphites æqualis.

TAB. XXVIII.

Fig. 1.
2. Pecten quinquecostatus.
3.
4. —— Dujardinii.
5. —— Asellus.
6.
7. Xiphidium maximum.
8.
9. —— angustum.
10. Leda pulchra.
11. Byssoarca Marullensis.
12. Serpula Plexus.
13. Modiola quadrata.
14. Lima læviuscula.
15. Lima or Plagiostoma.
16. Plagiostoma parallelum.
17.
18. Pecten æquicostatus.
Fig. 19. Pecten subinterstriatus.
20. Pinna decussata.
21. Plagiostoma Hoperi, var.
22.
23. Ostreæ.
24.
25. Lima granosa.
26. Pecten jugosus.
27.
28. Teredo rotundus.
29. Inoceramus Lamarckii.
30.
31. Spondylus latus.
32. Inoceramus involutus.
33. Lima spinosa.
34. Spondylus fimbriatus.
35. Teredo Amphisbæna.

TAB. XXIX.

Fig. 1. Holaster subglobosus.
2. Turritella turbinata.
3. Discoidea cylindrica.
4. Cidaris Bowerbankii.
Fig. 4 *a*. A part magnified.
5. Solarium catenatum.
6. Pholadomya decussata.
7. Cassidaria incerta.

Fig. 8. Nautilus Archiachianus.
9. Serpula annulata.
10. Dentalium difforme.
11. Scaphites æqualis.
12. Hamites angustus.

Fig. 13. Hamites armatus.
14. Fragment of a Crustacean.
15. Ammonites Milletianus.
16. Turrilites triplicatus.
17. —— Scheuchzerianus.

Tab. XXX.

Figs. 1 & 2. Teeth of the Ptychodus latissimus.
3. A tooth of the Ptychodus paucisulcatus.
4 & 5. Nascent or incomplete teeth of a Ptychodus.
6. A tooth of the Ptychodus mammillaris.
7 & 8. Teeth of the Ptychodus decurrens.
9. A tooth of the Ptychodus polygyrus.
10. A tooth of the Ptychodus altior.
11 & 12. Teeth of the Acrodus Illingworthi.
13. A tooth of the Acrodus cretaceus.
14. A group of teeth of the Gyrodus angustus.
15. A series of teeth of the Gyrodus cretaceus.
16. A group of teeth of the Phacodus punctatus.
17. A tooth of the Corax maximus.
18. A tooth of the Corax falcatus.
19. A tooth of the Lamna acuminata.
20. ? Teeth of a species of Enchodus.
21 & 21 *a, b, c, d.* Teeth of the Saurocephalus lanciformis.
22. A tooth of the Polyptychodon interruptus.
23. Portion of a larger tooth of Polyptychodon interruptus.
24. A tooth of the Oxyrhina Mantelli.
25 & 25 *a, b, c.* Teeth of the Otodus appendiculatus.
26. A tooth of the Lamna acuminata.
27. Portion of jaw and teeth of the Enchodus halocyon.
28 & 29. Palatine teeth of the Saurodon leanus.
30. Teeth of the Notidanus microdon.
31. Portion of jaw and teeth of the Tomognathus leiodus.
32. Teeth of the Odontaspis rhaphiodon.
33. Coprolites of a Macropoma.
34. Teeth of the Lamna acuminata.
35. Teeth of a Squaloid fish.

TAB. XXXI.

Fig. 1. A tooth of the Ptychodus decurrens.
2. A tooth of the Ptychodus Oweni.
3. A tooth of the Ptychodus latissimus.
4. A tooth of the Ptychodus mammillaris.
5. A tooth of the Ptychodus rugosus.
6 & 7. A tooth of the Ptychodus Mortoni.
8. Squaloid vertebra, probably of Ptychodus.
9. A tooth of the Ptychodus depressus.
10 & 10 *a*. Teeth of the Ptychodus polygyrus.
11. A tooth of the Enchodus halocyon.
12. Portions of jaws of Saurocephalus lanciformis.
13 & 13 *a*. Two views of a tooth of Oxyrhina crassidens.
14. Fin-rays of a Ptychodus.
15. A portion of fossil shagreen, or skin of a Placoid fish.
16. Vertebræ of Tetrapterus minor.
17. Two views of a tooth of Otodus appendiculatus.
18 & 18 *a*, *b*. Tooth of the Lamna acuminata.
19. Vertebra of Placoid fish.
20. Tooth of a Mosasauroid reptile.
21 & 21 *a*. Tooth of a Leiodon, two views.

TAB. XXXII.

Figs. 1 & 2. Upper maxillary bone, left side, of Edaphodon Mantelli.
3 & 4. Mandible of Orthagoriscus.
5. Teeth of Ptychodus decurrens.
6 & 6*. Dental plate of Aulodus Agassizii.
7. Microdon nuchalis.
8. A group of teeth of Gyrodus conicus.
9. Two teeth of Acrodus Illingworthi.
10. Cœlorhynchus cretaceus.
11 & 12. Calamopleurus Anglicus.

TAB. XXXII*.

Fig. 1. Portion of rostrum or prolonged premaxillary bone of Saurocephalus lanciformis.
2. Microdon occipitalis.
3 & 3*. Prionolepis angustus.
4. Dental plate of Plethodus oblongus.
5 & 5*. Teeth of a new species of Microdon.
6 & 6*. Teeth of a new species of Gyrodus?

Fig. 7 & 7*. Defensive spine of Placoid fish, probably of the Ray-tribe?
8. Teeth of Cestracion canaliculatus, twice the natural size.
9 & 9*. Portion of jaw and teeth of the Hypsodon minor.
10, 10* & 10**. Saurocephalus lanciformis.

TAB. XXXIII.

Figs. 1 & 1*. Portions of the scales, with jaws and teeth of Gyrodus angustus.
2. A fragment of the dental plate of Plethodus expansus.
3. Series of the teeth of Pycnodus parallelus.
4. Osmeroides Lewesiensis.
4 *a*. A scale, magnified, of Osmeroides Lewesiensis.

TAB. XXXIV.

Fig. 1. The head of Beryx ornatus.
2. The head of Macropoma Mantelli.
3. Beryx microcephalus.
4, 4 *a*, 4 *b*. Jaws of a Beryx.
4 *c*. The hypotympanic bone of a Beryx.
5. Dercetis elongatus.
6 & 7. Lower maxillary bone of Edaphodon Mantelli.
8. Premaxillary bone, right side, of Ischyodus gigas.
9, 10, 10 *a*. Portions of jaws and teeth of Pachyrhizodus basalis.
11. Portion of upper jaw of the Saurocephalus lanciformis.

TAB. XXXV.

Fig. 1. Portion of head of Tomognathus mordax.
2. Homonotus dorsalis.
3 & 3*. Portion of jaw and teeth of Belonostomus cinctus.
4 & 4*. Portion of jaw and teeth of Belonostomus attenuatus.
5 & 5*. Portion of jaw and teeth of Saurocephalus striatus.
6 & 7. Pomognathus eupterygius.
8. Portion of Berycopsis elegans.
8*. One of its scales, magnified.

TAB. XXXVI.

Figs. 1 & 3. Beryx ornatus.
2. Stenostomus pulchellus.
Fig. 4. Beryx radians.
5. —— superbus.

Tab. XXXVII.

Fig. 1. Portion of the lower jaw of the Mosasaurus gracilis.
1 *a.* A fragment of the upper jaw of Mosasaurus gracilis.
2–5. Portions of vertebræ of Mosasaurus gracilis.
6 & 7. Middle cervical vertebra of Plesiosaurus constrictus.
8 & 9. Teeth of Plesiosaurus Bernardi.
10 & 11. Pterygoid teeth of Mosasaurus gracilis.
12. Crown of a tooth of a Leiodon.
13. Tooth of Plesiosaurus constrictus.
14. Fragment of a tooth of a Mosasauroid reptile.
15. Fragment of a tooth of a Plesiosauroid reptile.
16 & 17. Tooth of Polyptychodon interruptus.
18. Series of vertebræ of Coniasaurus crassidens.
19. Portion of jaw with teeth of Coniasaurus crassidens.
19*a.* Crowns of teeth, magnified, of Coniasaurus crassidens.
20. Upper view of alveolar process and teeth of Coniasaurus crassidens.

Tab. XXXVIII.

Fig. 1. Portion of the skull and anterior part of the vertebral column of the Dolichosaurus longicollis.
2. Part of the lower jaw of the Dolichosaurus longicollis, magnified; and outline of the same, natural size.
3. Portion of lower jaw with a tooth of the Polyptychodon interruptus.
4 & 5. Anterior portion of the skull of Pterodactylus conirostris.
6. Portion of scapular arch of Pterodactylus conirostris.
7. Metacarpal bone of the fifth digit of the fore-limb of a Plesiosaurus.

Tab. XXXVIII*.

Figs. 1 & 2. Upper view of the Palæastacus Dixoni.
3. The fore-part of the carapace and a portion of the claw of the Palæastacus Dixoni.
4. A portion of the carapace and two claws of the Palæastacus Dixoni.
5. Side view of the Palæastacus Dixoni.
6 & 7. The pincer-claws or 'chelæ' of the Palæastacus macrodactylus.
8. Part of the carapace of a Crustacean.
9. The carapace of Platypodia Oweni.
10. Portion of the carapace of a Crustacean.
11. The claw of a Grapsoid Crustacean.
12. Five legs of the same side of a Grapsiform Brachyurous Crustacean.

Tab. XXXIX.

Figs. 1, 2 & 3. Portion of lower jaw and teeth of the Raphiosaurus Lucius.
4. Posterior part of the vertebral column and pelvis of the Dolichosaurus longicollis.
5 & 6. Marginal plates of a Turtle (Chelone).
7-9. Three views of the body of a vertebra of the Mosasaurus gracilis.
10. A group of teeth of the Ichthyosaurus communis.
11. Shaft of the humerus of Cimoliornis diomedeus.
12. Distal end of tibia of Cimoliornis diomedeus.

Tab. XL.

Fig. 1. Front view of a cervical vertebra of Plesiosaurus Bernardi.
2. Back view of a cervical vertebra of ditto.
3. Side view of a cervical vertebra of ditto.
4. Under view of a cervical vertebra of ditto.

THE
CHALK FORMATION
AND
TERTIARY DEPOSITS
OF
SELSEY, BRACKLESHAM BAY AND BOGNOR.

INTRODUCTION.

NOTWITHSTANDING the rapid advancement of geological knowledge, and the number of works which have appeared both in England and on the continent full of Palæontological discoveries, yet the right progress and stability of the generalizations of science depend so much on particulars well-determined, that having devoted much attention to the formations and their fossils in my immediate neighbourhood, I am induced to publish some illustrations of the Cretaceous period, more especially of Kent and Sussex, and of the Tertiary deposits of Bracklesham Bay, Selsey and Bognor. Many interesting facts have been discovered since Dr. Mantell's valuable work on the Fossils of the South Downs, which have been noticed by himself and others. But the extent of the Chalk formation is so great, and the parts accessible to examination so limited, that the fossils of each locality merit the special attention of the collector, and I trust I shall be able through the assistance of my friends, which will be more particularly noticed when treating of the Chalk, to add several new and interesting specimens, especially amongst the *Asteriæ.* Bracklesham Bay has been known for many years as a rich deposit of the London Clay fossils. Mr. Webster, Dr. Mantell and Mr. Bowerbank have each added to its celebrity; yet still I hope to show, that this part of Sussex is deserving of a more minute inspection, and of ranking, if not the first in England, yet as a very rich locality, to those geologists who are fond of examining the fossil records of the Eocene period*.

I am well-aware that individual exertion is not sufficient to give a faithful account of any geological position. To keep pace with modern discoveries, and compare specimens from other localities of the same date, more time and leisure are requisite than a professional man can devote to such pursuits. I have been very fortunate in having the cabinets of my friends Mr. Bowerbank and Mr. Fred. Edwards to refer to on all occasions; these gentlemen have been with myself collectors at Bracklesham for the last eight or ten years, and their authority will be often mentioned in this part of my work. I am much indebted to Mr. J. De C. Sowerby for his descriptions and valuable information,

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* "There are few localities where the London Clay can be examined, of which so little is known, and which at the same time is so worthy of a careful investigation, as that portion presented to our view by the action of the sea at Bracklesham Bay and its neighbourhood, on the coast of Sussex. The deposit here differs so much, both in its mineral character and fossil contents, from the same formation in other parts of England, and exhibits so close an approximation in both these respects to the corresponding beds in France—those of the Calcaire Grossier—as to render it a matter of surprise that it has not attracted a greater share of attention from English geologists."—On the London clay formation at Bracklesham Bay, Sussex, by J. S. Bowerbank, Esq., F.R.S., F.G.S., &c., from Magazine of Natural History, 1840, volume iv. p. 23.

and for engraving most of my plates. I have also had the assistance of the British Tertiary Club in naming many of the new fossils. With my friends Mr. F. Edwards and Mr. G. A. Coombe, I have passed many pleasant days at Selsey in collecting specimens. To all these gentlemen I return my sincere thanks for their valuable assistance, since without their aid I should not have written the account of Bracklesham Bay: there are still many inaccuracies, nor do I publish it as anything more than an advanced catalogue of the Eocene fossils of this country.

To some of my readers, a few observations may not be unacceptable in reference to the general utility and objects of geological research.

Geology may be considered a new science. It is the investigation of the substances that constitute the earth's surface, and the revolutions which that surface has undergone in former years and is still undergoing. The geologist may be considered as the historian of the changes of the world, who not only gives an account of its large divisions, minerals, and strata, but inquires into the various characters of the lost tribes of plants and animals which once inhabited the globe.

The ancients knew nothing of this science, nor do we find it a subject occupying much attention before the last century. It is true, at all periods fossil bones and petrifactions have occupied the attention of philosophers; nor must the work of the elder Pliny be forgotten: but it is only within the last fifty years that any scientific arrangement of the earth's surface has been formed, and divided into the Primary, Secondary, and Tertiary periods. The Germans have been most conspicuous in the investigation of the Primary strata; the Secondary formations with their fossil contents have engaged the peculiar attention of the English; and the French, guided by the illustrious Cuvier, Brongniart, Lamarck, and Deshayes, have minutely examined and clearly explained the Tertiary period.

Every branch of Geology has been improved by the advancement of chemical knowledge. The perfection of microscopical instruments, aided by a more accurate examination of minute objects, has created almost a new theory as to the origin of many rocks and formations.

The study of Geology has been condemned on the supposition that the science was opposed to the Mosaic account of the earth's formation, that it tended to scepticism and to sap the religious principles of its admirers, and that it was of little use. I do not wish to discuss the various opinions which have been brought forward by geologists with regard to the extent of time requisite to produce certain changes, or attempt to reconcile these with the formation of the world as recorded in the book of Genesis. The pleasure that is derived from the contemplation of the beautiful works of Creation, and the internal feeling of adoration and delight which they inspire, are greatly disturbed by theories that are in opposition to our religious faith. I would only say, that the limited intellect of man will never allow him to explain the commencement any more than it will to foretell the final destruction of the earth. Of what utility is the science of Geology? is a question not difficult to answer those who would ask it. There are some minds,—and let us hope very few,—who are incapable of appreciating any study which does not immediately tend to gain. To those I would answer, that it is by geological science we are enabled to discover the hidden treasures of the earth, to sink mines with accuracy, and work them with the least possible expense. The position of coal, that most useful mineral, is not only well-ascertained, but we can go still further, by stating, from geological examination, that there is a supply of it in this country for more than two thousand years, and I might fill pages by describing the various metals and useful building materials which Geology has brought into notice; but I must turn to the higher feelings of our nature, and consider it as a science well-calculated to improve our intellectual powers, to stimulate our exertions, and raise our adoration and gratitude to the Supreme Disposer of all things.

We are endowed with faculties capable of understanding the general arrangement and magnificent structure of the globe. We derive a great source of happiness from examining the recent forms of animal and vegetable life; and as geological knowledge advances, we shall be able to restore the lost links of Creation, which the revolutions of our planet have scattered and destroyed, and to form some faint notion of the great design and perfect harmony which our Almighty Creator has manifested in the system of the world*.

The name of Cuvier must ever be mentioned with the greatest respect and delight; it will shine as a beacon to direct the geologist in the true path of discovery. His extensive knowledge of Comparative Anatomy enabled him to classify an extinct race of animals and explain even their habits; and by his labours we are now able, from a single tooth or bone, to reconstruct animals of the most wonderful description, which have long since ceased to exist.

Geology, connected with Comparative Anatomy, Conchology and Botany, is a pursuit most gratifying to the mind, either taken as a scientific pursuit, or forming an occasional recreation from the more arduous duties of life.

In the contemplation of the larger animals, such as the Ichthyosaurus or Iguanodon, which Geology has brought to light, the mind is

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* The same wise Hand directed the formation of the world from the beginning. The physiologist is able to determine from the examination of even a portion of bone, however small, that its structure could not have taken place without the aid of blood-vessels and nerves. So we have a right to suppose from the remains we discover, that the softer and perishable parts must have been in accordance to the laws of animal creation. The skeleton, or I may say, solid part of an animal, is all that remains in a fossil state; but, from its contrivance, and a knowledge of recent animals, we are enabled to form a pretty accurate idea of its habits and destinations.

awfully struck with the wonderful power and infinite wisdom of our great Creator; but those who trace the chain of animal existence link by link find the same harmony and beauty of construction in the lowest orders of fossil beings: so in like manner, rising step by step, we arrive through the higher orders of creation up to Man himself, who is endowed not only with the most complete organization, but has reason to direct his steps, if rightly used, to happiness.

Several English and foreign names of the highest reputation, and deserving our best thanks, must be omitted in a work of this local character. In Sussex Dr. Mantell has been most conspicuous in the advancement of geological knowledge, and as the historian of the Wealden formation and discoverer of the Iguanodon, his name is placed amongst the first geologists of any age or country. We have also my friend Mr. Martin, who has written a valuable memoir on part of Western Sussex, and who first applied the term Wealden to designate that peculiar freshwater formation.

I am under great obligations to my friend Professor Owen for his advice and most valuable assistance during the progress of the work.

I cannot conclude this brief introduction without adding a few words with the warmest feeling in recommendation of Natural History in its extensive sphere, assuring those who will make it their study, that they will have a perpetual source of delight, subject to no worldly change, a solace in affliction, and strengthening in every advance their knowledge of the greatness and goodness of God.

“ O let your songs be of Him, and praise Him, and let your talking be of all His wondrous works.”—*Psalm* cv.

PART I.

CHAPTER I.

GENERAL GEOLOGICAL VIEW OF SELSEY AND BRACKLESHAM BAY.

In giving to the geological collector a description of this most interesting locality, where the Eocene division of the Tertiary period is so extensively developed, I trust I may be allowed, before entering on the peculiar subject of my work, to devote a few words to the early and known history of this celebrated peninsula; one of the places where Christianity was first taught in this country*, and where, as Dr. Johnson has so beautifully expressed on a similar occasion, "savage clans and roving barbarians derived the benefits of knowledge and the blessings of religion. To abstract the mind from all local emotion would be impossible if it were endeavoured, and would be foolish if it were possible: whatever makes the past, the distant, or the future predominate over the present, advances us in the dignity of thinking beings. Far from me and from my friends be such frigid philosophy as may conduct us indifferent and unmoved over any ground which has been dignified by wisdom, bravery or virtue."

Selsey is the southernmost point of the county of Sussex, and was most likely visited at a very early period by the inhabitants of the

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* The historical account is taken principally from Camden, Dallaway and Baxter.

opposite coast. The remains of a Roman station prove it to have been known to the early conquerors of this kingdom, and it was also one of the most ancient Saxon establishments. But the æra to which we can refer with greater precision, is that of the grant of this peninsula by Edilwalch, king of the South Saxons, and confirmed by Ceadwalla, to Wilfrid, the exiled bishop of York, about the year 680, at which time it is stated to have consisted of 5220 acres of land, together with 85 families and 250 peasants or slaves for agricultural purposes. Wilfrid, who has deservedly been styled saint and apostle, made the abolition of slavery the first requisition of the Christian religion, and these 250 slaves were baptized by him and made free.

The encroachment of the sea on Selsey Island* during the lapse of the last eight hundred years has been very extensive. We learn that the creek called Pagham Harbour on the south-east side was the effect of a sudden irruption not many years before 1345, when 1700 acres of land were destroyed; and on the south side, the Bishop's Park, formerly of great extent, has been absorbed within a few acres.

This peninsula consisted of 5220 acres as before stated, and the parish now contains only 2880. Of the ancient cathedral and episcopal palace, supposed to have been situated to the south-east of the present church, there are no remains†: what was left of the primæval church was taken down to construct the present, in which are two Saxon stone coffin-lids made of Purbeck marble, and several other slabs of the same material. The Font is very ancient, and made also

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* The terms Island and Peninsula have been applied to Selsey parish, as it was formerly surrounded by the sea.

† The site is said to have been nearly a mile in what is now sea.

The sea now rolls in triumph o'er the ground
Where once thy sacred edifice was rear'd;
No mark, no stone to trace thy wall is found:
All, all is gone, as if thou ne'er appear'd.

of Purbeck marble. Camden states in his Britannia: "In this Isle remaineth only the dead carkase as it were of that antient little citie, hidden quite with water at every tide, but at low-water evident and plaine to be seen."

The Bishop's Park, as the shore and sands are still called, extended for many acres on the south-east coast, and the remaining fragment has still the name of Park Coppice. The village occupied nearly the centre of the island before the reduction of its boundary by the sea: on a moderate calculation, the sea has gained more than a mile on this shore since its cathedral was established.

In the year 1075 the episcopal see was removed from Selsey to Chichester. Wilfrid was the first bishop of Selsey, A.D. 680: Stigand was the first bishop of Chichester, A.D. 1070; twenty-two bishops having resided at Selsey.

The derivation of the name Selsey, or Sealsea, is, according to the historian Bede, from the number of seals which used to abound on the coast; but according to others, and with greater probability, *Sel* was adopted from the British language by the Saxons, and signifies great, or good, or fertile, when applied to soil.

The houses are built of an arenaceous limestone, similar to the

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But yet 't is said, at midnight's fearful tide,
  When wintry storms in angry surges sweep
  The shore, complaining spirits from the deep
Pour forth their melancholy voices wide,
Speaking an awful tale of former days,
  How holy men were torn from saintly graves,
  Their bones neglected,—scatter'd by the waves.
Rest, troubled spirits; and to Him give praise
Whom storms and tides obey;—direct thy care
To Heaven, not earth, for all 's recorded there.

Sonnet on Selsey Cathedral.

Milliolite limestone of Paris, almost entirely made up of microscopical shells; which was formerly procured in great abundance at a moderate expense from a ledge of rocks off Selsey Bill, extending some distance to the east and west; but the demand for this stone as a building material was so great, that it was deemed absolutely necessary about the year 1830 to prevent their removal, as the rocks formed a barrier in some measure to the encroachment of the sea.

There is an extensive fishery for crabs, lobsters and prawns at Selsey, which are procured during the season in great abundance, and are considered superior to those caught in any other part of the kingdom. The mode of catching them is in pots made of wicker-work, which are baited with fish and placed amongst the rocks, running from two to fifteen miles in a southerly direction. Camden also states that in his time the best cockles were procured at Selsey.

Bracklesham Bay, so celebrated for its fossils, is the southern boundary of the marshes of East Thorney, being the north-west portion of the peninsula of Selsey; and the parishes of East and West Wittering, extending as far as Chichester Harbour, being two-thirds in the Wittering parishes, and one in Selsey.

Bracklesham, which has given its name to this Bay, is situated on the coast in the parish of East Wittering, but is greatly diminished from its original extent. There was a chapel endowed and annexed to the vicarage, but no remains of it are now to be found: more than six acres of glebe land have been absorbed by the sea since 1725. The view of the Isle of Wight and surrounding coast and scenery from Bracklesham is beautiful, which, independent of its geological interest, is well worth visiting. The distance from Chichester is about eight miles.

During my geological researches along the coast, I have collected several coins and British relics which have been washed on the shore by the encroachments of the sea, some of which I shall introduce when treating of the localities from whence they were procured ; they serve to preserve facts, the result of which may be useful to antiquarians in the arrangement of particular British coins peculiar to certain districts of this kingdom.

The coins and British remains contained in the wood engraving were picked up by the fishermen and others on the shore at Selsey and Bracklesham. They tend to elucidate and bear record of the early and most interesting historical period of this part of the county.

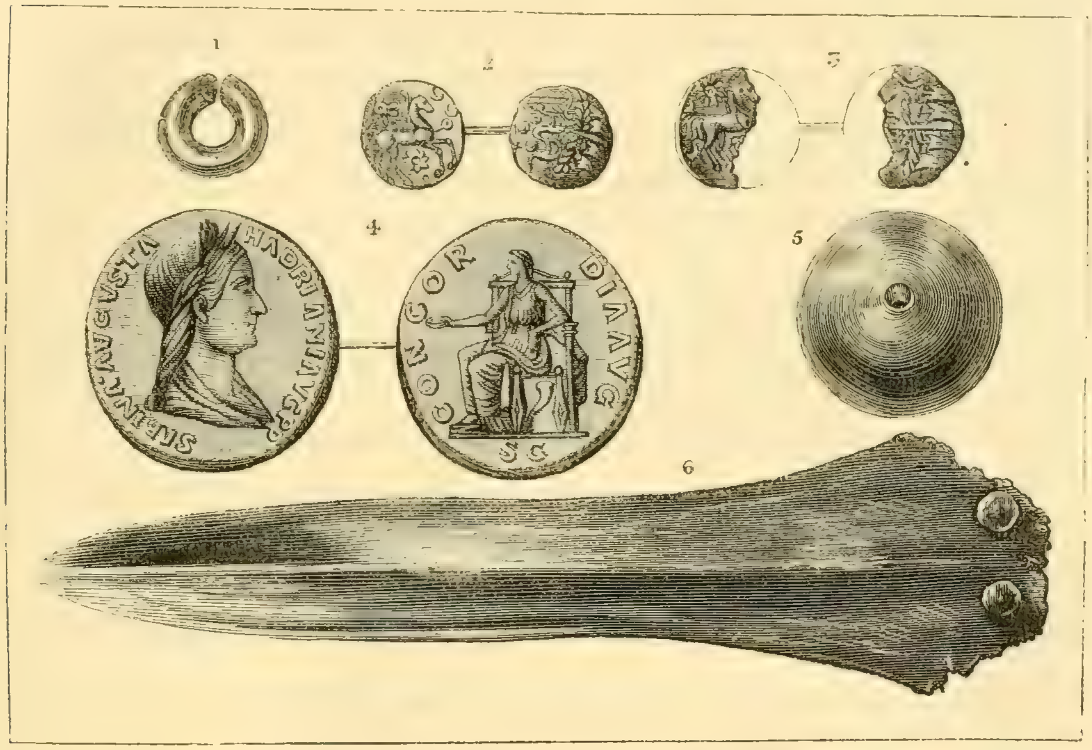

Fig. 1. Ring of pure gold weighing 104 grains, found at Bracklesham, supposed to have been passed as money by the early inhabitants of this country, before the introduction of coins. These rings are frequently found in Ireland of various shapes and sizes, and weighing several ounces, but are rarely discovered in England. I have seen one similar in form and weight to this found in Kent.

Fig. 2. British coin of pale gold weighing twenty grains, like one figured in Ruding, plate 1. fig. 16. from Dr. Hunter's cabinet weighing twenty grains. This is not an uncommon type on the Kent and Sussex coast. I have seen several similar: two in the possession of Mr. R. Elliott, surgeon at Chichester; two or three in the collection of C. R. Smith, Esq., found at Bognor or on the Sussex coast. This type was probably struck and passed in the southern counties.

Fig. 3. Portion of a gold coin of a very similar type, but larger in size, weighing fourteen grains: found at Selsey.

Fig. 4. Large brass coin of Sabina, wife of Hadrian, found with several other brass coins of Hadrian, Marcus Aurelius, Faustina, &c., much decomposed, near the mill at Selsey. Julia Sabina, daughter of Matidia, was married to Hadrian, A.D. 100.

Fig. 5. British or Roman bead, found on the shore at Bracklesham, the size of the drawing: made of calcedony: similar to one in the possession of C. R. Smith, Esq., discovered with Roman remains, and to some mentioned by Douglas in his 'Nænia Britannica.'

Fig. 6. British weapon of brass, reduced one-third in size, in excellent preservation, being covered with a black patina of tin, found at Bracklesham in the bed containing so many shells of the *Venericardia planicosta*. The countryman who found it told me, with much simplicity, that "he thought he had discovered the knife by which the former blockaders opened those large cockles with, as them fish must have been very good to eat."

These weapons are also frequently found in Ireland.

The general reader must bear in mind, that the ground on which Selsey, Bognor, Littlehampton, Worthing, and other places on the Sussex coast westward of Brighton are built, is a much more recent formation than the London clay, being the Post-Pliocene division of Mr. Lyell's excellent arrangement[*]. The Eocene period is represented by different deposits, all of which are visible only at low-water; at Bognor by true London clay, and a hard arenaceous limestone of a greenish colour peculiar to this locality; at Selsey by London clay,

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[*] Mr. Lyell's arrangement of the Fossiliferous strata, observed in Western Europe, placed in what is termed a descending series, or beginning with the newest:—

1. Post-Pliocene, including those of the recent or human period.
2. Newer Pliocene. }
3. Older Pliocene. } Tertiary, or Supra-cretaceous.
4. Miocene. }
5. Eocene. }

and by an extensive range of rocks similar in their composition to the Milliolite limestone of Paris, running to the east and west some miles into the sea; and on the shore by a coarse, soft, yellowish limestone often passing into sand, like the calcaire grossier of the Paris basin: at Bracklesham the Eocene deposits consist of a loose greenish sand, of calcaire grossier, and of a very great extent of London clay.

These beds are often intersected by superficial muddy deposits and extensively overlaid by the Post-Pliocene formation: this is well-seen between Bognor and Selsey at low-water. The remains of mammiferous animals are discovered in the muddy deposits, some being referable to extinct species, and others to existing species not now found in this part of the kingdom; with these are associated marine shells of existing species, but many of them not known as such on the Sussex coast. A still newer deposit may be observed to the east of Bognor at very low tides, in which are the remains of large trees; also to the west of Selsey, the trunks and roots of trees, hazel-nuts, &c. may be seen at low-water. These trees are not fossilized: they were probably destroyed by the encroachment of the sea at no very remote period.

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6. Chalk.	Secondary.
7. Greensand.	
8. Wealden.	
9. Upper Oolite.	
10. Middle Oolite.	
11. Lower Oolite.	
12. Lias.	
13. Upper New Red Sandstone and Muschelkalk.	
14. Lower New Red Magnesian Limestone.	
15. Coal.	
16. Old Red Sandstone and Devonian.	
17. Upper Silurian.	Primary Fossiliferous.
18. Lower Silurian.	
19. Cambrian and older Fossiliferous strata.	

Large blocks of granite, and the remains of much older formations than the London clay, are observed lying on the shore, particularly in Bracklesham Bay. It is difficult to account satisfactorily for their appearance. The general opinion is, that they have been transported by the agency of ice, and those frozen masses called glaciers.

The remains of the fossil Elephant or Mammoth, the Horse, Ox, Deer and Goat, are occasionally discovered in the muddy deposit of Selsey and Bracklesham.

The discovery of tusks, teeth and bones of Elephants in England caused much wonder and discussion amongst our early geologists, who considered the introduction of tropical animals into temperate regions as the trophies of Roman greatness and splendour, and the remains of the Elephant were deemed an additional proof of the former subjection of this country to that mighty empire. We are indebted to Cuvier for correcting these vague conjectures, who says,—" If, passing across the German Ocean, we transport ourselves into Britain, which, in ancient history, by its position, could not have received many living elephants besides that one which Cæsar brought thither according to Polyænus, we shall, nevertheless, find these fossils in as great abundance as on the continent."

The great comparative anatomist clearly shows, that the bones and teeth of the Mammoth are distinct from those of the present living Indian or African Elephant. Professor Owen, in his admirable account of the *Elephas Primigenius* in the history of the 'British Fossil Mammalia,' observes: "The difference between the extinct and existing species of Elephant, in regard to the structure of the teeth, has been more or less manifested by every specimen of fossil elephant's tooth that I have hitherto seen from British strata, and those now amount to upwards of three thousand. Very few of them could be mistaken by a comparative anatomist for the tooth of an Asiatic

Elephant, and they are all obviously distinct from the peculiar molars of the African Elephant :" also page 240 he says, "The abraded margins of the component plates of the Mammoth's molars most commonly present a slight expansion, often lozenge-shaped, at their centre." This is well-observed in the specimen from Selsey. In the now advanced state of Palæontology, it is ascertained that the remains of the Mammoth are very generally distributed over England, occurring also in Ireland and Scotland, on the continent, and over all parts of Europe. In Asiatic Russia they occur in the greatest abundance, forming an extensive article of commerce, the tusks producing very fine ivory : the remains of the Mammoth are met with also in various parts of America, but no authentic relics have been found in tropical latitudes.

The discovery of the carcase and entire skeleton of the Mammoth at the mouth of a river in the north of Siberia in the year 1799 has thrown much light and information on the nature and habits of this animal. A most interesting account was published by Mr. Adams in 1807 in the fifth vol. of the 'Memoirs of the Imperial Academy of Sciences at St. Petersburgh,' and an excellent English translation was published in 1819. It appears that the Mammoth had a mane on its neck, and that its skin was of a dark grey colour covered with a reddish wool and coarse long black hairs. A part of the skin and hair of this animal was sent by Mr. Adams to Sir Joseph Banks, and is preserved in the Museum of the Royal College of Surgeons.

The inference that Cuvier has drawn from this singular discovery is, that the carcase of a tropical animal could only have been so transported and preserved in ice by some great convulsion of nature : but Professor Owen has shown that the structure of the teeth, by which the Mammoth differed from existing Elephants, fitted it to subsist on the coarser vegetation of temperate latitudes, and that the hair and wool with which the Mammoth was clothed, must have enabled it, like the Musk Ox, to have braved the rigours of a northern winter.

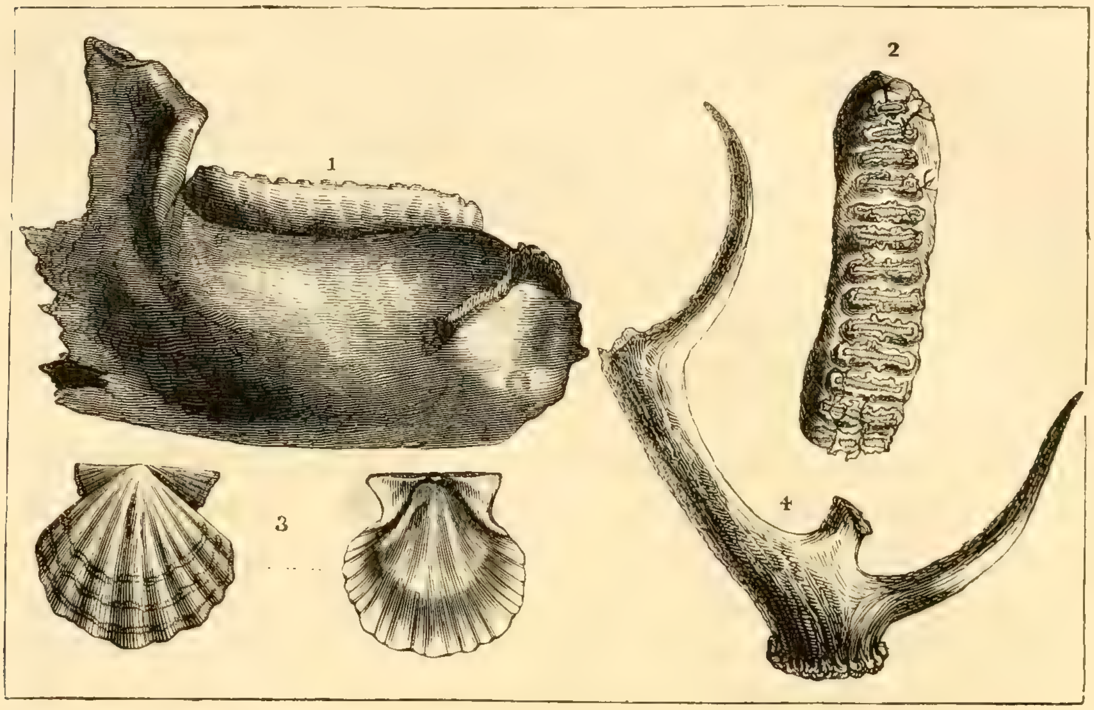

Fig. 1. represents the right ramus of the lower jaw with the fourth grinder of the *Elephas Primigenius* or Mammoth, reduced one-fifth : found in the mud at low-water, opposite the new Thorney station at Selsey in 1841 by James Bly, one of the coast-guard, who informed me that the tusks of the same head were discovered and taken away some years previous. I possess the fourth grinder of both sides of the upper jaw of the same specimen.

Fig. 2. is a view of the same tooth as fig. 1, showing the grinding surface and irregular-shaped plates. Mr. Owen considers it to have been from an animal not full-grown, and with the teeth rather narrower than usual.

Specimens containing the teeth in their sockets are rare in this country. Many detached teeth and bones of the Mammoth have been found on the shore at Selsey and Bracklesham. I possess teeth from the mud deposit of Bognor, Littlehampton and Worthing, and I have seen tusks that have been discovered in the Isle of Wight in such preservation that they might be cut into ornaments. At Peppering near Arundel, an interesting account of the discovery of a fossil

Elephant was sent to Dr. Mantell by the late Mr. Drewitt of that place, who was ever anxious to promote scientific research. I saw these remains soon after they were found, and possess one of the teeth. They consisted of a tusk four feet and a half long, four grinders, and the bones of the head. The teeth were in very good preservation, but the bones and tusk too much decayed to be removed, though great care was exercised in order to preserve them. My friend Mr. Robert Drewitt, who now resides at Peppering, informs me, that his father found also a tusk near seven feet long and other bones of the Elephant at a short distance from the locality of the former discovery. This spot may be considered as a similar deposit to Dr. Mantell's Elephant-bed at Brighton, the Post-Pliocene formation of Mr. Lyell. The remains of elephants have been discovered at Burton, in Arundel Park, at Brighton, and in other parts of Sussex, and I may say, in most counties of England.

Fig. 3. *Pecten polymorphus,* Bronn, p. 627: natural size. Described at great length with several varieties in Philippi's 'Enumeratio Molluscorum Siciliæ,' pp. 79 and 85, both as fossil and recent. This shell I believe has not been observed before in this country; I have several specimens of it, some much larger, from the muddy deposit in which the Elephant's head was discovered; it occurs with other marine shells which are not now found recent on the coast.

I am much obliged to Mr. G. B. Sowerby for naming the more obvious examples of this deposit; the *Lutraria rugosa* and the *Pullastra aurea* are not uncommon in the Post-Pliocene deposits at Bracklesham Bay.

Those marked with an asterisk are found quite recent on the shore.

Shells named by G. B. Sowerby.—Most of the shells named in this list are well-known and common species belonging to the shores of Britain; one however is a very remarkable exception, namely the *Lutraria rugosa,* a species which abounds in some parts of the Mediterranean, and of which I possess specimens in a fossil state from Astigiani.—G. B. S.

Pholas Dactylus.
—— crispata.
—— candida*.
Saxicava rugosa†.
Solen Siliqua.
Lutraria Listeri.
—— arenaria.
—— Solenoides.
—— rugosa.
Mya arenaria.
—— truncata.
Mactra stultorum*.
—— subtruncata*.
Nucula margaritacea.
Amphidesma Boysii.
Lucina Radula.
Pullastra vulgaris*.
—— decussata.
—— aurea‡.
—— perforans.
Venus verrucosa.
Cardium edule.

† These shells are frequently found in the Eocene rocks of this locality, and on breaking the stone their perforations are well observed.

‡ The specimens of this shell resemble the Mediterranean variety.—G. B. S.

Cardium tuberculare.
——— exiguum.
——— fasciatum.
Pecten maximus.
——— varius.
Ostrea edulis.
Helix nemoralis (Land).
——— hortensis (Land).
Bulla hydatis*.
Assiminia Grayana (estuary).
Rissoa varia.
——— cimex.
——— reticulata.
——— costata.
——— elegantissima (Turbo elegantissimus, *Mont.*).
Lacuna pallidula.
Natica monilifera *or* castanea, *Lam.**
Littorina neritoides, var.
——— Faba.
——— petræa.
Trochus ziziphinus*.
——— cinereus.
——— magus*.
——— cinerarius.
Buccinum undatum*.
Nassa reticulata*.
Purpura Lapillus*.
Murex erinaceus*.
Cypræa europæa*.

Fig. 4. *Cervus Elaphus,* antler of the Red Deer, reduced one-third. I have seen other specimens found at Selsey and Bracklesham.

Antlers and bones of the Red Deer have been found in most parts of England: in Ireland they are associated with the remains of the magnificent Irish Elk (*Cervus Megaceros*), and they are also discovered in the morasses and lacustrine marls beneath the peat-mosses of Scotland. Professor Owen observes, "that a species of Deer, undistinguishable, from the characters of its enduring remains, from the Red Deer, *Cervus Elaphus,* co-existed with the Megaceros, the spelæan Hyæna, the tichorhine Rhinoceros, and Mammoth, and has survived, as a species, those influences which appear to have caused the extinction of its gigantic associates, as well likewise such smaller animals as the Trogontherium, the Lagomys, and the more diminutive Palæospalax."

The remains of the *Bos primigenius* are also occasionally discovered in these superficial deposits. There is a portion of a horn of this animal in the Chichester Museum, which, if complete, would measure two feet, found near Pagham. This species of Ox was of larger dimensions than any of the domesticated breeds.

Teeth and bones of the Horse (*Equus Caballus*) are likewise observed, as well as the remains of the Goat (*Capra Hircus*).

CHAPTER II.

EOCENE FORMATIONS OF SELSEY AND BRACKLESHAM BAY.

The geological position of the shore at Bognor, Selsey and Bracklesham Bay is of the Eocene or London clay division of Mr. Lyell's arrangement of the Tertiary period. It has also been called Supracretaceous by Sir H. de la Beche, as lying immediately above the chalk. Mr. Lyell has termed it Eocene, as the supposed dawn or commencement of shells, some few of which are similar to recent genera. The name 'London clay' is given to the argillaceous form of the Eocene deposits, because of its extensive development at London and its vicinity; and it is a curious circumstance that London and Paris should be built on the same geological formation, though under different mineral conditions*; yet, compared to many other deposits, the Eocene may be considered of limited extent. It is principally confined in England to two districts, which are called the London and Hampshire basins; the London basin is considered to lie between the North Downs and the chalk of Cambridgeshire, Hertfordshire and Suffolk. The Hampshire basin may be said to include the continuation of the same range into Hampshire, Dorset-

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* Those of England being almost exclusively of mechanical origin,—accumulations of mud, sand and pebbles, while in the neighbourhood of Paris we find strata enclosing a similar assemblage of organic remains, but composed partly of a coarse white limestone, and partly of a compact siliceous limestone of great thickness, with here and there intercalated beds of crystalline gypsum, or pure flint.—*Lyell's Elements of Geology.*

shire and the English Channel, occurring to a great extent at Sheppey and other parts of Kent, in Essex, and under different forms at Bagshot, Basingstoke, Guildford and other parts of Surrey; it is usually surrounded by chalk elevations.

The London clay varies in thickness from 300 to 500 feet, but at High Beech in Essex it attains a height of 700 feet, and probably its total thickness may be more than 1000 feet. Nodules of an irregular, often ovate shape, containing a large portion of carbonate of lime, are interspersed through this formation. These concretions contain the remains of shells, mostly marine, but occasionally freshwater, which H. Warburton, Esq. M.P., has lately pointed out*; often *Nautili*, wood, the bones of turtles and crocodiles, which appear, like the flints in the chalk formation, to owe their origin to some organic substance; when pulverized, they form the celebrated Roman cement so much used for building. They have been called *Septaria*, from having many divisions or septa which traverse the stone; and when filled with crystallized carbonate of lime and polished, make very beautiful tables and ornaments. At Sheppey, radiated crystals of sulphate of barytes occur on the crystallized carbonate of lime, and in the centre of the clay sulphate of lime is often found in radiated crystals. The cement stone is found in large quantities at Bognor, but not at Bracklesham. Pyrites, or sulphuret of iron, is picked up at Sheppey and on the shore at Bognor and Bracklesham, and sent to London.

The Eocene formation has been subdivided into the three following divisions: the uppermost portion has been called Bagshot sand, the second or middle the London clay, and the lowermost the Plastic clay. These divisions are considered unnecessary by some geologists; yet as certain shells are more abundant in one stratum than another,

* There are no freshwater Eocene formations observable at Selsey, Bognor or Bracklesham Bay, like those in the Isle of Wight and other places.

and our knowledge of the Eocene Palæontology in this country is still far from being complete, I am inclined to think that a series of deposits of regular succession will one day be clearly pointed out. Local descriptions will greatly tend to determine this point.

Although Bracklesham Bay affords at some tides and seasons the most abundant harvest to the palæontologist, yet I have been greatly disappointed on more occasions than one in not being able to procure any specimens, owing either to the wind covering the beds with sand, sometimes to two or three feet in thickness, or to the tide not leaving the shore sufficiently exposed; so that a stranger might conclude that there were no fossils to be procured at Bracklesham. This circumstance may be in a great measure obviated by consulting the Almanac. The best time for collecting is the first two days before and the last three days after the full and new moon: the highest tides are generally in March and October. When the beds are visited under favourable circumstances, there is an exposure at one view of an immense horizontal surface of fossils, differing in this respect from Sheppey, or the cliffs of Barton or Hordwell. Here the collector can at one moment be gratified by beholding thousands of the *Venericardia planicosta*, at another by seeing a great extent covered with the *Turritella imbricataria*, giving him the most perfect idea of the formation of a bed of fossiliferous marble; the rarer shells are dispersed, and require time and patience to procure them.

The fossils are generally in a soft state, and much care must be exercised in removing them. I have found a small flat trowel, which does not bend, the best instrument; though, for such large shells as the *Cypræa Combii*, or *Cerithium cornucopiæ*, &c., a spade is requisite; a large portion of the surrounding matrix must be removed with the shell, and then it should not be disturbed, or any attempt made to clear the fossil, for two or three days. Packing the specimens in fine sawdust or bran answers extremely well; by this method they may be conveyed to any distance: the more delicate shells also require to be cemented as they are uncovered, and a preparation of equal parts of diamond-cement and water may be used with advantage, as it does not discolour or alter their character. The shells are seldom found in a perfect state at Bracklesham; they are usually flattened, and appear as if they had been pressed down. This circumstance may arise in some measure from the pressure of the sea-water and the action of the waves, for I do not consider the fossil beds to have been visible more than two or three hundred years, and their exposure is entirely owing to the encroachment of the sea on the shore; for it has been ascertained, that in little more than a century, six or seven acres of the glebe land have been absorbed at Bracklesham.

The cliffs, if I may so term them, extending from Selsey Bill to Chichester Harbour, seldom rise more than nine feet, and the average would not be more than six or seven; they are composed of the much more recent Post-Pliocene formation, containing broken chalk flints, yellowish clay and sand in no regular deposit, the highest point being Selsey Bill. The wells at Selsey do not exceed twenty-five feet in depth, and show the remains of a former beach.

The further we advance in geological knowledge, particularly in the examination of the Tertiary formations, the greater necessity there appears for giving local descriptions and accurately examining the palæontological characters of every district. In this manner we shall be able to compare one country with another, and attain some knowledge of the real state of the world during the Eocene deposits. The Tertiary formations have been much neglected in England. Besides, the fossils at this period are usually found in great abundance in certain localities, while large districts of the same geological epoch may be seen without containing any. Most of the shells at Bognor, a distance of only seven miles, are of a distinct character from those of Selsey and Bracklesham Bay. The *Venericardia planicosta* and the *Nummularia lævigata,* so abundant at Bracklesham, are not found at Bognor; but this will be more particularly noticed when speaking of that deposit. At Barton, a distance of little more than thirty miles, there are no *Venericardiæ planicostæ* or *V. acuticostæ,* though some shells are found in both localities. The *Cytherea suberycinoides* is plentiful at Bracklesham, and only occasionally found at Barton. The *Rostellaria macroptera* and *Lucina mitis* are common at Barton, and very rare at Bracklesham. Crustaceans are abundant at Sheppey and Highgate, but rarely found at Bognor or Bracklesham.

In drawing our conclusions from the genera of shells, of fishes, vegetable remains, and animals which are found in this immediate portion of the London clay, it would appear that the greatest number of shells are of those genera now found in shallow seas or estuaries. The fish are of a character frequently observed near the shore. The *Siluridæ* are found in lakes and rivers. The *Myliobates* are discovered in shallow sea-water. Crocodiles exist in estuaries, rivers and lakes: Boa Constrictors commonly lurk for their prey in or near fresh waters. A greater proportion of the earth was probably covered with fresh water during the Eocene period than at the present time. It is evident,—reasoning from the situations in which the recent types of most of these genera are observed, and the supposition that these different creatures lived and died near the spot where their remains are discovered,—that the climate must have been during the Eocene period considerably warmer than at present. Some species of fruit would even indicate a tropical region*.

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* That France and England were united during the Eocene period is evident from the remains of the same fossil animals being found in each country; we may also infer, that during the Mam-

The following observations may be useful to the collector in marking the localities in which some of the rarer organic remains are procured.

The deposit of Eocene fossils lying to the south-east of Selsey, I shall term the ' Park-bed,' as it is part of the shore which still retains the name of Park Coppice. It is rather more than a mile to the left of Selsey Bill, and its length is half a mile towards Pagham Harbour. The Park-bed developes to a great extent the formation called ' Calcaire grossier* '; it contains myriads of the *Nummularia lævigata*, with other shells interspersed, such as *Pecten corneus*, *Bulla Edwardsii*, *Cypræa inflata*, *Solenes*, *Arcæ*, &c., *Astræa Websteri* and several corals. This may be considered one of the best spots for the collector; the shells are also in good preservation. Adjoining this bed to the east, we perceive a greenish sand and clay deposit, containing *Tellina scalaroides* and *Tellina tenuistria*, but it is difficult to get these shells perfect; and we also find rolled fragments, somewhat similar in their composition to the Bognor rock, but containing Nummulites and a greater proportion of lime; on breaking these, good casts of rare fossils may be found, sharks' teeth, &c. On one occasion I obtained a good specimen of the *Myliobates*. I have picked up also on the shore crocodiles' teeth, and several specimens of the *Myliobates*, *Ætobates* and *Edaphodon*. Further eastward we recognise three distinct patches of arenaceous limestone, of a greenish blue colour, divided into different-sized nodules, some two or three feet high, containing *Turritellæ*, *Nuculæ*, &c. Between these

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moth's existence no division of the land had taken place, as it is common for fishermen to drag up in all parts of the Channel unrolled specimens of the tusks, bones and teeth of that animal. But we have still a further right to suppose, that the division called the English Channel is of a much more modern date, and was caused by some great irruption during the Post-Pliocene period; for the same living animals exist common to both countries, or did exist since the historical period —wolf, goat, moles, shrews, water-rats, &c., which could not have been all imported.

* From the calcaire grossier bed in the neighbourhood of Grignon, four hundred distinct species of shells have been procured.

patches are beds of Eocene fossils, but not in good preservation; and before we come to the last appearance of the nodules, there is an exposure of thousands of the *Turritella imbricataria,* though less abundant than in the Turritella-bed of Bracklesham Bay. The Park-bed is situated close to the shore, and is usually accessible to the collector at low-water. There are no more Eocene fossils observable on the shore on this side of Pagham Harbour. The bank at this point shows, by its wasted appearance, how the constant action of the waves absorbs the land. Here also at spring-tides the sea leaves the shore to a great extent, and the very recent Post-Pliocene formation may be observed overlying the Eocene deposits.

From the promontory called Selsey Bill, which forms the southern extremity of the parish, may be said to commence Bracklesham Bay, extending near eight miles as far as Chichester Harbour. At this point the Eocene formation presents itself at low-water in large detached portions called the 'Clibs,' the larger part lying to the south-west, and the 'Mixen Rocks'; the Mixen Pole being about a mile in the sea off Selsey Bill. From these rocks, which extend a mile and a half east and west, varying from two to four hundred yards wide, was procured the Milliolite limestone, which furnished building material for many houses at Selsey and in the neighbourhood. No more stone is now taken, as these rocks are supposed to be a defence to the rapid encroachment of the sea. This rock is composed principally of Foraminifera. The Clibs contain very few organic remains.

Opposite the New Thorney Station are those muddy deposits of the Post-Pliocene period from which I procured the elephant's head and recent shells.

Between the Mill and Medmeney* Farm-house, about six hundred

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* Medmeney signifies a whirlpool in the Saxon language.

yards from the shore, may be said to commence the bed containing those rare fossils called *Beloptera,* surrounded by innumerable Foraminifera and microscopical shells. I shall denominate this the 'Beloptera-bed'; it may be said to extend some distance beyond Medmeney Farm-house: adjoining this bed a little nearer the shore are procured the *Cypræa Bowerbankii* and other rare shells. This may be called the 'Cypræa-bed,' as that fine species I have found nowhere else. Pursuing our course westward we arrive at Old Thorney Station, opposite to which there is a bed containing very fine specimens of the *Cytherea suberycinoides.*

To the left of this bed, and facing Old Thorney Farm-house, the *Arca duplicata* is discovered in brownish clay; and a quarter of a mile from this spot to the west, we find those magnificent shells the *Cerithium Cornucopia* and *C. giganteum,* some nearly two feet long. This may be called the 'Cerithium-bed'; it is half a mile from Old Thorney Station-house, but only clearly discernible at spring-tides in March and October. Near this place may also be found the *Ostrea elegans,* lying undisturbed in its original bed. To the right nearer the shore are seen *Bulla Edwardsii, Solenes, Arcæ,* &c. in loose greenish sand; the Calcaire grossier also peeps out with its innumerable fossils*. At a distance of two miles from this spot the Eocene fossils usually again make their appearance.

When I first visited Bracklesham, a barn served the collector for a direction-post to the fossils of the Bay; but about six years ago it was taken down, the wind having nearly destroyed it; and the sea now washes its foundations.

Opposite this ruin the *Venericardia planicosta* and *Turritella imbrica-*

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* The Houngate rocks, of the same formation and character as the Mixen, are situated opposite Old Thorney Station-house, visible at low-water. They are nearly a mile in extent, and vary from fifty to sixty yards in width; building stone has also been procured from these rocks.

taria may be found in the greatest abundance; no description can come up to the reality of the scene to the palæontological collector. I propose to call this, in remembrance of former times, the 'Barn-bed.' Here we can contemplate the myriads of creatures that must have perished at the Eocene period; though perhaps the Beloptera-bed in numbers, and with a microscope, may appear far more extraordinary, being almost entirely composed of minute shells.

The 'Barn-bed' is more than half a mile long, and may be separated into three divisions; the eastern part I shall call the 'Palate-bed,' the middle the 'Turritella-bed,' and the western the 'Venericardia-bed.' The vertebræ of serpents, the bones of turtles, the finest palatal remains of fish, the *Myliobates*, *Ætobates*, *Edaphodon*, portions of the *Pristis*, the teeth and vertebræ of sharks, and the defensive bones of the *Siluridæ*, are all procured from the 'Palate-bed.' In the middle and western division, that superb shell the *Cypræa Combii* is found, together with the *Conus diversiformis*, *C. deperditus*, *Voluta Cithara*, &c. At the north-west extremity of the 'Barn-bed' may be observed large portions of a green arenaceous limestone, containing *Venericardia planicosta*, *V. acuticosta*, *Fusus longævus*, &c., also a few blocks almost entirely made up of the *Rostellaria macroptera*, and detached pieces of Nummulite rock*. Beyond this, deposits of wood and sulphuret of iron may be seen; but these beds are the last good development of Eocene fossils in Bracklesham Bay, being about three miles from Chichester Harbour, which is the western boundary of the shore in Sussex.

I will endeavour now to point out the Eocene deposits which lie to the east of Pagham Harbour.

The parish that divides Selsey from Bognor is called Pagham.

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* The Nummulite limestone is characteristic of the lower beds of the Milliolite limestone in the neighbourhood of Paris.

There is a large estuary of an irregular shape extending more than a mile in length towards Sidlesham Mill*, and a mile broad in some places, called 'Pagham Harbour.' It is stated to have been formed by a sudden irruption of the sea in the beginning of the fourteenth century, when 1700 acres of land were devastated. This inundation formerly extended more towards Selsey, but of late years the sea has been gaining on the land to the east. Only small vessels can enter the harbour, as it is much blocked up with loose beach.

Archbishop Thomas à Becket sometimes resided here with a large retinue, and his interfering with a manor within this lordship gave rise to his dissension with Henry the Second, which terminated in his assassination. The church is dedicated to St. Thomas à Becket, and is well worth visiting, having been repaired in excellent taste. The remains of the archiepiscopal palace are still visible in a field a short distance south-east of the church.

The Post-Pliocene formation covers the shore to a great extent opposite the harbour; but the Eocene period may be remarked towards the east not far from the Blockade station, making its appearance about twenty yards from the shore in true London clay; it contains no fossils, but is perforated by immense numbers of the recent *Pholades*. From this spot, which is three miles from Bognor, the

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* The parish of Sidlesham joins Selsey on the north. The beauty of the following epitaph, in the church-yard, to Joan wife of Cornelius Carnaby, who died January 19th, 1775, aged 29 years, must plead my excuse for inserting it:—

When Sorrow weeps o'er Virtue's sacred dust,
Our tears become us, and our grief is just:
Such were the tears he shed, who grateful pays
This last sad tribute of his love and praise;
Who mourns the best of wives and friends combined,
Where female softness met a manly mind;—
Mourns, but not murmurs; sighs, but not despairs;
Feels as a man, but as a Christian bears.

Eocene formations may be said to recommence, and continue in a greater or less degree to Bognor. At the Barrack-lane end may be procured some good fossils, the *Pyrula Smithii*: the *Panopæa corrugata* and *Cultellus affinis* occur in the clay, but being delicate shells they are difficult to get perfect; wood perforated by *Teredines* is likewise found.

The Barn and Bognor rocks unite opposite Aldwick; among them the cement-stone is found in great quantities, and occasionally beautiful specimens of the Nautilus are discovered by breaking the nodules; some of the stones run into calcareous divisions, which circumstance has given them the name of 'Septaria.'

The sea is gaining on the shore, but at Aldwick a most excellent barrier was made by the late Sir Thomas Brooke Pechell, Bart., who placed large rocks opposite his house, in such a position as effectually to stop its encroachment.

CHAPTER III.

GEOLOGICAL POSITION OF BOGNOR AND THE SUSSEX COAST TO BRIGHTON.

Bognor, situated in the parish of South Bersted, has gradually risen to an extensive town for the accommodation of visitors, who resort to the sea-coast for a summer residence or for the benefit of sea-bathing; many families remain in it during the winter, some of the houses being of a very superior class. The Duchess of Kent and her present Majesty when Princess Victoria resided at Bognor for some time.

The Bognor rocks have been long celebrated for containing beautiful fossils of the Eocene period; they are now only seen at low-water. The general opinion is, that these rocks formerly were the southern boundary of Bognor before the inundation of Pagham Harbour. In deeds of the date of Queen Elizabeth, which are still extant, the southern boundary of Bognor was called Bognor Common, an extensive tract of land, over which there was a right of pasture for a certain number of beasts. This common in the time of the Saxons and at a much later period was covered with trees, and formed part of the Bishop's Park at Selsey, extending as far as Ferring to the east*.

The Bognor rocks are composed like the 'Barn' of an arenaceous

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* "The park was not gone in Bishop Sherburne's time, as it appears that in the 25th of the reign of Henry VIII., a lease was granted of it by that bishop to John Lews and Agatha his wife, at a rent of £4, with a covenant to have sufficient herbage for seventy or eighty deer."—*Baxter's History of Sussex.*

limestone varying much as to the proportions of lime and silex. They extend more than a mile, the greatest number being to the west, and off Aldwick join the Barn rocks; they are of all sizes, some as high as sixteen feet, and before the inundation were most likely of greater extent and magnitude.

Casts of fossils may be procured in great number by breaking the rocks, but it is difficult to get good specimens with the shell on: the *Pectunculus brevirostris* is the most abundant shell; *Pinna affinis, Vermetus Bognoriensis*, the *Voluta denudata, Pyrula Smithii, Natica*, &c. may be likewise obtained. These rocks, as well as the 'Barn,' extend many miles into the sea. Portions of London clay may be observed between these rocks and the shore, but containing few fossils. I have seen however the *Modiola elegans* and *Anomia lineata* in beautiful preservation with their external shell perfect, and others may be found under favourable circumstances. The London clay is seldom exposed immediately opposite the town; though in March and October during high tides the sand is sometimes entirely removed, and a few Eocene fossils may be observed*.

The Post-Pliocene formation may be seen more especially in muddy deposits opposite the Clarence Hotel, extending towards Felpham: the stumps of trees and thousands of the *Lutraria Listeri* and *Cardium edule* may be remarked; and off Felpham Station-house large trees twenty feet long lie in a horizontal position, and some large stumps still remaining in the situation in which they grew. The bank of the shore is six or eight feet above the level of these trees; it is reasonable therefore to suppose that the ancient forest or park was in some parts similar to the common now facing the houses on the beach at Little-

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* Bognor was the first place on the Sussex coast in which the chalk sponges were cut and polished into ornaments. There resides a good lapidary of the name of Wyse, who has generally an assortment of stones and fossils for sale, and cuts extremely well the Nautilus and other local specimens.

hampton, where a depression in the land of many feet may be observed.

The wood-engraving represents four gold British or Gaulish coins found with six others of well-known types on the shore between Pagham and Bognor in the year 1841, and in 1842 the large brass coin of Agrippina was found near the mill to the west of Bognor in digging a ditch close to the shore.

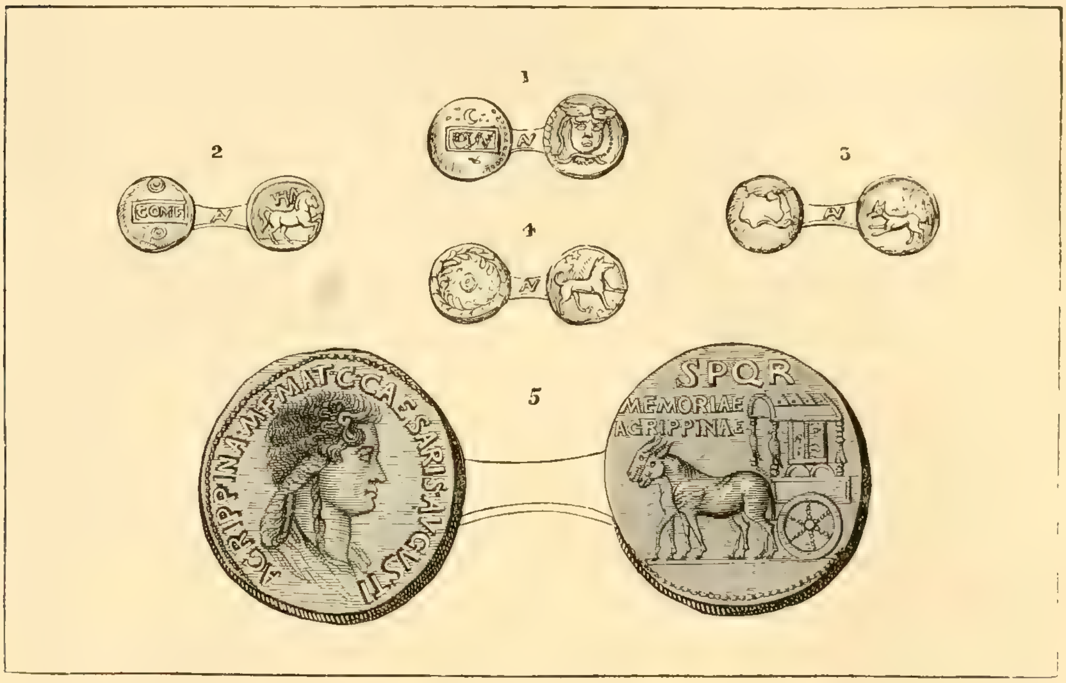

Fig. 1. Pale gold, weight 13 grains: obverse, a label containing unintelligible letters; reverse, winged head of Medusa.

Fig. 2. Red gold, weight 13 grains: obverse, in a label COMF, a small pellet or bead enclosed above and beneath; reverse, a horse; above, VIR.

Fig. 3. Pale gold, weight 17 grains.

Fig. 4. Red gold, weight 16 grains.

The first three of these most interesting coins are in the possession of James D. Cuff, Esq., who possesses an unrivalled British and Saxon collection. Fig. 4. is in the possession of C. R. Smith, Esq., who gave a description of these coins in 1841, in the 'Proceedings of the Numismatic

Society,' from which I have taken the above account. I may here observe that British coins are usually more or less convex on the obverse, and concave on the reverse.

Fig. 5. First brass coin of Agrippina Senior, wife of Germanicus, born in the year of Rome 739, before Christ 15 years. The reverse, representing the carpentum, is scarce. Large brass coins are rarely found in England, particularly those prior to the time of Claudius.

I beg to return my best thanks to the gentlemen who have the superintendence of the Numismatical department in the British Museum, who are ready at all times to give every assistance and information. I have improved the drawings of the large brass coins of Sabina and Agrippina from more perfect specimens in the National collection.

The parish of Felpham joins Bognor, and opposite the Mill the plastic clay may be observed by its peculiar character of red decomposed sulphuret of iron, covering the chalk formation. It contains no organic remains, nor can I trace any more deposits of the Eocene period immediately on the shore this side of Brighton. The rocks called 'Middleton Ledge,' are, I have no doubt, of the Eocene Period, but all my endeavours to procure fossils from them have been ineffectual; they are very compact, of a yellowish white colour, consisting of lime and silex, similar to the *calcaire silicieux* of the Paris basin.

Half the parish of Middleton which joins Felpham has been absorbed by the sea since the historical period[*]. The church, of which only the walls are left, is now on the shore, and will be in a short time entirely destroyed. Bones are protruding from the church-yard, and are carried away as the tide increases. It repeats the tale, though in a smaller degree, of what was the fate of Selsey Cathedral[†].

Following the coast we come to the parish of Climping, which includes all that remains of the ancient parish of Cudlawe, or Cudlow, of which little more than 100 acres have escaped the devastations of

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[*] Felpham and Middleton parishes, in Doomsday-book, were in the possession of Roger earl of Montgomery as belonging to the earldom of Arundel, and mention is there made of a large wood which has entirely disappeared.

[†] Between the years 1260 and 1340, a period of only eighty years, sixty acres of land were destroyed at Felpham and a similar quantity at Middleton.—*Mantell's Geology of Sussex.*

the sea ; but it does not appear from the Conqueror's survey that the present parish of Climping has lost many of its acres. Part of the church is of very early architecture.

Littlehampton, like Bognor and Worthing, has risen of late years to a considerable place for the reception of visitors. The village is situated three-quarters of a mile from the sea ; the new houses are well-placed on the beach at some distance from the shore. The sea does not appear to have gained much on the land at this point, which may be accounted for in some measure by its being the mouth of the river Arun. The shore is covered with sand, and the only fossil remains I have been able to discover are portions of elephants' teeth and bones. Beautiful sponges of the cretaceous period, converted into chalcedony, like those of Bognor and along the coast, are picked up on the shore.

The parishes of Rustington and Preston show a gradual devastation of land by the sea*. The shore is covered by a superficial Post-Pliocene deposit, and underneath the chalk formation. Kingston parish annexed to Ferring had formerly a chapel, which has been entirely destroyed. The register terminates in 1670, but I can get no decided information as to its site. The general opinion is that it was destroyed by the encroachment of the sea. There are some conglomerate rocks seen on the shore, of the Post-Pliocene formation, called

* On the 28th of October 1845, I had a most interesting conversation with Mr. John Gratwicke Heasman, a fine old man ninety-five years of age, now residing in the parish of my brother, the Rev. H. Dixon, at Preston: Heasman was born in the adjoining parish of Angmering ; his intellects were perfectly clear and memory wonderful. He told me many circumstances within his own recollection of the encroachment of the sea, and also stated that when he was young, a man of fourscore years old told him, that when he was a boy, there was a park called Ruston Park, which the sea now covers, and that large elm-trees grew there, which were cut down and sold for one farthing a foot.

The remains of trees are to be seen off the shore at Rustington, Preston and Ferring, forming, as before stated, part of the domain of the bishops of Selsey.

Kingston rocks. Ferring parish in the time of the Saxons was part of the endowment of Selsey, and its shore, as well as that of the adjoining parish of Goring, shows the gradual advancement of the sea.

The Kingmer rocks may be said to commence opposite Goring about six miles in the sea, extending in a north-westerly direction nearly as far as the Bognor rocks ; they are situated outside of the 'Middleton Ledge': in colour and composition they are similar to those of Bognor, but it is difficult to procure portions of them for examination, being many feet under water : those which I have been able to get contained no fossil remains, yet I am certain that these rocks are of the Eocene period, joining the Hooe and Owerslight rocks, which are four or five miles still further south opposite Littlehampton and Bognor; and that the bottom of the coast of western Sussex is covered to a great extent with rocks of the same geological formation*.

Tarring, the southern portion of which is called the Manor of Heene, forms part of the sea-shore. The following passage is taken from Cartwright's History of the Rape of Bramber, p. 28:—" Extract of a letter from William Bray, Esq., the historian of Surrey, dated March 3rd, 1827 :—In the year 1755 I was sent to inquire about a wreck which happened on the coast below Tarring, and which was claimed by the lord of the manor. The tenant went with me to the high-water mark, and told me that when he was young (I do not remember his age) they used to play cricket in the ground on which we stood, and that the sea was then at such a distance that no one ever struck the ball into it. Though so long ago as seventy-two years, I have a perfect recollection of what passed."

The woodcut represents a British boat discovered 200 yards from the shore, and coins found near the coast in this parish.

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* "The Owerslight vessel is situated eight miles south of Bognor. The Hooe rocks are two miles bearing south from the Owerslight vessel; they are covered by twenty-six feet of water."—*Channel Chart.*

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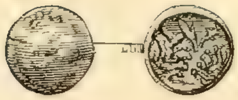

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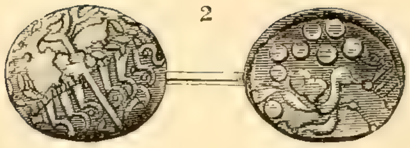

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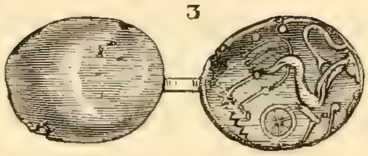

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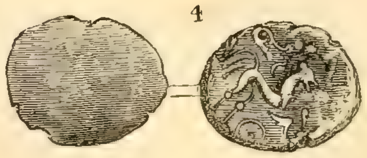

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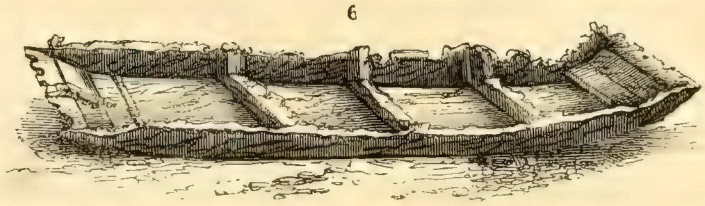

Fig. 1. British coin, pale gold, weight 21 grains: coins of this size and character are frequently found in Normandy.

Fig. 2. British, very pure yellowish gold, weight 95 grains. The obverse may represent a rude attempt at the delineation of the human head, and the reverse may possibly mean a horse. See Ruding, plate 1. nos. 9, 10, 11 and 12, gold coins of nearly the same weight.

Fig. 3. British, pale gold, weight 89 grains: very similar to a gold coin (no. 2. plate 1. of Ruding) weighing 88½ grains in the Tyssen cabinet. This coin was found at Worthing, and is in the possession of Edward Paul, Esq.; the other coins represented are in my own collection, except those particularly noticed.

Fig. 4. British, red gold, weight 79 grains: somewhat similar to Fig. 3, but of inferior gold. Figs. 1, 2 and 4. were found in digging a ditch close to the shore at Heene.

Fig. 5. Second brass coin of Vespasian, found on the shore a little to the east of Worthing.

Fig. 6. British boat made out of an oak-tree, without any metal fastening, eighteen feet long by three feet wide, found in 1842 on the shore after a storm, in the mud about 200 yards from the beach opposite Heene-lane. Shells of the Post-Pliocene formation were found in it, such as *Lutraria Listeri, Cardium edule,* &c. This boat is similar in its character and construction to one found at North Stoke, Sussex, in 1834, and now in the British Museum.

CHAPTER IV.

GEOLOGICAL VIEW OF WORTHING AND ITS VICINITY.

Worthing, which is in the parish of Broadwater, has sprung up within a few years to a large town. In summer it is frequented by visitors, and many families reside in it through the winter. The air is mild, and well-calculated as a winter residence for delicate persons. The sea formerly gained much on the shore, but about thirty years ago extensive groins were placed opposite the town, which have prevented its further approach. A little to the east, at the spot where the Blockade station was situated in 1845, the sea encroached so rapidly, that in less than twelve months seventy feet of land was destroyed. The chalk is seen on the coast covered by a very superficial deposit of sand and flints. The sands are very celebrated, and no place in England is better suited for bathing. The most beautiful specimens of chalcedonic sponges are collected on the shore, and occasionally rolled specimens of palm-wood, some of which are figured on the Plate illustrative of the geology of Worthing. The teeth of elephants, and rolled specimens of older formations are occasionally met with. Recent specimens of crustaceans are very abundant on the grass-banks off this place; they have been noticed by my friend Thomas Bell, Esq., F.R.S., in his beautiful work on 'British Crustacea'; the coast is also well-adapted for dredging, and many rare recent *Echini*, *Asteriæ*, sponges, &c. may be taken.

The situation of Worthing and its vicinity affords a good opportunity for elucidating the general geological character of that portion of the land situated between the Downs and sea-shore ; and in offering the following remarks on this subject I must express my obligation to Mr. W. Munday, jun., of Worthing, who is a careful observer, for much information on the geology of the neighbourhood.

It has been shown in the preceding pages, that for a number of years, indeed during the whole of the historical period, the sea has been making considerable encroachments on the coast of West Sussex ; at the same time alluvial deposits have accumulated, serving in a great measure to counterbalance this loss ; and the result is, that an important change has taken place in its general configuration. The land which has been absorbed at Selsey, Bognor, Worthing, &c., by the encroachment of the sea, has been regained by the silting up of the estuaries of the rivers Adur and Arun, and many smaller inlets of the sea, making the coast from Bognor to Worthing almost a straight line, which formerly must have been very irregular. That the valleys through which these rivers run were occupied by arms of the sea, has been clearly proved by Dr. Mantell. Deposits of sand or silt containing sea-shells are everywhere found in them.

The bank of the estuary of the river Adur is very readily traced : at Botolph's church, five miles from the sea, a shingle-beach evidently forming part of it is observed, and may be seen in various places in the parish of Coombes ; at the Sussex Pad Inn, near Old Shoreham Bridge ; and in a south-westerly direction at Lower Lancing, as far as Sea Mills Bridge. At this point may be traced a creek or inlet of the sea, which must have flowed in a north-westerly direction over the meadows between Broadwater and Worthing, converting the site of the town into a peninsula, covering a considerable portion of the parishes of Lancing, Sompting, and Broadwater. Its extent may be easily discerned by its low level, by the character of the soil, which is in some places mere shingle, and by the presence of marine shells of existing species, such as the *Lutraria Listeri*, *Pullastra decussata*, &c. Similar inlets may be seen at Goring, Ferring, and other places; and if they were contemporaneous, as is probable, the coast must have then nearly resembled that to the westward of Selsey Bill.

The examination of the strata afforded by the digging of wells at Worthing and several miles westward, along the ridge of land situated near the shore as far as Selsey, producing such fine crops of wheat, presents very nearly the same geological characters; good water being procured at from eighteen to twenty-five feet. At Worthing is found from four to ten feet of surface soil, containing from two to three feet of good mould; the rest is an indifferent loamy brick-earth more or less mixed with rolled flint stones; below this is a stratum of brownish sand and pebbles, of varied extent and thickness from one to ten feet, and extending in a less or greater degree to Selsey*. This may be the remains of an old beach, but as it contains no shells it is impossible to determine its geological period, though evidently very modern. Underneath this stratum lie broken chalk and flints, provincially called 'marl,' in which water is found, but in most cases it is penetrated seven or eight feet in order to get a good supply. The stratum of sand and pebbles does not extend far beyond the ridge, and the marl gradually thins out as we approach the Downs.

At Broadwater, a mile from Worthing to the north, in digging a

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* A pit was dug in 1845 three hundred yards to the east of Lower Lancing, and a good opportunity afforded of viewing a section of twenty-four feet of this stratum; it is here raised at least twenty feet above the level of the sea, and consists of three or four feet of common mould and broken flints, no loamy earth fit for making bricks, and twenty feet of rolled flint pebbles with sand varying from a dark ferruginous colour to white, containing no shells. In digging a well a short distance from this spot in the level, the result was eight or ten feet of these rolled flints and sand, ten or twelve feet of chalk marl, and five or six feet of genuine upper chalk with unrolled or unmoved flints, in which was an excellent supply of water.

well at the Rectory, the strata differ in a great degree: no marl is here observed, or any remains of the stratum or beach without shells as at Worthing. The result was fifteen feet of mould and gravel, most likely of the same age as the marl; and then a stratum of sand of seven or eight feet, containing recent marine shells,—*Littorina rudis* and *L. Neretoides*, *Purpura Lapillus*, &c. This is also the remains of a former beach, but older than the one described at Lancing, Worthing, and along the coast.

At Sompting, more to the east, a little marl was mixed with the gravel for ten or twelve feet; then came the sand with the same recent shells for six or seven feet as at Broadwater, under which the true chalk was penetrated and very good water procured.

The beds containing gravel with and without marl, and the lower sand with shells, are evidently a continuation of those strata so well described by Dr. Mantell as forming the site of the eastern part of Brighton, and named by him the Elephant-bed. This bed may be traced westward from Brighton to Shoreham, forming a range of low cliffs: on the north side of Shoreham Harbour, and a little to the west of Copperas Gap, they can be advantageously examined, the geological position being well-marked. The bed of sand containing the shells still found on the coast, *Littorina Neretoides*, *Mytilus edulis*, *Purpura Lapillus*, &c., is seen *in situ*, lying under the chalk marl and gravel; also many specimens of much older formations: rolled portions of granite and porphyry are mixed up with the shells and sand, similar to what may be observed on the shore at the present day. Under the remains of this old beach the true chalk formation is found, as at the Elephant-bed beyond Brighton and at Sompting.

We may therefore safely state, that in the neighbourhood of Worthing the tertiary beds from the Newer Pliocene are entirely absent. The most elevated point of these modern beds must be from eighty to one hundred feet above the level of the sea, and may be considered full proof that the whole district has been lifted to at least that extent during a very late geological æra.

Mr. Lyell and Dr. Mantell consider, in the south-eastern parts of England, that the land must have been elevated or upheaved after the deposition of the London clay, because patches of that formation reach a great height on the chalk, which is well observed at the north of Highdown Hill, and the Castle Hill, Newhaven; and they affirm with confidence, that considerable movements of elevation have taken place at periods decidedly Post-Pliocene.

Dr. Mantell's Elephant-bed, between Brighton and Rottingdean, at Peppering near Arundel, and other places, formed of calcareous rubble, shows every appearance of having been spread out by successive horizontal layers of water in motion.

Mr. Lyell observes in his 'Elements of Geology,' vol. ii. page 37, "First, the south-eastern part of England had acquired its actual configuration, when the ancient chalk-cliffs were formed, a beach of sand and shingle having been thrown up at their base: afterwards the whole coast, or at least part of it, where the Elephant-bed now extends, subsided to the depth of fifty or sixty feet; and during the period of submergence, successive layers of white calcareous rubble were accumulated, so as to cover the ancient beach: subsequently the coast was again raised, so that the ancient shore was elevated to a level somewhat higher than its original position."

I fully concur in these remarks of Mr. Lyell and Dr. Mantell. The remains of still more recent strata or beaches, in the neighbourhood of Worthing, extending along the coast to Selsey, confirm the opinion that many comparatively modern changes must have taken place in the south-western part of Sussex, between the sea-shore and the Downs.

The loamy earth from which the bricks are made varies much in thickness; at Hove near Brighton it is considerable, and there is a good stratum of it between Worthing and Lancing. It may be seen all along the bank of the sea-shore, from Lancing to Chichester Harbour. It is probably derived from the remains of the once-extensive plastic clay formation, but being mixed with marl containing more or less carbonate of lime, the bricks are by no means good. The bricks at Clapham Common, near Highdown Hill, are excellent, as the plastic clay at that point is well-developed. The plastic clay may be derived from the Wealden clay formation, as the best bricks in Sussex are procured from that deposit in the neighbourhood of St. John's Common, near Linfield, Sussex*.

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* The plastic clay formation, which has been called the lowermost division of the Eocene period, or nearest the chalk, may be observed between Highdown Hill and the Downs. Highdown Hill is a detached elevation of the chalk formation protruding itself to the south more than a mile from the Downs. The plastic clay is well-seen opposite Castle Goring, and extends in a greater or less degree five miles to the west as far as Calceto Farm, Arundel. At Clapham Common near Castle Goring, the following is the result of digging a well near the brick-field half a mile from Highdown Hill:—

5 feet small round gravel.
5 feet brick-earth.
2 feet hard ferruginous clay, of no use.
8 feet excellent plastic clay.
20 feet red clay containing much decomposed iron.
28 feet clay of a dark colour, the lowermost part assuming the appearance of London clay.
5 inches of sulphuret of iron, under which the water rushed to the top of the well and has remained ever since.

I have not been able to procure any fossils from this district: small round pebbles, sand and clay containing more or less decomposed iron, giving it a red appearance, similar to the beds at Castle Hill and Seaford in Sussex, at Woolwich, and parts of Kent, are the general characteristics of the strata, which at one time must have been very extensive. The water from the wells is highly impregnated with iron. Dr. Mantell in his 'Geology of Sussex' says, page 266, "Dr. Buckland observed many years ago the plastic clay formation in a valley at the village of Binstead, three miles west of Arundel, and also on the declivity of the hill by which the Binstead and Chichester road descends into Arundel."

Roman urns with funereal vessels and coins of Diocletian and Constantine were found not far from the shore at Park Crescent in 1826 and 1828.

The geologist may cavil at my inserting specimens not strictly geological, and the antiquarian be angry for trespassing on his manor; but as Sir Thomas Browne says in his epistle dedicatory to his work entitled 'Hydrotaphia Urn Burial,'—"We were hinted by the occasion, not catched the opportunity, to write of old things, or intrude upon the antiquary. We are coldly drawn into discourses of antiquities, who have scarce time before us to comprehend new things, or make out learned novelties. But seeing they arose as they lay, almost in silence among us, at least in short account, suddenly passed over, we were very unwilling they should die again, and be buried twice among us."

"Besides, to preserve the living and make the dead to live, to keep men out of their urns, and discourse on humane fragments in them, is not impertinent unto our profession; whose study is life and death, who daily behold examples of mortality, and of all men least need artificial mementos, or coffins by our bed-side, to remind us of our graves."

On the 4th of August 1845, in cutting the Shoreham and Chichester railroad near Worthing, a little to the west of Ham Bridge, in the parish of Broadwater, the workmen discovered, from twelve to twenty inches under the ground, (the surface not more raised than in other places) from twenty-five to thirty Roman urns and funereal vessels; five urns of a common shape and coarse material, containing burnt bones; nine or ten bottle-shaped funereal vessels,—two with handles, one with painted ornaments, but of no specific character; six or seven red pieces, usually called Samian pottery, stamped in the centre with the maker's name; and one very beautiful and interesting small urn, three inches and a half high, and two inches and a half wide at the top, of a bluish-grey colour; on one side is represented a stag, which from its horns and shape I should call a red deer; on the other a dog, like a large greyhound, which appears to be of a similar variety to that now used in Scotland for red-deer hunting, and which may be seen at the Duke of Athol's. The animals are in high relief. I was fortunate in obtaining this specimen perfect, as well as one small piece of Samian pottery, which has no stamp, but four ornaments on the rim, by some considered a leaf: this pattern of Samian ware is often found in the graves of Romans, or Romanized Britons. One bottle also was found perfect, of a light brown colour, which would hold near a quart, and larger than any lacrymatory I have ever seen found in England, and probably, like the other bottle-shaped vessels, it held oil, milk, or wine. The other pieces of pottery were more or less broken, many of them old fractures, including the urns containing the calcined bones. I have parts of five or six different-shaped Samian vessels, three or four funereal bottles, also some fragments of wood, perhaps *Armillæ*; the diameter of one is three inches and a half, the other two inches and a half; and more than two hundred short iron nails, much decomposed, and very similar to those now used in countrymen's shoes, which appeared to have been inserted into some decayed substance in a circle of eight or ten inches, and which was probably a buckler. There are two shields in the British Museum, one in particular having iron ornaments very like in shape to these nails: both are said to be British. It is rare to find ornamented funereal vessels in England, except on Samian pottery. Burning the body and putting the bones into urns, surrounded with more or less ornamented vessels and articles of value, according to the wealth and circumstances of the deceased, is of the earliest date; the bones having always the greatest respect paid to them.

These funereal relics were deposited in irregular order, three or four feet apart, and appeared as if placed on different occasions : they ordinarily consisted, in this mode of interment, of a bottle-shaped vase, a Samian dish, and two or three other pieces of pottery placed round the urn containing the bones, which was always uppermost and upright, not reversed, like the urns of the early British. There were no remains of ashes, or anything to mark that the body was burnt near the spot.

It is not unreasonable to suppose the tomb containing the interesting ornamented vase, (or by some thought drinking-cup,) with the stag and dog, to have been the grave of a Romanized British hunter, whose last request was to have represented on his urn his love of the chase. The wishes, as well as the character and pursuits of deceased persons, were delineated on funereal urns, as may be seen on Etruscan vases ; and this hunter might have died at a time when the Romans were destroying the woods, and clearing the ground for the purposes of agriculture.

Imported red Samian pottery with stags and animals has been occasionally found in England ; but this curious relic I think, from its material and manufacture, was made in this country, and is of double interest ; first, as a specimen of art, and secondly, as representing animals almost extinct, which were formerly common in England, as geological evidence fully corroborates, and showing besides how the Red Deer, like the Ox, Goat, Wolf, and other animals, has been scattered and destroyed by the hand of civilization.

To date the exact period of this burial-place is impossible : I possess coins of Vespasian and Marcus Aurelius, found not far from the spot, which would place it early in the Roman history of this kingdom, between seventeen or eighteen hundred years ago.

On the 29th of August, about three weeks after the first discovery of urns, some more ground was removed near the same spot, and I was lucky in procuring five more perfect funereal vessels, and three broken,—the fractures having been of long standing; for I took most of these vessels out myself, using every care, and can speak of the exact order in which they were deposited. This appeared to have been another grave, four feet from the last; the contents of which consisted of two urns, one eight inches high, six inches at the top, three inches and a half at the bottom, increasing to eight inches in the centre, containing burnt human bones; the other nine inches high, three inches at the bottom, seven inches in the middle, and five inches at the top, containing the bones of a bird the size of a crow; and burnt human bones, five or six nails, &c.; near this urn was a small bottle. Surrounding the other were two vessels like drinking-cups, two black saucer-shaped pieces of pottery, and one beautiful specimen of glass, quite perfect, of a transparent green colour, two inches high with handles, very similar to one preserved in the Museum at Boulogne: a small fragment of glass was also found with the human bones in the large urn: the urns containing the calcined bones were in every instance nearest the surface. At the bottom of this tomb was a flat metallic substance, eight or ten inches in length and breadth, much broken, having a few iron nails near it, but not more than eight or ten, and larger than those of the prior discovery. Iron is also the chief ingredient of this vessel or shield; but it is not oxidized like the nails, and was originally broken; for I found pieces of it, with two or three nails, in the urn containing the birds' bones, &c., which must have been placed there at the interment.

Perfect specimens of glass funereal vessels are rare in England; at Boulogne there is a valuable and extensive collection of glass vessels found in the Roman tombs near the town, and most probably this, as well as other specimens of glass discovered in England, were imported from and manufactured in Gaul.

At Avisford near Arundel in 1817, a most interesting tomb was discovered on the estate of Sir Thomas Reynell, Bart., containing a great many pieces of different-shaped pottery, and two glass vessels; one an urn twelve inches high by eight inches broad, of a light transparent sea-green colour, very thick, and nearly full of calcined bones; the other a small vessel, something similar to the one just found. I have also seen portions of a very fine glass urn discovered at Warburton near Arundel, eight or ten inches high, of a round shape having handles, containing burnt bones and a brass coin of Vespasian.

I have been present at two discoveries of Roman funereal vessels in this neighbourhood besides the one just mentioned, and possess specimens from each: one at Park Crescent near Worthing in 1826, and one on the Downs at Findon, Sussex, in 1823; and in both of these the pottery was much of the same description, but containing no ornamented or glass vessels.

It is probable that these deposits were like the vaults or cemeteries of the present day; those that I have seen would indicate such an idea, the urns being placed about four feet apart. These Roman, or perhaps Romanized British tombs, have no mark like the British or Saxon tumuli on the Downs to direct the antiquarian, and are only occasionally met with in cutting for roads or buildings, and when found the vessels are commonly broken in the expectation of finding coins, or are carelessly destroyed.

On the coast of the adjoining parish of Lancing may be observed large blocks of recent breccia or pudding-stone, not far from the Sluice.

Many acres of land have been recovered from the sea in this parish, which formerly extended as an estuary some distance beyond Bramber Castle. In 1684 Sir William Goring embanked 600 acres of land, by which a farm called the 'Salts' was joined to his other property. The name of 'Salts' is derived from salt-pans, the remains of which may be observed to the east of this farm; the sea-water was enclosed and left to evaporate, and the residuum of salt collected; but of late years this plan is abandoned, as salt is procured at much less expense and trouble.

I have found the *Lutraria Listeri, Cardium edule, Pullastra decussata,* &c. lying on the banks of many ditches as far as Bramber Castle; the discovery of these marine shells fully proves the ancient extent of the estuary of the river Adur. I have also seen them at Sompting, and the upper part of Broadwater.

For the geological history of Brighton, and an account of the encroachments of the sea on the Sussex coast eastward of Shoreham, I must refer the reader to the works of Dr. Mantell, who has done so much for the advancement of Geology. The Post-Pliocene deposit, or elephant-bed forming part of the cliff beyond Kemptown, and the plastic clay formation of Newhaven, Castle Hill, and Seaford have been described in Dr. Mantell's work on the Fossils of the South Downs.

It may be interesting to state, which I shall do as briefly as possible, the well-authenticated countries in which the Eocene period has been observed in different parts of the world.

In Europe the principal Eocene formation consists of the Paris basin, which is chiefly of marine origin, but also containing most interesting freshwater deposits.

Mr. Lyell in his 'Elements of Geology' states, "that the area which has been called the Paris basin is about 180 miles in its greatest length from the north-east to the south-west, and about ninety miles from east to west. This space may be described as a depression in the chalk, which has been filled up by alternating groups of marine and freshwater strata."

We are indebted for our knowledge of these formations to the immortal works of Cuvier: the examination of the fossil bones which they contain led that extraordinary man to reconstruct a race of animals which had long since perished, and to point out the only true path to be pursued in the investigation of palæontological knowledge. In the vicinity of Brussels, at Grignon, Epernay, &c. are marine deposits; at Auvergne, Cantal and Velay in Central France are freshwater; other Eocene formations are in the west of France, also at Aix in Provence, and in the north of Italy.

In a memoir read before the Geological Society in 1842 by Sir R. I. Murchison, F.R.S., on the geological structure of the central and southern regions of Russia in Europe, he stated "that the lowest tertiary beds which he personally examined were the marls with concretions forming cliffs at Antipofka on the right bank of the Volga below Saratof, where they were first noticed by Pallas. Among these shells are several species undistinguishable from those published by Sowerby from the London clay of Bognor and Hants, such as *Cucullæa decussata, Venericardia planicosta, Calyptræa trochiformis, Crassatella sulcata, Turritella edita*, &c."

In Asia, the sub-Himalayan and Sewalik Mountains of Northern India produce the most wonderful organic remains of this period. The strata in which they are found extend for more than 200 miles, and the mountains are 3000 feet above the level of the sea: a tortoise measuring nearly fourteen feet, following the curvature of the carapace, was brought to England by Captain Cautley, and presented to the British Museum. This monster has been well named the *Megalochelys Atlas*. The remains of the Anoplotherium, Anthracotherium, &c., of the Eocene Pachydermata, have also been brought to England from these mountains, and several new and undescribed animals; amongst which are the Sivatherium, and some species nearly allied to the Giraffe or Camelopard.

In Africa the Nummulite limestone has been considered of the Eocene period, and forms part of the Egyptian Pyramids, and is so compact as to be cut into sphinxes and other idols.

In North America, the greensand of Virginia contains fossils of this formation, the *Venericardia planicosta*, &c.* At Alabama, one of the Southern states, a creature of enormous size has been discovered upwards of 100 feet long, and was first described under the name of *Basilosaurus*; but Professor Owen, with his excellent knowledge of Comparative Anatomy, demonstrated that the animal possessed no saurian character, but was unquestionably a mammal, referable to the Cetaceous order and probably allied to the Dugong, one of the herbivorous whales; he has proposed for it the name of *Zeuglodon*, in reference to the peculiar yoked form of its molar teeth, and has stated, from its colossal dimensions and the small size of the bones of the extremities, the dense structure of the ribs, and the extreme elongation of the bodies of the caudal vertebræ, that it was one of the most extraordinary of the mammalia which the revolutions of the globe have blotted out from the number of existing beings. Subsequent discoveries of more complete skeletons have confirmed the accuracy of the reference of the *Zeuglodon* to the Cetaceous order†.

In South America, according to M. D'Orbigny, the Eocene period

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* Mr. Lyell states that, "Out of 125 species of Eocene shells which I collected in the Southern states, or which were presented to me, I have only been able to identify seven with European species of the same epoch. These are, *Trochus agglutinans, Solarium canaliculatum, Bonellia terebellata, Infundibulum trochiforme, Lithodomus dactylus, Cardita*, or *Venericardia planicosta*, and *Ostrea bellovacina*. But there are a considerable number of representative species, and an equal number of forms peculiar to these older tertiary strata in America. The *Ostrea Sellæformis*, which may be considered as representing the *Ostrea flabellula* of the Paris basin, appears to be one of the most characteristic and widely disseminated Eocene shells in Virginia, South Carolina and Georgia, for I found it at Shell Bluff and on the Santee river, and the James river in Virginia."—*Lyell's Travels in North America*, vol. i. p. 178.

† See Silliman's American Journal of Science, vol. xliv. p. 411; and Dr. Gibbes in Proceedings of the American Acad. of Sciences, June 1845.

has been most extensively developed, but at present our information respecting this part of the world, from the want of good palæontological specimens, is comparatively limited.

Thus it is seen that the same types of mammals, of shells, and vegetable productions characterize the Eocene period in all parts of the world; although in some localities there may be a difference in specific or even generic characters. In the strata of this period we find the remains of extinct Crocodiles, but not those of any of the numerous Saurians which are met with in the older formations; neither can we produce a single example of an Eocene Saurian or mammalian species existing at the present day. It is true, that the remains of the same genera of reptiles which now inhabit warm countries are discovered with the Mammalia of this period, and a few of the Eocene genera of Mammalia now exist; but the Tapir, Rhinoceros and Hippopotamus are respectively the nearest approximations to the Lophiodon, Palæotherium, and Anthracotherium of the Eocene catalogue. In the Cretaceous æra some few fossils may approach the Eocene; and nothing is more probable than that creatures of a deep sea should have co-existed with those of a shallow sea or of an estuary. Some Infusoria and Polythalamia, according to Professor Ehrenberg, are specifically the same, and certain existing fishes are also generically identical with those of the Eocene deposits; but in this country the separation between the Cretaceous and Tertiary formations is so apparent, that in our present state of geological knowledge, no divisions can be followed with greater safety than those proposed by Mr. Lyell.

In England the comparative anatomist has few opportunities of studying the remains of the early Tertiary animals. Binstead and Seafield in the Isle of Wight have afforded the best examples, and a few specimens have been obtained from other places*. Two teeth of the

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* Owen's British Fossil Mammalia, pp. 299–306.

Lophiodon minimus have been procured from Bracklesham Bay; but the remains of land mammals ought not to be expected from this locality, as the fossils are those which principally belong to the lower portion of the Eocene period or nearest the Chalk. So numerous are the remains of these extinct Pachydermata from the gypsum quarries of Montmartre, which may be chiefly considered of freshwater origin, that Cuvier has observed, "every block contains the fragment of some skeleton," and after many years collecting, adds this most interesting paragraph in his 'Ossemens Fossiles,' tom. iii. Introduction, pp. 3, 4:—

"I at length found myself, as if placed in a charnel-house, surrounded by mutilated fragments of many hundred skeletons, of more than twenty kinds of animals piled confusedly around me: the task assigned me was to restore them all to their original position. At the voice of Comparative Anatomy, every bone, and fragment of a bone resumed its place. I cannot find words to express the pleasure I experienced in seeing, as I discovered one character, how all the consequences which I predicted from it were successively confirmed: the feet were found in accordance with the characters announced by the teeth; the teeth in harmony with those indicated beforehand by the feet: the bones of the legs and thighs, and every connecting portion of the extremities, we found set together precisely as I had arranged them, before my conjectures were verified by the discovery of the parts entire: in short, each species was, as it were, reconstructed from a single one of its component elements."

The researches of Cuvier and Professor Owen have justly placed the study of Comparative Anatomy as the highest branch of Palæontology. The geologist must not however neglect Conchology, as the evidence produced by the remains of shells is more frequent, and shells afford more certainty that the animals they belonged to lived where they are found.

Geological inquiry has unfolded some of the most beautiful as well as extraordinary beings of creation: it has shown the wonderful power and greatness of God in all ages of the world, and is an endless source of expectation. There is no part of the world in which a geologist may not find some object for contemplation: it is a most healthful occupation, improving at the same time the bodily as well as the mental powers.

To the sensitive mind the study of Geology is far more agreeable than any other department of natural history. The creatures that come under consideration have perished ages ago; no compunctious visitings of nature obstruct the path of inquiry into their organic characters. We know not the exact conditions or purpose for which so many generations of Beings were created to enjoy the boon of life in this planet, and effect certain changes by reaction on the surrounding media for allotted periods, and then finally disappear from the stage and give way to other and commonly higher organized races. This is a mystery we may never be able to unravel. But from what we do know of the wise ordinances of Providence, we ought to be well satisfied that these great events must have been essential to the order and arrangement of the universe. A distinguished philosopher has observed, that "fossiliferous strata are the monuments of the felicity of past ages."

"It is clear," says the Rev. Dr. Buckland in his Bridgewater Treatise, p. 529, "that next to the study of those distant worlds which engage the contemplation of the astronomer, the largest and most sublime subject of physical inquiry which can occupy the mind of man, and by far the most interesting, from the personal concern we have in it, is the history of the formation and structure of the planet on which we dwell, of the many and wonderful revolutions through which it has passed, of the vast and various changes in organic life that have followed one another upon its surface, and of its multifarious adaptations to the support of its present inhabitants, and to the physical and moral condition of the human race."

These are thy glorious works, Parent of good,
Almighty! Thine this universal frame,
Thus wondrous fair; Thyself how wondrous then!
Unspeakable, who sitt'st above these heavens,
To us invisible, or dimly seen
In these thy lowest works; yet these declare
Thy goodness beyond thought, and power divine.

PART II.

CHAPTER I.

THE CHALK FORMATION.

Dr. Mantell's work on the fossils of the South Downs, published more than twenty years ago, created much interest, not only in Sussex, but in all countries where the chalk formation is a principal feature of its geology. Having resided many years in Sussex, and procured fossils from the various chalk-pits in the neighbourhood, I found that my collection contained many unnoticed specimens; and, with the assistance of several geological friends, I am enabled to offer some further illustrations of the Cretaceous period.

I beg to return my grateful thanks to the following distinguished cultivators of geological science and collectors of its evidences, from whom I have derived information:—The Marquis of Northampton, P.R.S.; the Earl of Enniskillen, F.R.S.; Sir Philip Grey Egerton, Bart., F.R.S.; Sir Francis Shuckburgh, Bart., F.R.S.; the Rev. J. Austin; the Rev. H. Hoper; Dr. Mantell, F.R.S.; Ed. Forbes, Esq., F.R.S.; J. E. Gray, Esq., F.R.S.; J. S. Bowerbank, Esq., F.R.S.; N. Wetherell, Esq., F.G.S.; Channing Pearce, Esq., F.G.S.; W. Flower, Esq., F.G.S.; W. D. Saull, Esq., F.G.S.; Major Boys; Robert Drewitt, Esq.; Edward Clark, Esq., F.G.S.; W. Harris, Esq., F.G.S.; J. Morris, Esq., F.G.S.; Mr. J. Bass, Jun.; Mr. Tennant, F.G.S.; Captain Burgh; Mr. Salter, F.G.S.; Mr. Perdue; Mrs. W. Trower, Weston; and to Mrs. Smith, of Tonbridge Wells.

I have great satisfaction in stating, that Professor Agassiz and Sir

P. Egerton have been so kind as to render me their assistance in arranging and naming many of the fish, both of the Tertiary and Secondary formations.

The corals of the chalk, like those of the Eocene deposits, have been described by W. Lonsdale, Esq., F.G.S., to whom I am much indebted.

I owe to Professor Owen many obligations, particularly on this occasion, for his most valuable description of the chalk saurians.

I am obliged to G. A. Coombe, Esq., of Arundel, for some beautiful specimens; and to Henry Catt, Esq., of Brighton, who has a rich cabinet of chalk fossils, and has added within the last few years some most interesting specimens from the pits in the neighbourhood of Lewes.

Mr. J. D. C. Sowerby, Mr. Dinkel, Mr. Scharf, Mr. Erxleben, and Mr. Lens Aldous have engraved the plates. Mr. Sowerby has also rendered me great assistance in my descriptions.

In the southern, as well as some other counties of England, where the downs form a beautiful undulating character, the landscape is often broken by the appearance of white patches; these are generally the remains of pits that have been opened for the purpose of procuring that useful substance, chalk, the material of which these hills are composed. Chalk is, chemically speaking, a carbonate of lime: kilns are built at most of the quarries for converting, by the process of burning, the carbonate of lime into lime, the carbonic acid being expelled by heat. Lime is most extensively used in building, is of great value in many manufactures, and is an excellent manure for some lands; and in these applications, to most persons begin and end the interest and value of the Chalk formation. To the scientific man, however, it opens another field of inquiry: he perceives, upon examination, that it often contains shells, the scales of fish, &c., mixed up with the white mass; he consults the geologist, who informs him that the material, chalk, is only one character of an extensive formation, the sepulchre of an innumerable race of marine beings, whose remains are occasionally observed in strata of a very different mineral condition; that its white appearance is not essential to its geological period; and that it is not confined to England, but is distributed under different forms over Europe, Asia and America*.

The strata which have been called the Cretaceous group are, in the south of England, divided into the following order by Mr. Lyell, Dr. Mantell, Dr. Fitton and the Rev. Mr. Conybeare :—

Cretaceous group.	Chalk formation.	*a.* Upper soft white chalk, containing flints.	United thickness from 600 to 1000 feet.
		b. Lower hard grey chalk, without flints.	
		c. Chalk marl.	
	Greensand formation.	*a.* Upper greensand	Thickness from 30 to 100 ft.
		b. Gault or blue marl	Thickness from 10 to 150 ft.
		c. Lower greensand and ironsand, with occasional limestone	Thickness 250 ft.

My illustrations are entirely confined to that portion of the Cretaceous group more especially called the Chalk formation; and for the investigation of the greensand, I beg to refer my readers to the excellent researches and observations of Dr. Fitton and Dr. Mantell.

Upper white chalk in its purest state contains nothing but lime and carbonic acid; it loses half its weight when burnt, the carbonic acid being expelled from it in the form of gas. It yields by analysis the following results :—

Lime	56·50
Carbonic acid	43·00
Water	0·50
	100·00

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* The name Cretaceous group designates rocks in all parts of the world which contain the same palæontological characters.

Lower chalk and chalk marl contain more or less alumina and silica, a great variation occurring in different localities*.

Mr. Lyell observes, that "the area over which the white chalk preserves a nearly homogeneous aspect is so great, that geologists have often despaired of finding any analogous deposits of recent date; for chalk is met with in the north-west and south-east direction from the north of Ireland to the Crimea, a distance of about 1140 geographical miles, and in an opposite direction it extends from the south of Sweden to the south of Bordeaux, a distance of about 840 geographical miles. But we must not conclude that it was ever spread out uniformly over the whole of this space, but merely that there were patches of it, of various sizes, throughout this area." (Lyell's Elements, page 401.)

The Chalk formation of England may be briefly stated as follows, and can be well traced on Mr. Greenough's magnificent Geological Map of England and Wales. The strata may be said to commence at Dover on the east, at which point the Kentish Downs arise and are continued westward until they unite with the North Downs of Surrey. On the south-east the chalk again appears in the cliffs of Beachy Head, forming there the South Downs of Sussex. The North and South Downs of Surrey and Sussex† are continued westward until they join

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* Mr. Bakewell observes in his 'Geology,' page 341, "Chalk is not, however, absolutely pure, for besides the nodules and veins of flint that occur in it, but which bear no sensible proportion to the whole mass, some of the strata contain an intermixture with siliceous sand, and in other strata calcareous earth is combined with magnesia. In some chalk strata in France, the magnesia exceeds ten per cent., and I believe many of the English chalk strata contain as great a proportion of magnesian earth.

"Chalk which contains a notable portion of magnesia may generally be known by an appearance of dendritical spotted delineations on the surface of the natural partings, and by minute black spots, like grains of gunpowder, in the substance of the chalk."

The appearance of black spots, from my own observation, is more confined to the upper chalk than the lower, and well seen at Burpham and Beeding, Sussex.

† The South Downs, properly speaking, are only those hills which lie between Eastbourne and Shoreham, being twenty-six miles long and seven wide.

the Hampshire Downs in the east, which unite with another range of Downs, commencing with the cliffs between Weymouth and the Isle of Purbeck. This includes the north of Hampshire, and nearly all the south of Wiltshire; its longest diameter, from east to west, being about fifty-six miles, and its shortest, from north to south, about twenty. A part of this range may be said also to extend eastward as far as the Isle of Wight. These Downs are marked by a succession of rounded elevations; and the chalk is often broken by valleys transverse to its strike, which is well seen in the North and South Downs.

From the Marlborough Downs, the Whitehorse Hills and Ilsey Downs, the chalk is continued into Oxfordshire; it again makes its appearance, in a succession of Downs, through Buckinghamshire, Hertfordshire, Bedfordshire and Cambridgeshire, into Suffolk and Norfolk, rising again in hills near Norwich; it is continued to the coast, forming the cliffs between Cromer and Hunstanton. At this point the Wash breaks its continuity, but it re-appears on the opposite coast, forming the Wolds of Lincolnshire; the stratum is then divided by the river Humber, but the chalk is discovered again near Hull; from thence it is continued through the Wolds of Yorkshire as far as Speeton, which is six miles from Flamborough Head, and the most northern extent of this formation.

The Chalk formation is not observed in the western part of England, in Wales, or in Scotland. In the north-east of Ireland it forms a compact limestone, but in a much more limited character, the deposit not exceeding 300 feet in thickness.

In Lincolnshire and Yorkshire the chalk occasionally assumes a red appearance, probably from the presence of iron in a state of oxide.

The highest elevation of the chalk is the Inkpen Beacon in Wiltshire, being rather more than 1000 feet above the level of the sea*.

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* In Sussex the Ditchling Beacon is the highest point, being 856 feet above the level of the sea.

Many geologists have endeavoured to trace the origin of white chalk. Mr. Lyell has remarked, that chalk which appears to an ordinary observer quite destitute of organic remains, is nevertheless, when seen under the microscope, full of fragments of corals and sponges, the shells of foraminifera, and still more minute infusoria. The bold idea, that chalk was of animal origin, produced by the decomposition of testacea and corals, was considered by some naturalists quite vague and visionary, until its probability was strengthened by new evidence, brought to light by modern geologists. Lieut. Nelson and Mr. C. Darwin have published some valuable observations in support of this argument; but the following are the most remarkable facts relating to the Chalk formation which have ever appeared.

In the Transactions of the Royal Academy of Berlin for 1840, Prof. Ehrenberg read a most important and highly interesting paper on the numerous animals of the Chalk formation which are still to be found in a living state. He enumerates fourteen forms which have been noticed by different authors,—six Echinoidea, six Mollusca, one Coralline and one Polythalamia, and adds fifty-seven new species; of these, nine are calcareous-shelled Polythalamia, and forty-seven siliceous-shelled Infusoria; of these, thirty belong to the undoubted chalk and Sicilian marls; the remaining twenty-seven occur in marls which contain so many well-known animals of the chalk period, as to leave little doubt of their contemporaneous origin. Several of these siliceous Infusoria have been observed in England, such as *Fragilaria rhabdosoma* and *F. striolata* in white chalk from the Gravesend quarries; and in flint, several species of Xanthidia and other genera have been noticed from Kent and Sussex.

“ Mr. Lonsdale, on examining, in October 1835, in the museum of the Geological Society of London, portions of white chalk from different parts of England, found, on carefully pulverizing them in water, that what appear to the eye simply as white grains, were, in fact, well-preserved fossils. He obtained about a thousand of these from each pound weight of chalk, some being fragments of minute corallines, others entire Foraminifera and Cytherinæ." (Lyell's Elements, vol. i. p. 56.)

Professor Ehrenberg's observations on his discovery of recent species identical with the fossils of the Cretaceous period are so important, that I cannot do better than quote his own words, from a translation by Dr. W. Francis, published in R. Taylor's 'Scientific Memoirs' for 1842 and 1843 :—

"There are numerous animals of the Chalk or secondary formation of the earth which are still found living, and precisely such as do not, either from great variation of form within generic limits, or from the simplicity of their exterior, leave any uncertainty in determining their specific difference.

"Of the animal forms which constitute the greater mass of the white chalk, those which preponderate in number of individuals are identical with living species; and hitherto all the principal species which form the rocks have been observed alive, even in the short time during which the inquiry has been proceeding.

"The principal number of species, and the great mass of individuals of these recent forms, are microscopic Infusoria and calcareous-shelled Polythalamia, scarcely or not at all perceptible to the naked eye, which nevertheless form so incalculably great a volume of the solid portion of the earth, that the few species asserted to be still living, from other groups of animals of higher organization, even if they were all decidedly identical, bear not the slightest comparison with the number and mass.

"The microscopic organisms are, it is true, far inferior in individual energy to lions and elephants; but in their united influences they appear far more important than all these animals.

"The fifty-seven recent species of the chalk in Europe, Africa and

Asia do not live solely or principally in southern latitudes, as has been shown with respect to the recent larger forms of the so-called Eocene formation, but have been observed living both in those and in northern latitudes. These recent species also are not rare nor isolated, but fill in incalculable numbers the seas of northern Europe, and are not wanting on the tropical coasts of the American ocean.

" The idea that the temperature and constitution of the atmosphere and oceans were essentially different at the period of the Chalk formation, and adverse to the organized beings at present existing, naturally acquired more probability and weight the more decidedly different all the creatures of that period were from those of the present time ; but loses more and more in importance the less the chalk proves to be a chemical precipitate, and the more numerous the forms agreeing with those of the present day become by renewed inquiry. Nay, there is not the least doubt that the perfectly ascertained identity of a single species of the present day with one of those of the chalk, renders doubtful the necessary transformation of all the others subsequently to the formation of the chalk rocks ; how much more so when these are numerous, and such as form masses ! The size appears to be of no importance, as the small organisms have already been shown to agree with the large, with regard to the effect of external influences upon them.

" The period of the dawn of the organic creation coexistent with ourselves, can only be admitted as being anterior to and below the Chalk formation, if indeed, which is questionable, such a distinction can be made ; or the chalk, with its rocks, covering far and high the superficies of the earth, forms part of the series of recent formations, and, since of the four as yet well-established great geological periods of the earth's formation, the quaternary, tertiary and secondary formations contain recent organisms, it is as three to one more probable that the transition or primary formation is not differently circumstanced, but that, from the gradual longer chemical decomposition and change of many of its organic relations, it is more difficult to examine and determine.

" *Paludina vivipara* and *Cyclas cornea* of the Weald clay, and the recent Trochus below the chalk, according to Defrance, as well as the confirmation of the occurrence of *Terebratula caput serpentis* in the Upper Jura by Von Buch, together with my observations of microscopic yet nevertheless peculiar Polythalamia in the flints of the Jura, are additional positive indications of the inconceivable extent of similar organic relations, the further investigation of which is one of the important questions to be determined in the present age.

" Since now Polythalamia, and other forms identical with chalk animals, exist which are not endowed with spontaneous division, this faculty of the Infusoria, and their general nature, are not the sole causes to which the indefinite duration of the species is owing.

" In consequence of the mass-building Infusoria and Polythalamia, the secondary formations can now no longer be distinguished from the tertiary; and in accordance with what has been above stated, masses of rock might be formed even at the present time in the ocean, and be raised by volcanic power above the surface, the great mass of which would, as to its constituents, perfectly resemble the chalk. Thus then the chalk remains still to be distinguished by its organic contents as a geological formation, but no longer as a species of rock.

" The power so conspicuous in the organic beings under consideration is, according to experience, so immensely great, even in its influence on the inorganic, that with the concurrence of favourable circumstances they alone might give rise to the greatest changes in the distribution of the solid of the earth in the shortest space of time, especially in the water; and the ascertainable extent of such influences however great, remains constantly small in comparison to those that are possible, consequently do not give by their magnitude any certain measure of periods of time.

"The correctness of the above expositions is not founded on individual opinion formed from hasty inspections of petty objects; but the microscopic objects on which the opinions are based (though fading from our notice as individuals, yet by their number forming mountains and countries) are accessible to any comparison in distinct preparations, made according to the methods already described; and almost all the forms here mentioned, especially all the more important ones, have been carefully preserved by me, and laid before the Academy.

"Thus then there is a chain, which though in the individual it be microscopic, yet in the mass a mighty one, connecting the organic life of distant ages of the earth, and proving that it is not always the smaller or most deeply lying which is the base and the type of those which are larger and nearer the surface on our earth; and moreover, that the dawn of the organic nature coexistent with us, reaches further back into the history of the earth than had hitherto appeared."

These discoveries, by so accurate an observer as Professor Ehrenberg, have to a certain degree modified the views as to the period of introduction of existing animated species. No recent beings were considered before this statement to be specifically the same as the fossils observed in the secondary period; yet it has been shown that fifty-seven species are clearly made out to be identical. I am willing to admit that small bodies are difficult of examination, and require a great nicety of microscopical observation; but it must also be allowed, that, in the supposed changes which the world has undergone, no material alteration has taken place in the chemical composition of sea-water; and from the myriads of Infusoria that must have been in existence at the Cretaceous epoch, some few may have escaped general destruction. A continuance of species is more possible and probable in these minute and low organized creatures than in the higher orders of animals.

No part of the Chalk formation has been the subject of so much diversity of opinion as the origin of Flint*. With respect to one species of remarkable products of the chalk, called paramoudras, Dr. Buckland has recorded some valuable observations which bear upon the theory of the origin of siliceous bodies in general. He says ('Geological Transactions,' vol. iv. 1817, pp. 416, 417, 418), "In all these cases the organic bodies thus preserved appear to have been lodged in the matter of the rock while it was in the state of a compound, unconsolidated, pulpy fluid; and before *that* separation of its siliceous from its calcareous ingredients, which has given origin to the flinty nodules in chalk, and to beds and nodules of chert in other limestone rocks. The present shape of many chalk flints being that of organic bodies, demonstrates the latter to have existed before the consolidation of the former; for the fidelity with which the silex has often copied the organization, and even the accidents and irregularities of the bodies enveloped, is so accurate, that it is impossible to attribute the form of the flint to any other cause than that of the body on which it was deposited. Sometimes the organization is so delicately retained, that it seems not to have undergone the smallest derangement before the siliceous cast was taken; and the model is thus permanently pre-

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* When first extracted from the quarry, flint is brittle, has a conchoidal fracture and feeble lustre; thin fragments are transparent; its specific gravity is 2·594. According to the analysis of Klaproth, it consists of—

Silex	98
Lime	·05
Alumine	·025
Oxide of Iron	·025
Water	·1

served. In other cases the minute fibres and tubes of the animal are not expressed by the silex which has filled the spaces which they occupied, yet the external form represents with faithful accuracy that of the body which afforded to the silex its mould or nucleus.

" Before the consolidation of the original compound fluid, which is now hardened and separated into beds and nodules of flint and chalk, a variety of organic bodies being dispersed through its mass would afford a number of nuclei, to which, in separating itself from the chalk, the silex seems to have had a tendency to attach itself. Hence the insulated nodules that occur irregularly in the chalk, out of the line of the flinty strata, do, I believe, bear traces of an organic nucleus; so also in many cases do those that occupy the flinty strata. But the greater number of these latter, though their form be usually that of nodules separated from each other by an intervening portion of chalk, yet indicate no traces that refer them to organic origin, and are sometimes extended into thin, continuous tabular masses.

" The organic bodies that afforded nuclei to these nascent flints appear to have been dispersed pretty uniformly through the original compound mass, which is now divided into beds of chalk and flints; but it is not easy to determine what cause it was that regulated the distances at which the beds of flints have been disposed, or to say why we sometimes find organic bodies preserved in flint, at other times enveloped and filled by pure chalk. The solution of the latter question may be, that different genera of organic remains afforded centres that attracted the silex with unequal force, and that this will in some degree explain the phænomenon so common in the Chalk formation, that bodies allied to the genus Sponge and Alcyonium are most frequently preserved in flint and calcedony, whilst shells and other bodies, which in their natural state were more calcareous, generally have their form retained by chalk or calcareous spar."

There are no organic remains discovered in the substance of the chalk that may not be occasionally met with imbedded in flint. I have seen the bones of Saurians and Echinoderms ; I have in my own collection both palatal and sharp maxillary teeth of more than six species of fish ; the common Ananchytes and Spatangus, which have their interior filled with flint, are good examples of its extreme fluidity. Thin portions, which can with a little management be broken from flints, form good objects for the microscope : some of these contain Foraminifera and Infusoria in great abundance, the scales of fish, and many organic forms, which have not been particularly noticed.

On entering a pit of upper chalk, the stranger is surprised at seeing detached, but usually horizontal rows of flints distributed through the mass, varying from three to six feet apart, in regular divisions ; these are the remains of the heavier zoophytes, which have attracted the silica and sunk to the bottom of the pulpy fluid ; and, as Dr. Buckland observes, each division may indicate a period so long as to consolidate the preceding layer*. In some localities (though rarely) the flint strata assume a vertical position, running in thin seams from one to two inches in thickness ; this is well seen in the section of the chalk at Findon Hill near Worthing.

Among the spongeous bodies which are abundant in the upper chalk, there is one that claims our peculiar attention—the *Choanites Konigii* of Mantell. I have given a drawing of this sponge, as near as possible to its original form : it is found in great abundance on the beach of those shores which are in approximation to the Chalk formation, and of late years has been much sought after under the name of pebbles or agates. This sponge is often more or less converted into calcedony, yet still in many instances preserving its structure, and

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* Most of the chalk, and many recent sponges, contain needles or spicula of flint, and some zoophytes and many marine plants have the power of secreting siliceous matter. The boiling springs of the Geyser in Iceland contain also much silica in solution. It occurs also in the waters of Carlsbad and Bath.

when cut and polished forms beautiful ornaments. Bognor was the first place at which they were brought into notice, and I had them cut more than thirty years ago: in Plate XIII. are figured specimens in my own collection, found at or near Worthing. The expectation of finding a good stone on the beach affords some amusement to the visitors of watering-places; some specimens look remarkably well, polished all over; in others, during the decomposition of the sponge, more or less oxide of iron was generated, giving to the calcedony a beautiful yellow or orange tint and black mossy character. The stones mostly prized by lapidaries are those which assume the appearance of landscapes. I have seen some very beautiful ones of this description, which might vie with the better-known and far-famed Mochas of the East. This trade has within the last six years very much increased; and many persons are now employed in the cutting and polishing these stones into brooches, buckles, earrings, &c. They are also brought in great numbers from the opposite coast of France.

Very beautiful calcedonies are found in chalk-pits, and at the top of the Downs; these cut and polish like the specimens on the shore. There are in my collection varieties which mineralogists have denominated 'botryoidal,' from a resemblance to grapes; 'reniform,' from a kidney-shaped appearance; 'stalactitic,' from a dropping or columnar character. The form and colour of these calcedonic flints are much varied; some are white, others pink and blue, of various shades, and often covered with a most delicate bloom. The flints in Houghton chalk-pit are sometimes coated with a light blue-coloured calcedony, which looks very like paint; these specimens lose their colour when placed in water, the colour returning again when dry. Collectors should examine the flints that are thrown out of chalk-pits, as often good specimens of shells, &c. may be found adhering to them; and they are not unfrequently found encrusted with Polythalamia in an unusually perfect condition: Choanites and Ventriculites also occur here in a much more perfect state of preservation than on the coast. The shore specimens are generally round, and deprived of their stems or roots by the constant action of the waves.

I have collected on the range of Downs between Sullington and Amberley Mount magnificent calcedonies, and flints filled with quartz crystals; also cubic crystals of calcedony, and beautiful and rare crystals of sulphuret of iron. On the Parham Hills radiated crystals of carbonate of lime are seen in large masses, as well as on other parts of the Sussex Downs. These specimens all belong to the Upper Chalk formation*.

Wood is found occasionally in the upper and lower chalk; more frequently in the upper, sometimes adhering to or even in the centre of flints. It usually assumes a light brown colour, though I have seen it quite black, having the appearance as if it had been burnt. The specimens I have examined are dicotyledonous, and show occasionally the perforations of Teredines.

Small pebbles and large rolled fragments of sandstone and quartz rock are occasionally discovered in the centre of the upper chalk. Mr. Coombe found one specimen, weighing near fourteen pounds, at Houghton, Sussex, and I have seen others from the same pit of two or three pounds weight; several also have been sent me by Mr. Catt from the pits near Lewes. It is not uncommon to find rolled portions of chalk shells, which must have been broken many years before they were enveloped in the chalk fluid. I have also portions of Sphærulite showing this appearance, from the lower chalk of Balcombe, near Houghton, Sussex. Mr. Lyell has published some ingenious remarks

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* "Obtuse rhomboidal crystals of great beauty have been found in a chalk-pit near Alfriston: their colour is of a delicate pearl white, and in their general appearance they resemble the double refracting spar of Iceland, except in their inferior degree of transparency. The cavities of Echinites are sometimes lined with rhomboidal crystals of carbonate of lime, disposed in lines parallel with the section formed by the areæ of the shell; and the inner surfaces of Terebratulæ are frequently frosted over with crystals of the same substance."—Mantell's Geology, p. 89.

on the occurrence of these pebbles in the chalk, in the second edition of his 'Elements of Geology,' p. 394.

Iron, in the form of sulphuret or pyrites, and in different degrees of oxidation, is the only metal found in the Chalk formation: I have casts of shells, star-fish and sponges entirely composed of it. Nodules of pyrites occur in all shapes and sizes; many of them when broken exhibit brilliant radiated crystallization; but this appearance, when exposed to the air, soon vanishes, for the surface imbibes the oxygen from the atmosphere, and decomposes in the form of sulphate of iron. Pyramidal crystals often fill the cavities of shells and cover large masses of this substance. Acute and truncated octohedral crystals are found single, or disposed in irregular groups. Cubic crystals (though rare) I have found in the pits near Lancing; and some specimens at Houghton assume the shape of the cockscomb crystallization. In breaking the balls of pyrites, a Terebratula or small shell is sometimes found in the centre, forming the nucleus of crystallization; and crystallized sulphate and carbonate of lime are also observed in some masses.

CHAPTER II.

In the preceding chapter I have endeavoured to explain the general appearance of the Chalk formation as it occurs in England, more particularly the southern counties; but in order fully to understand its great extent, diversity of form, and mineral condition, it will be requisite to notice for a few moments some of the various deposits in other parts of the world, which, from the character of their organic remains, have been assigned to this period.

In France the Cretaceous formation is most extensively developed. The tertiary beds on which Paris is built are surrounded by a broad girdle of chalk, extending westward to the mouth of the Seine, and northward into Belgium; in its substance it is harder and more compact than in England, and frequently used as a building-stone. On the north side of the Pyrenees, the Cretaceous period is represented by a crystalline marble composed almost entirely of Hippurites, Sphærulites and Nummulites*. Sphærulites, though very rare, are sometimes found in the English chalk; I know but of two or three localities in Kent and Sussex in which they have been discovered. Nummulites are most abundant in the Eocene deposits of Bracklesham Bay; but I have never been able to detect them in the chalk or flint of our own country.

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* "It is evident from the great range of the Hippurite and Nummulite limestone, that the south of Europe was occupied at the Cretaceous period by an immense sea, which extended from the Atlantic Ocean into Asia, and comprehended the southernmost part of France, together with Spain, Sicily, part of Italy, and the Austrian Alps, Dalmatia, Albania, a portion of Syria, the isles of the Ægean, coasts of Thrace, and the Troad."—*Lyell's Elements*, vol. i. p. 412.

Professor Agassiz has clearly pointed out that the black slate of Engi in the canton of Glaris in Switzerland, so celebrated for fossil fishes, is of the lower cretaceous age. This shows the great value of Palæontology; for nothing can be more unlike, than a piece of Glaris slate to white chalk. I possess a good series of these fish, through the kindness of Lord Enniskillen.

In the east of Europe, near Dresden, the chalk assumes a dark grey colour, but is readily recognised by the appearance of Ammonites, Scaphites, teeth of fish, &c. In Poland the white chalk reposes on the greensand, as in this country. In the south of Russia, Sir R. I. Murchison has declared the chalk undistinguishable from that of England.

M. Dubois, in his late researches, has pointed out that many parts of the Circassian mountains are cretaceous, and their appearance similar to our English downs, with their slopes covered with trees. We trace the Chalk period through the Crimea into Asia Minor, where, according to Mr. Hamilton, the beds become semi-crystalline, and are frequently hollowed out into basins filled with tertiary deposits.

The Morea and intermediate islands contain cretaceous fossils. The island of Rhodes, and part of Syria on the Lebanon range immediately above Beyroot, are composed of chalk containing flints, but few fossils. In the neighbourhood of Lisbon, Mr. Sharp has found the Hippurite, in hills traceable many miles to the south of the Tagus.

In North America there are four distinct forms in which the Chalk period is recognized: 1st, in a thin mass almost entirely composed of comminuted corals; 2nd, in a compact limestone of a yellowish colour; 3rd, in a subcrystalline limestone; and 4th, by a white limestone, the whole series being loaded with cretaceous fossils, and extending in an irregular crescent near three thousand miles.

In South America, according to M. d'Orbigny, the Cretaceous period is largely developed, and can be traced from Columbia to Tierra del

Fuego. I have in my collection a great many fish from the fossiliferous limestone near Brazil, which are considered by Agassiz as referable to this period.

The extent of the Chalk formation cannot be more strongly impressed on the reader, than by transporting him from the shores of Kent and Sussex into Southern India, and showing him at Trichinopoly and Pondicherry fossils decidedly cretaceous. I am indebted to the late Mr. Kaye for a series of these beautiful fossils, who brought them for my inspection on his arrival in England, since which they have been ably described by my friend, Professor E. Forbes. I cannot omit this opportunity of paying a just tribute of praise and respect to the memory of Mr. Kaye, who was a zealous geologist, and adding my sincere regret at his early death. These fossils are mostly representatives of the gault and lower greensand, but they contain many forms not discovered in England, together with a few others which Professor Forbes cannot but consider as tertiary.

Having briefly pointed out the immense space which the Cretaceous period occupies on the surface of the globe, there are one or two localities of this formation which must be mentioned, that contain genera discovered also in tertiary deposits, besides those of Southern India, and considered by some geologists as forming a connecting link between the secondary and tertiary divisions. The beds near Maestricht and the Faxoe formation consist of a yellowish stone, like the soft upper chalk of England, and with similar shells, but to these are added genera decidedly tertiary, such as Cypræa, Oliva, Bulla*, &c.; there are no black flints, as in the upper chalk deposits of England, but occasional nodules of chert and calcedony, together with Ammonites,

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* "The species however do not agree with those of the tertiary strata, and are associated with Cephalopoda characteristic of the Cretaceous, and foreign to the Tertiary epoch."—*Lyell's Elements,* 2nd edit. vol. i. p. 397.

Hamites, Baculites, &c. In these beds turtles are found, and near Maestricht that magnificent reptile, the Mososaurus, was discovered.

The Cretaceous period is a marine formation, and the fossils discovered in it are chiefly of beings that lived and died in or near the sea. The genera of most of the shells are referable to deep-water species, though there are exceptions made by some geologists to the univalves : its duration must have been immense, and the progress of its deposition gradual, for we often find rolled portions and whole shells, on which are serpulæ, corals, &c., which must have attached themselves after the death of the shell, and lived many years before they were enveloped in the pulpy fluid of the chalk. I have never seen any older fossils than those of the Cretaceous period adhering to these specimens. The remains of fish are abundant in some localities, and generally speaking they belong to the Ctenoid and Cycloid orders of Agassiz*. Turtles have been discovered ; a most beautiful specimen from Kent is figured in the 'Transactions of the Royal Society' by Dr. Mantell. The bones of birds, resembling in their character those of the Albatros, have been described by Professor Owen. In the 'Geological Journal for 1846,' Mr. Bowerbank has published an account of a large Pterodactyl found in the upper chalk of Kent. I have much pleasure in stating, that I am enabled, by the kindness of my friends, to add some new Reptilia to this formation, which have been ably explained by Professor Owen, adding greatly to the value of my work.

A most excellent treatise on Palæontology, or natural history of fossil animals, has been published by F. J. Pictet of Geneva, in four volumes 8vo, 1844–45–46. A good general view of this work may be

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* The Ctenoid fishes have their scales on the posterior margin jagged or pectinated like a comb, similar to the perch. The cycloid fishes have their scales smooth on the posterior margin, but often ornamented with figures on the upper surface, like the salmon and herring.

found in the 'Quarterly Journal of the Geological Society of London, 1846,' by Professor Ansted; and I think I cannot do geology better service than by making some extracts from it.

"It is one of the most elementary facts of geology, that there are certain groups of species found fossil in the various sets of strata of which the earth's crust is made up, and that these demonstrate the existence of something like a series of distinct faunas. . . . . . . The comparison of such faunas sometimes presents very important results, by generalising from which certain supposed laws have been arrived at, which it is assumed have governed the succession of organized beings. Possibly these have been too hastily assumed, and the importance of some phænomena overrated; but at any rate such generalizations have been useful, and they have greatly tended to advance palæontological science."

These views have been very generally admitted in reference to the four great geological periods, viz. the Diluvial, Tertiary, Secondary, and Primary; but recent investigations have gone further, and pointed out, that these large divisions may also be separated into distinct faunas, each having characteristic fossils. The Cretaceous formation, for instance, has been divided into the upper and lower greensand, the gault, and chalk, and as a general law, with much propriety and correctness.

"This law is true for all classes of animals, but is differently exhibited in each, the groups first introduced having, it would seem, undergone the smallest amount of change, and the converse. Thus if we compare the mollusca and mammalia, we shall find that the former, which existed at the earliest period, have hardly changed their form since the close of the Cretaceous epoch, and that the shells of the tertiary period are generically the same as those now existing; while the mammalia, though only recently introduced, have been subject to many changes, and have required the introduction of new and important groups. But this law, though sound as a general expression of results, must not be applied too minutely. The Nautilus and the Terebratula, the companions of the most ancient form of cephalopodous and brachiopodous mollusca, are still represented by existing species; and associated with the pachyderms of the earliest tertiary period, we find bats and small carnivora, which can hardly be distinguished from animals of the same kind now living.

"The comparison of the faunas of different epochs shows that the temperature of the earth's surface has undergone change.

"This appears from the discovery of the remains of animals in parts of the world where the nearest allied species could not now exist; and it has also been supposed that the extinct faunas of Northern Europe indicate a climate nearly tropical. It is probable however that this law has been the result of a generalization somewhat too hasty, the most that we can at present safely assert being, that there have existed different climates at the same spot at different geological epochs, and that the changes in the cases we are best acquainted with were sometimes, and most frequently, from a higher temperature to a lower, but sometimes also from a lower to a higher.

"That the species belonging to the more ancient periods had a wider geographical distribution than the species now living, is a law rather indicated than demonstrated, and it is clear can only be definitely admitted when the numerous localities still unexamined have given evidence on the subject." It was formerly considered by some geologists, that "the faunas of the most ancient formations are made up of the less perfectly organized animals, and the degree of perfection increases as we approach the more recent epochs."

In some of the early writers on cosmogony, the most absurd notions were entertained respecting bones of any extraordinary character; they were considered to have belonged to fallen angels. After this, various conjectures on the nature of fossils appeared, and they were placed in cabinets as objects of curiosity; but of late years geology, by uniting itself to chemistry, zoology and comparative anatomy, has gained a truly scientific position, and has pointed out that fossil remains at all periods must have been constructed by the same laws that now regulate animal creation, and that the more ancient faunas are composed of highly organized beings.

"The vertebrate type is represented in the older formations by fishes, but the invertebrata are by no means reduced to their less complex forms of organization; since, among the mollusca for example, we find numerous gasteropoda and cephalopoda, the most perfect orders of the class. . . . . At present, no higher orders of vertebrata have been discovered than fishes; but then all the other groups of existing animals (excluding reptiles, birds and mammalia) were represented, as perfectly organized as those of the present day.

"The intermediate faunas, such as that of the Oolite period, differed from those of the earlier and later periods by analogous characters. The fishes, the mollusca, the articulata and the radiata, compared with the preceding and succeeding forms, exhibit similar organization neither more nor less perfect. But these intermediate faunas differed from the earlier ones yet further, since the vertebrata in them included reptiles and didelphine mammals, while they differed from the more modern ones by the absence of the monodelphous mammals.

"We find that neither the radiata, nor the articulata, nor the mollusca, nor the fishes, were imperfectly developed in ancient times, and that ever since their first appearance, the species belonging to these classes of animals have possessed the same degree of perfection as those that live now. It is therefore a mistake to suppose that the early faunas generally were composed of animals less perfect than the recent ones, although indeed we find that the highest point to which organization reached has risen during successive geological periods; so that while fishes at first formed the superior limit of organization, they were afterwards surpassed by the reptiles, and these also, after an interval, by the mammals.

"The theory of successive creations in the present state of our knowledge is the only one admissible, though I am bound to add that it is by no means satisfactory, since it does not seem to me to account sufficiently for all facts, and perhaps it is at best only provisionary. It explains well the differences which exist between successive faunas, but there are also resemblances between these faunas for which it offers no explanation.

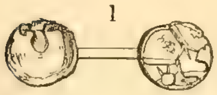
"All observations and researches of any value agree in proclaiming the permanence of species at the present day. The thirty centuries which have passed away since the Egyptians embalmed the carcases of men and animals, have not in any way influenced the characteristic peculiarities of the races which inhabit Egypt. The crocodiles, the species of ibis and the ichneumons now living there, are identical in specific character with those which so many ages ago trod the banks of the Nile. Between the living animal and the mummy there are not only no differences in the essential organs, but there are none even in the most minute details. . . . . . True it is, indeed, that the changes and varieties introduced in domesticated species have been brought forward as an argument against this conclusion; but although such changes unquestionably take place in horses, oxen, sheep, pigs and goats, and yet more remarkably perhaps in dogs, where the form of the cranium becomes modified; yet these very facts appear to me to furnish a conclusion totally different from that which it has been attempted to draw. The individuals the most widely removed from the primitive type never present any real difference of form in the important organs. The skeleton always exhibits invariable characters, as well with regard to the number of the bones and their apophyses as to their relations with one another, while the organs of nutrition, the nervous system, and, in short, every distinctive peculiarity of organization is submitted to the same law. . . . . . It cannot be said that any one of the domestic animals, in its most extreme varieties, loses the character of the species. . . . . .

" The science of geology is not yet in a condition to give a satisfactory answer to many difficulties that may arise in the theory of successive creations ; and though we may with greater or less distinctness foresee such a solution, it cannot yet be demonstrated. A strict and intelligent study of nature is required, in order to bring together the various materials. We must know better than we do now each one of the successive creations, in order to form a complete idea of their mutual relations, and of their differences from those which have preceded and followed them. This is the most important problem of palæontology, and its solution is only to be found in the observation of facts, for they alone are permanent, and they perhaps will outlive all the theories discussed at the present day."

Di, quibus imperium est animarum, umbræque silentes,
Et Chaos, et Phlegethon, loca nocte silentia late;
Sit mihi fas audita loqui: sit numine vestro
Pandere res altâ terrâ et caligine mersas.

I add a few more British and Roman coins found in Sussex, principally from my own cabinet.

1



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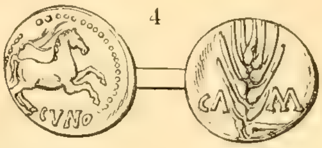

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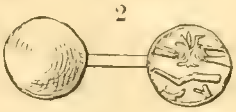

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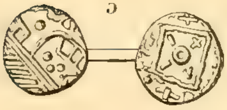

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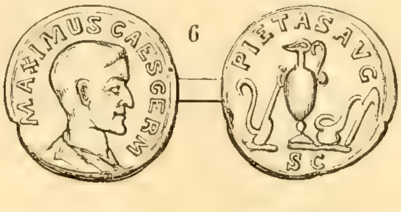

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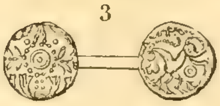

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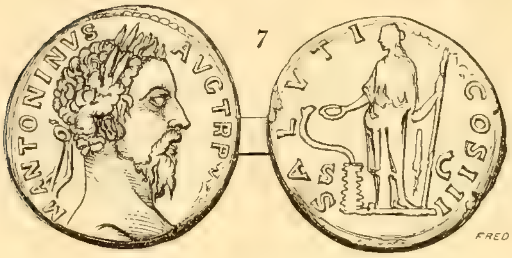

FRED CYDE SC

8

No. 1. British, pale gold, weight 20 grains; found by Mr. Henry Adames at Pagham. I am much obliged to Mr. George Dale of Chichester for procuring me this, as well as some Roman coins found in the neighbourhood.

No. 2. British, pale gold, 19 grains; found at Bracklesham. In the possession of Frederic Edwards, Esq.

These coins, with a little variation, are similar to others discovered on the coast of Kent and Sussex, and on the opposite shore of France, and called Gaulish. Fig. 1. page 36 of this work represents another, and I have seen ten or twelve found in this country.

No. 3. Beautiful British coin of red gold, 15 grains; found at Bracklesham. Unpublished.

No. 4. Gold coin of Cunobeline, found near Chichester harbour, of a pale reddish colour, weight 76 grains; similar to one represented in Ruding, plate 4. fig. 2, from Dr. Hunter's cabinet, weighing 81 grains. The obverse: an ear of corn, with Cam, abbreviated for Camulodunum, Colchester. Ruding remarks that this symbol of Plenty is not found on any of the Gaulish coins, and was probably copied from a Greek coin of Augustus. Reverse: Cuno, for Cunobeline, with a horse in good workmanship.

No. 5. A Saxon sceatta, found at Sullington. Unpublished.

No. 6. Middle or 2nd brass coin of Maximus, found on Parham Hill, 1830. The reverse with sacrificial instruments is not very common.

No. 7. Large brass, of Marcus Aurelius, found on Parham Hill, 1830. Obverse: Antoninus Aug. T.R.P. . . . . Reverse: Saluti. Aug. Cos. iii. Hygeia, standing.

No. 8. Large brass, of Faustina, senior wife of Antoninus Pius, found at Washington Hill. Obverse: Diva Faustina. Reverse: Juno.

These three brass coins are beautifully patinated and in good preservation.

CATALOGUE

OF

THE ORGANIC REMAINS

FROM

BRACKLESHAM BAY, SELSEY, AND BOGNOR.

FOSSILS

FROM

THE EOCENE FORMATION OF BRACKLESHAM BAY, SELSEY, AND BOGNOR.

In giving the accompanying list of fossils from Selsey and Bracklesham Bay, I beg to return my grateful thanks to Lord Enniskillen, Sir P. G. Egerton, Bart., and Professor Agassiz, for their kind assistance in elucidating the fishes. I am much indebted to my friend Frederic Edwards, Esq., for his valuable help in completing the Catalogue of Shells. I must also return my thanks to J. S. Bowerbank, Esq., F.R.S., and G. A. Coombe, Esq. The shells have been examined and described by Mr. J. D. C. Sowerby, F.L.S., and I am under great obligations to W. Lonsdale, Esq., F.G.S., for his excellent description of the Corals.

The fossils from Bognor, except the *Fusus tuberosus,* which is in the museum of Mr. Bowerbank, and a few marked with a star, I have found myself. Serles Wood, Esq., F.G.S., first pointed out to me the *Xiphidium* as occurring in such perfect preservation at Bognor, single valves having been found before at Hampstead and Highgate, by N. Wetherel, Esq., F.G.S.

My estimate of the rarity of the species is drawn from several cabinets, and I have arranged them as in coin collections. This method may not only be satisfactory to the palæontologist, but useful in showing the distribution of the species through the various localities.

V.C. Very common.
C. Common.
R.1. R.2. R.3. R.4. Rare in different degrees, those marked R.4. being almost unique.

PLANTÆ.

	British localities.	*Foreign localities.*
Lycopodites squamatus, R. 4. Tab. IX. f. 1. *Brong. Env. de Paris,* t. xi. f. 3. *Morris,* 12.	Sheppy.	Paris.
Cucumites variabilis, R. 3. Tab. IX. f. 2. *Bow. Fos. Fr.* t. 13. f. 1, 34. *Morris,* 6.	Sheppy.	
Pinites Dixoni, R. 2. Tab. IX. f. 3 & 4. *Bowerbank. Morris,* 18.		

The subjoined letter I have received from my friend Mr. Bowerbank, respecting the Fir-cones.

> "My Dear Sir,—The following are the characters I have adopted for the Cones:—
>
> "PINITES DIXONI.
>
> "*Sp. Char.* Cone about three and a half diameters long. Scales incrassate towards the apex. Apex recurved and terminating in a rhomboidal, obtusely spinous umbo, which is elongated at right angles to the axis of the cone.
>
> "The most perfect of your two specimens affords the best proportional characters of the three, but in my one, the structural characters are most distinct. From a careful comparison of these two, there can be no reasonable doubt of their being the same species. In the third specimen, the large fragment of a cone, in your possession, there is at the first sight an appearance as if it were a different species. The scales appear broader, and the incrassation of the apex extends laterally, so as to give the scale the appearance of terminating in a semilunar ridge, so as to cause them to approximate in their structure to those of *Pinus anthracina,* fig. 164, vol. iii. of Lindley and Hutton's 'Fossil Flora of Great Britain'; but I feel convinced, from a careful inspection and comparison with the more perfect specimens, that these apparent differences of character are due solely to the more decomposed and compressed condition of the specimen; and I am the more strongly confirmed in this belief, from finding the same lateral extension of the apex in one or two of the most compressed of the scales of my own specimen; and moreover, although they are not very apparent, yet there are the remains of the terminal umbones to be found on two or three of the scales of this large fragment of a cone. The difference in size from your more perfect specimen is not greater than that which occurs between the larger and smaller specimens of the cones of *Pinus Russelliana* in the collection of the Linnæan Society, and to which species *P. Dixoni* appears to be closely allied.
>
> "J. S. B."
>
> "3 Highbury Grove, Jan. 6th, 1847."

I possess a large rolled specimen of Palm Wood, of a dark colour, resembling in structure the stem of the cocoa-nut, found in Bracklesham Bay*. The remains of Dicotyledonous and Coniferous Wood are common.

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* See description of Palms.

ZOOPHYTA.

FORAMINIFERA.

NAUTILOIDEA.

	British localities.	*Foreign localities.*
Nummularia lævigata, C. Tab. VIII. f. 12 & 13. *Min. Con.* t. 138. f. 1. *Morris,* 62. Nummulites lævigata, *Lam. Ann. du Mus.* v. 5. 241; *Hist. Nat.* v. 7. 629. *Parkinson, Org. Rem.* v. 3. 152 & 158. t. 10. f. 13 & 14. *Mantell, Geol. Suss.* 269. Nummulina lævigata, *D'Orbig. Tabl. des Ceph.* 129.	Stubbington.	Villers-Coterets.
———— Variolaria, C. *Min. Con.* t. 538. f. 3. *Morris,* 62. Lenticulites Variolaria, *Lam. Ann. du Mus.* v. 5. 187; *Hist. Nat.* v. 7. 619.	Stubbington.	Grignon. Betz. Chaumont.
———— elegans, R. 1. *Min. Con.* t. 538. f. 2. *Morris,* 62.	Alum Bay, Isle of Wight.	
———— radiata, R. 2. Tab. IX. f. 7. Nautilus lenticularis δ, *Fichtel et Moll,* 25. t. 7. f. 9. Rotalites radiatus, *Montfort,* 162. Helicites radiatus, *Blainville, Malac.* 373. Nummulina radiata, *D'Orbig. Tabl. des Ceph.* 130; *Foram. de Vienne,* 115. t. 5. f. 23 & 24.	. . . .	Nussdorf.
Alveolina elongata, C. Tab. IX. f. 4^a. *D'Orbig. Tabl. des Ceph.* 131?	. . . .	Hauteville. Valognes?
———— fusiformis, new, C. Tab. IX. f. 5.		

TURBINOIDEA.

Rotalia obscura, new? R. 1. Tab. IX. f. 6.

MULTILOCULIDEA.

Triloculina Cor-Anguinum, C. Tab. IX. f. 9. Miliolites Cor-Anguinum, *Lam. Ann. du Mus.* v. 5. 351; *Hist. Nat.* v. 7. 612.	. . . .	Grignon. Hauteville.
Quinqueloculina Hauerina, R. 1. Tab. IX. f. 8. *D'Orbig. Foram. de Vienne,* 286. t. 17. f. 25–27.	. . . .	Baden.

ANTHOZOA.

FUNGINA.

Turbinolia sulcata, R. 1. Tab. I. f. 1.

OCELLINA.

Oculina raristella, R. 3. Tab. I. f. 2.
———? dendrophylloides, new, R. 4. Tab. I. f. 3.
Dendrophyllia? . . . . . R. 3. Tab. I. f. 4. Tab. IX. f. 26, 28 & 30.
Siderastræa Websteri, C. Tab. I. f. 5.

MADREPORINA.

Stylophora Monticularia, R. 3. Tab. I. f. 6.
——— emarciata, R. 4. Tab. IX. f. 25.
Porites panacea, R. 4. Tab. I. f. 7.

BRYOZOA.

ASTERODISCINA.

Lunulites urceolata? R. 3. Tab. I. f. 8.

ESCHARINA.

Eschara Brongniarti? R. 2. Tab. I. f. 9.

CELLEPORINA.

Cellepora Petiolus, new, R. 2. Tab. I. f. 10.
Idmonea Coronopus, R. 4. Tab. IX. f. 24.

ECHINODERMATA.

ECHINIDÆ.

Echinus? cased in Pyrites. Tab. IX. f. 27 & 29. The species unknown and even the genus doubtful.

ARTICULATA.

ANNELIDA.

SERPULACEA.

	British localities.	*Foreign localities.*
Serpula flagelliformis, R. 2. *Min. Con.* t. 634. f. 2 & 3. Vermilia flagelliformis, *Morris*, 67.		
——— heptagona, R. 3. *Morris*, 66. *Min. Con.* t. 634. f. 7. Dentalium elephantinum, *Brander*, 11. No. 10 & 11.	Barton.	
——— ornata, new, R. 3. Tab. IX. f. 21.		

CRUSTACEA.

Remains of two or three species of Macroura, but too imperfect to be described.

MOLLUSCA.

CONCHIFERA DIMYARIA.

TUBICOLARIA.

Clavagella coronata, R. 2. Tab. II. f. 17 & 19. *Desh.* v. 1. 8. t. 5. f. 15 & 16. *Min. Con.* t. 480. *Morris*, 82.	. . . .	Bordeaux. Meaux.
Gastrochæna Corallium, new, R. 4. Tab. II. f. 27.		

PHOLADARIA.

Teredo Antenautæ, C. See Bognor list.	Bognor, &c.	

SOLENACEA.

	British localities.	Foreign localities.
Solen obliquus, C. Tab. II. f. 1. *Min. Con.* t. 641. f. 2.		
—— Dixoni, R. 3. Tab. II. f. 23. *Min. Con.* t. 641. f. 3.		
Cultellus affinis, R. 4. *Min. Con.* t. 3 & 643. Solen affinis, *Morris,* 101.	Highgate. Barton. Kingston.Bognor. Chalk Farm.	
Solenocurtus Parisiensis, R. 2. Tab. II. f. 24. *Min. Con.* t. 644. f. 1. Solen strigillatus, *Lam. Ann. du Mus.* v. 7. 428. v. 12. t. 43. f. 5. *Desh.* v. 1. 27. t. 2. f. 22 & 23. Solen Parisiensis, *Desh. Morris,* 101. Solecurtus candidus, *Nyst,* v. 1. 48.	. . . .	Paris. Calloo ?

MYARIA.

Panopæa corrugata, new, R. 3. Tab. II. f. 12.	Bognor.	
Thracia sulcata, R. 3. *Min. Con.* t. 632. f. 3.		

MACTRACEA.

Mactra semisulcata, R. 1. Tab. III. f. 10. *Lam. Ann. du Mus.* v. 6. 412. v. 9. t. 20. f. 3. *Desh.* v. 1. 31. t. 4. f. 7–10. *Nyst,* v. 1. 80. t. 3. f. 11 ? Mactra deltoides (*b*), *Lam. Hist. Nat.* v. 5. 479.	. . . .	Grignon. Valmondois. St. Josse-ten-Noode ? (Brabant).
—— compressa, R. 1. Tab. III. f. 3. *Desh. Enc. Méth.* v. 2. 399. Mactra depressa, *Desh. Coquilles Foss.* v. 1. 32. t. 4. f. 11–14. *Morris,* 90.	. . . .	Luzarches. St. Josse-ten-Noode.
Cardilia læviuscula, new, R. 3. Tab. II. f. 6^a.		
Crassatella plicata, R. 1. *Min. Con.* t. 345. f. 2. *Morris,* 84.	Barton. Southampton.	
—— compressa, C. Tab. II. f. 2. *Lam. Ann. du Mus.* v. 6. 410. v. 9. t. 20. f. 5; *Hist. Nat.* v. 5. 484. *Morris,* 84.	. . . .	Grignon. Courtagnon.
—— compressa, var. sulcata, C. Tab. II. f. 21.		
—— rostrata ? R. 2. *Desh.* v. 1. 35. t. 3. f. 6 & 7.	. . . .	Senlis. Mouchy.

CORBULACEA.

	British localities.	*Foreign localities.*
Neæra argentea, R. 4. Corbula argentea, *Lam. Ann. du Mus.* v. 8. 467. *Desh.* v. 1. 56. t. 8. f. 26–30. Neæra dispar, *Morris,* 93.	Barton.	Parnes. Chaumont.
Corbula Gallica, V.C. Tab. II. f. 11. *Lam. Ann. du Mus.* v. 8. 466; *Hist. Nat.* v. 5. 497. *Desh.* v. 1. 49. t. 7. f. 1–3. *Morris,* 83. *Nyst,* v. 1. 62.	Barton.	Grignon, &c. Rouge Cloitre (Brabant).
——— globosa, R. 1. *Min. Con.* t. 209. f. 3. *Morris,* 83.	Barton. Highgate. Pegwell Bay.	
——— Pisum, C. *Min. Con.* t. 209. f. 4. *Morris,* 83. *Nyst,* v. 1. 66. t. 3. f. 4. *Goldfuss,* v. 1. 252. t. 152. f. 3.	Barton. Hampstead.	Rouge Cloitre. Cassel.
——— longirostris? C. Tab. II. f. 8 & 10. *Desh.* v. 1. 52. t. 7. f. 20 & 21. *Morris,* 83.	. . . .	Noailles. Beauvais.
——— costata, R. 1. Corbula revoluta, *Min. Con.* t. 209. f. 8–13.	Barton.	
——— rugosa, R. 1. *Lam. Ann. du Mus.* v. 8. 467; *Hist. Nat.* v. 5. 497. *Desh.* v. 1. 51. t. 7. f. 16, 17 & 22. *Morris,* 83.	. . . .	Grignon. Parnes, &c.
——— striata, R. 1. *Lam. Ann. du Mus.* v. 8. 467; *Hist. Nat.* v. 5. 497. *Morris,* 83. *Nyst,* v. 1. 72. t. 3. f. 7.	Barton.	Grignon. Between Bruges & Ghent.
——— cuspidata, R. *Min. Con.* t. 362. f. 4–6. *Morris,* 83.	Barton. Colwell Bay.	

NYMPHACEA.

Sanguinolaria Hollowaysii, C. Tab. II. f. 6. *Min. Con.* t. 159. *Morris,* 100.	Stubbington.	
Psammobia compressa, R. 3. Sanguinolaria compressa, *Min. Con.* t. 462. *Morris,* 100. Solecurtus compressus, *Nyst,* v. 1. 49. t. 1. f. 7.	Barton. Colwell Bay and Hordwell (upper Marine).	Hoesselt (Limbourg).
Tellina donacialis, R. 1. Tab. III. f. 8 & 9. *Lam. Ann. du Mus.* v. 7. 233. *Desh.* v. 1. 8. t. 12. f. 7 & 8. *Morris,* 101. *Edw. Lond. Geol. Journ.* 51. t. 11. f. 6.	Hedgerley. Stratford.	Grignon. Parnes. Mouchy.
——— plagia, C. Tab. III. f. 5. *Edw. Lond. Geol. Journ.* 105. t. 23. f. 3.		
——— plagia, var. *obovata,* R. Tab. IX. f. 10.		

	British localities.	*Foreign localities.*
Tellina lunulata, R. 4. *Desh.* v. 1. 79. t. 11. f. 34. Donax lunulata, *Lam. Ann. du Mus.* v. 7. 230, v. 12. t. 41. f. 5. *Edw. loc. cit.* 49. t. 11. f. 3.	. . . .	Houdan. Valmondois.
——— filosa, R. 1. *Min. Con.* t. 402. f. 2. *Morris,* 102. *Edw. loc. cit.* 46. t. 10. f. 2.	Barton.	
——— tumescens, R. 1. Tab. II. f. 4. *Edw. loc. cit.* 50. t. 11. f. 4.		
——— concinna, R. *Edw. loc. cit.* 48. t. 11. f. 1.		
——— obovata, R. 4. *Edw. loc. cit.* 49. t. 11. f. 2.		
——— craticula, R. 4. Tab. III. f. 4. Tellina scalarioides ? *Edw. loc. cit.* 47. t. 10. f. 4. *excl. syn.*	Barton R.	
——— speciosa, R. 4. Tab. III. f. 11. *Edw. loc. cit.* 100. t. 22. f. 1.		
——— rhomboidalis, R. 3. *Edw. loc. cit.* 46. t. 10. f. 3.		
——— tenuistriata, C. *Desh.* v. 1. 80. t. 11. f. 9 & 10. t. 12. f. 5 & 6. *Edw. loc. cit.* 50. t. 11. f. 5.	. . . .	Chaumont. Parnes.
——— textilis, R. 3. Tab. III. f. 1. *Edw. loc. cit.* 100. t. 22. f. 3.		
——— dis-stria, R. 3. Tab. IX. f. 11. *Edw. loc. cit.* 102. t. 22. f. 4.		
——— canaliculata, R. 4. Tab. II. f. 22. *Edw. loc. cit.* 103. t. 22. f. 5.		
——— lamellosa, R. 4. *Desh.* v. 1. 81. t. 12. f. 3, 4. *Edw. loc. cit.* 108. t. 23. f. 4.	. . . .	Valmondois.
——— reflexa, R. 4. *Edw. loc. cit.* 107. t. 23. f. 6.		
Lucina serrata, R. 1. new, Tab. III. f. 7.		
——— mitis, R. *Min. Con.* t. 557. f. 1. *Morris,* 89.	Barton. Highgate.	
——— immersa, R. new, Tab. III. f. 24.		
Diplodonta dilatata, R. 2. Tab. III. f. 12 & 16. *Philip. En. Moll. Sicil.* t. 4. f. 7. *Nyst,* 138. t. 7. f. 1. Lucina dilatata, *Wood, Ann. & Mag. Nat. Hist.* v. 6. 248. *Morris,* 89.	Sutton (Crag).	Antwerp. Sicily. (Recent in the Red Sea.)

CONCHACEA (MARINE).

	British localities.	*Foreign localities.*
Cytherea trigonula, R. 1. Tab. III. f. 2. *Desh.* v. 1. 139. t. 21. f. 12 & 13. *Morris,* 87.	. . . .	Assy-en-Mulitien. Valmondois.
——— lucida, C. new, Tab. III. f. 6.		
——— nitidula, C. Tab. III. f. 13. *Lam. Ann. du Mus.* v. 7. 133. v. 12. t. 40. f. 1 & 2. *Desh.* v. 1. 134. t. 21. f. 3, 4, 5 & 6. *Morris,* 87.	. . . .	Grignon. Parnes, &c. La Chapelle près Senlis. Valmondois. Bracheux.
——— obliqua, C. Tab. II. f. 5. *Desh.* v. 1. 136. t. 27. f. 7 & 8. *Morris,* 87. Venus tenuistriata, *Geol. Trans.* 2nd Ser. v. 5. 136. t. 8. f. 8. *Morris,* 87. Venus nitidula, *Nyst,* v. 1. 174. t. 13. f. 2 ? *excl. syn.*	Barton. Hampstead. Highgate. Primrose Hill. Reading. Sheppy. Stratford. Well at Southampton.	Abbecourt. Bracheux. Noailles. Rouge Cloitre ?
——— sulcataria, C. *Desh.* v. 1. 133. t. 20. f. 14 & 15. *Morris,* 87. Venus sulcataria, *Nyst,* v. 1. 169. t. 11. f. 5.	. . . .	Parnes. Chaumont. Gremittingen. Hoesselt.
——— elegans, C. *Lam. Ann. du Mus.* v. 7. 134. v. 12. t. 40. f. 8. *Desh.* v. 1. 132. t. 20. f. 8 & 9. *Morris,* 87. Venus elegans, *Min. Con.* t. 422. f. 3. Venus Gallina, *Brander,* f. 90.	Barton.	Grignon, &c. Parnes. Ermenonville. Valmondois.
——— suberycinoides, C. Tab. II. f. 15. *Desh.* v. 1. 128. t. 22. f. 8 & 9. *Morris,* 87. Venus suberycinoides, *Nyst,* v. 1. 168. t. 11. f. 4 ?	Barton.	Mouchy. Assy-en-Mulitien. Bracheux. Ghent ? Rodenberg ?
——— striatula, C. Tab. II. f. 16. *Desh.* v. 1. 129. t. 20. f. 10 & 11.	. . . .	Grignon. Valmondois.

CARDIACEA.

Cardium hippopæum, R. 4. *Desh.* v. 1. 164. t. 27. f. 3 & 4. *Nyst,* v. 1. 188 ? Cardium gigas, *Def. Dict. Sc. Nat.* v. 5.	. . . .	Chaumont. Parnes. Mouchy. Vivray. Chateau Rouge. Lethen ?
——— semigranulatum, var. C. Tab. II. f. 20. *Min. Con.* t. 144. *Morris,* 82. *Nyst,* v. 1. 189. t. 14. f. 5 ? Cardium semigranulosum, *Desh.* v. 1. 174. t. 28. f. 6 & 7. Venus Cypria, *Brocchi,* v. 2. 545. t. 13. f. 14 ?	Barton. Primrose Hill. Hyde Park.	Abbecourt. Bracheux. Chaumont. Valmondois. Jette. Laeken. Sanesi.

	British localities.	*Foreign localities.*
Cardium porulosum, R. *Brand.* 39. t. 8. f. 99. *Lam. Ann. du Mus.* v. 6. 344. v. 9. t. 19. f. 9; *Hist. Nat.* v. 6. 18. *Min. Con.* t. 346. f. 2. *Desh.* v. 1. 169. t. 30. f. 1–4. *Morris,* 82. *Nyst,* v. 1. 188. t. 14. f. 4.	Barton.	Grignon. Parnes. Mouchy. Houdan, &c. Laeken. Ghent. Louvain. Antwerp ?
——— alternatum, R. new, Tab. III. f. 14.		
——— ordinatum, R. new, Tab. III. f. 17.		
Cardita planicosta, C. Tab. II. f. 14 & 18. *Desh. Enc. Méth. Vers,* v. 2. 198; *Traité Elem.* v. 1. t. 32. f. 1, 2 & 3. *Nyst,* v. 1. 205. t. 17. f. 1. Venericardia planicosta, *Lam. Ann. du Mus.* v. 7. 55. v. 9. t. 31. f. 10, & t. 32. f. 2; *Hist. Nat.* v. 5. 669. *Min. Con.* t. 50. *Desh.* v. 1. 149. t. 24. f. 1, 2 & 3. *Morris,* 104.	Stubbington. Isle of Wight.	Grignon. Parnes. Mouchy. Valmondois. Touraine. Ghent. Bruges. Ypres. Louvain. Hauteville.
——— acuticosta, R. *Desh. Enc. Méth. Vers,* v. 2. 200. *Nyst,* v. 1. 208. t. 16. f. 6. Venericardia acuticosta, *Lam. Ann. du Mus.* v. 7. 57. v. 9. t. 35. f. 2; *Hist. Nat.* v. 5. 611. *Morris,* 103. Venericardia carinata, *Min. Con.* t. 259.	Stubbington.	Grignon. Parnes. Courtagnon, &c. Bruges.
——— mitis, R. Venericardia mitis, *Lam. Hist. Nat.* v. 5. 611. *Desh.* v. 1. 155. t. 25. f. 9 & 10.	. . . .	Parnes. Valmondois.
——— elegans ? R. Tab. III. f. 15. Venericardia elegans, *Lam. Ann. du Mus.* v. 7. 59. v. 9. t. 32. f. 5; *Hist. Nat.* v. 5. 612. *Desh.* v. 1. 157. t. 26. f. 14–16.	. . . .	Grignon. Soissons. Bruges. Brussels, &c.
Cypricardia oblonga, R. Tab. III. f. 18. *Desh. Enc. Méth.* v. 2. 44; *Env. de Paris,* v. 1. 185. t. 31. f. 3 & 4.	. . . .	Chaumont. Parnes. Mouchy.
——— carinata, R. 4. Tab. III. f. 25. *Desh. Enc. Méth.* v. 1. 185; *Env. de Paris,* v. 1. 186. t. 31. f. 1 & 2.	. . . .	Chaumont.

ARCACEA.

Byssoarca Branderi, C. Tab. III. f. 23. Arca Branderi, *Min. Con.* t. 276. f. 1 & 2. *Morris,* 78. Arca hiantula, *Desh.* v. 1. 199. t. 34. f. 7 & 8.	Barton.	Valmondois. Touraine. Bordeaux. Dax.

	British localities.	*Foreign localities.*
Byssoarca duplicata, C. Tab. III. f. 22. Arca duplicata, *Min. Con.* t. 474. f. 1. *Morris,* 78. Arca lactea, *Brander,* 42. t. 8. f. 106. Arca barbatula ?, *Lam. Ann. du Mus.* v. 6. 219. v. 9. t. 19. f. 3. *Desh.* v. 1. 205. t. 32. f. 11 & 12. *Nyst,* 259. t. 20. f. 4.	Barton.	Parnes, Grignon, Mouchy, &c. ? Aeltre between Ghent & Bruges?
——— interrupta, R. Tab. III. f. 21. *Lam. Ann. du Mus.* v. 6. 220; *Hist. Nat.* v. 6. 46. *Desh.* v. 1. 213. t. 32. f. 19 & 20.	. . . .	Grignon, Parnes, Mouchy.
Pectunculus pulvinatus, R. 1. Tab. II. f. 25. *Lam. Ann. du Mus.* v. 6. 216. v. 9. t. 18. f. 9; *Hist. Nat.* v. 6. 54. *Desh.* v. 1. 219. t. 35. f. 15–17. *Morris,* 97.	. . . .	Parnes.
——— globosus, new, R. 4. Tab. III. f. 20.		
Nucula similis, C. Tab. II. f. 7. *Min. Con.* t. 192. f. 3, 4 & 10. Nucula margaritacea ? *Desh.* v. 1. 231. t. 36. f. 15–20. *Morris,* 93. Arca Nucleus, *Brander,* 40. t. 8. f. 101.	Barton. Highgate.	Grignon, Parnes, &c.? (*Deshayes*).
——— minima, C. *Min. Con.* t. 292. f. 8 & 9. *Morris,* 94.	Barton. Hampstead. Pegwell Bay. Primrose Hill.	
——— serrata, new, R. Tab. II. f. 9.		
——— bisulcata, new, R. Tab. II. f. 13.		
Limopsis granulatus, C. Tab. III. f. 19. Pectunculus granulatus, *Lam. Ann. du Mus.* v. 6. 117. v. 9. t. 18. f. 6. *Desh.* v. 1. 227. t. 35. f. 4–6. Trigonocœlia granulata, *Nyst,* 241. t. 19. f. 1.	. . . .	Grignon. Parnes. Mouchy. Senlis. Laeken de Forêt.

CHAMACEA.

Chama gigas, R. 3. Tab. II. f. 26, & Tab. III. f. 26. *Desh.* v. 1. 245. t. 37. f. 5 & 6.	. . . .	Parnes. Les Groux. Chaumont.
——— calcarata, R. 4. *Lam. Ann. du Mus.* v. 8. 349. & v. 14. t. 23. f. 4; *Hist. Nat.* v. 6. 98.	. . . .	Parnes. Chaumont. Grignon. Mouchy. Courtagnon.

MYTILACEA.

	British localities.	*Foreign localities.*
Modiola elegans, R. Tab. XIII. f. 13. *Min. Con.* t. 9. f. 1. *Morris,* 91.	Barton. Bognor. Highgate. Primrose Hill. Richmond Park, 300 feet deep.	
Lithodomus Deshayesii, R. 4. Tab. II. f. 28. Modiola lithophaga, *Desh.* v. 1. 267. t. 28. f. 10, 11 & 12. Mytilus lithophagus, *Desh. Traité Elém.* v. 1. t. 37. f. 5 & 6. *Nyst,* 272.	. . . .	Parnes. Bordeaux. Antwerp. Melsbroeck. Podolia.
Pinna margaritacea, R. *Lam. Ann. du Mus.* v. 6. 218. v. 9. t. 17. f. 8. *Desh.* v. 1. 280. t. 41. f. 15. *Nyst,* 274. t. 20. f. 9.	Bognor. Highgate.	Grignon. Courtagnon. Parnes. Mouchy, &c. Hauteville. Mons.Ghent,&c.

CONCHIFERA MONOMYARIA.

PECTENIDES.

Lima expansa, new, R. 4. Tab. III. f. 34.		
Pecten corneus, C. Tab. IV. f. 6. *Min. Con.* t. 204. *Morris,* 114. Pecten Solea, *Desh.* v. 1. 302. t. 42. f. 12, 13.	Chalk Farm. Stubbington. Sheppy.	Chaumont. Italy?
——— squamula, R. 3. Tab. III. f. 29. *Lam. Ann. du Mus.* v. 8. 354. *Desh.* v. 1. 304. t. 44. f. 15, 16.	. . . .	Chaumont.
——— plebeius? C. Tab. III. f. 28. *Lam. Ann. du Mus.* v. 8. 353; *Hist. Nat.* v. 6. pt. 1. 183. ed. 2. v. 7. 161. *Desh.* v. 1. 309. t. 44. f. 1–4. *Nyst,* 295. t. 22. f. 4. Pecten sulcatus, *Min. Con.* v. 6. p. 146.	Stubbington. Barton. } M.C.	Belgium.Grignon. Mantes. Courtagnon.
——— plebeius, var. R. 2. Tab. III. f. 32. Pecten reconditus? *Min. Con.* v. 6. p. 146.	Stubbington? Barton?	Belgium?
——— reconditus, R. Tab. III. f. 27. *Nyst,* 302. t. 25. f. 2. Ostrea recondita, *Brander,* 107.	Barton.	Belgium.
——— 30-radiatus, new, R. Tab. III. f. 30, 31.		
——— 40-radiatus, new, R. Tab. III. f. 33.		
Spondylus rarispina, R. 3. *Desh.* v. 1. 321. t. 46. f. 6–10. *Nyst,* 308?	. . . .	Chaumont. Belgium.

OSTRACEA.

	British localities.	Foreign localities.
Ostrea elephantopus, new, R.	Bognor.	
——— picta, new, R. 1. Tab. IV. f. 1.		
——— inflata, R. 1. Tab. IV. f. 7. *Desh.* v. 1. 359. t. 58. f. 4, 5. t. 59. f. 1, 2.	....	Valmondois.
——— longirostris, R. 1. Tab. IV. f. 4. *Lam. Ann. du Mus.* v. 14. t. 21. f. 9; *Hist. Nat.* v. 6. 217. *Desh.* v. 1. 351. t. 61. f. 8, 9.	....	Montmartre. Seaux, &c.
——— radiosa, R. 1. *Desh.* v. 1. 359. t. 60. f. 6, 7. *Morris,* 113.	....	Poissy.
——— flabellula, V.C. Tab. IV. f. 5. *Lam. Ann. du Mus.* v. 8. 164. v. 14. t. 20. f. 3. *Min. Con.* t. 253. *Desh.* v. 1. 366. t. 63. f. 5–7. *Morris,* 112. Chama plicata, *Brander,* 84 & 85.	Barton.	Grignon. Parnes, &c. Belgium.
——— elegans, R. 2. *Desh.* v. 1. 361. t. 5. f. 7–9. *Morris,* 112.	....	Chaumont. Valmondois.
——— dorsata, R. 2. *Desh.* v. 1. 355. t. 54. f. 9, 10. t. 55. f. 9–11. t. 64. f. 1–4. *Min. Con.* t. 489. f. 1, 2. *Morris,* 112. Ostrea semistriata, *Defrance, Dict. des Sci. Nat.* Ostrea oblongata, *Brander,* 82 ?	Barton.	Monneville. Valmondois. Senlis.
——— tenera, C. Tab. IV. f. 3. *Min. Con.* t. 252. f. 2, 3. *Morris,* 113.	Woolwich.	
——— tenera var. striata, C. Tab. IV. f. 2.		
Anomia tenuistriata, C. Tab. IV. f. 8. *Desh.* v. 1. 377. t. 65. f. 7–11. Anomia lineata (striata), *Min. Con.* t. 425, *and Index. Morris,* 106.	Barton. Bognor.	Grignon. Senlis. Valmondois. Hauteville, &c.

MOLLUSCA GASTEROPODA.

DENTALIACEA.

Dentalium nitens, R. Tab. VII. f. 3 & 3^a. *Min. Con.* t. 70. f. 1 & 2. *Morris,* 143.	Highgate.	
——— eburneum, R. 4. *Lam. Hist. Nat.* v. 5. 346. *Sow. Gen. of Shells. Desh. Monog.* 368. t. 17. f. 8, 9; *Zool. Journ.* v. 4. 191. *Sow. ib.* 198.	....	Grignon, &c.

	British localities.	Foreign localities.
Dentalium acuticosta, var. C. Tab. VII. f. 1 & 16. *Desh. Monog.* 357. t. 18. f. 3. Dentalium striatum, *Min. Con.* t. 70. f. 4. *Morris,* 143. *Non Lam.*	Barton.	
———— costatum, R. 1. Tab. VII. f. 2. *Min. Con.* t. 70. f. 8. *Morris,* 143. *Nyst,* 344. t. 35. f. 2.	Holywell near Ipswich (Crag).	Antwerp.

CALYPTRACEA.

	British localities.	Foreign localities.
Parmophorus elongatus, R. 4. *Desh.* v. 2. 13. t. 1. f. 15, 18. Patella elongata, *Lam. Ann. du Mus.* v. 1. 310 & v. 6. t. 43. f. 1. Parmophorus lævis, *Blainville, Bull. des Sci.* 1817, p. 28.	. . . .	Grignon. Mouchy. Valmondois.
Emarginula obtusa, new, R. 4. Tab. IX. f. 31.		
Fissurella Edwardsii, new, R. 3. Tab. VII. f. 9.		
Pileopsis squamæformis, R. 2. *Lam. Hist. Nat.* v. 6. pt. 2. 19. *Desh.* v. 2. 27. t. 3. f. 11, 12. Patella squamæformis, *Lam. Ann. du Mus.* v. 1. 311.	Barton.	Parnes. Senlis.
Hipponix cornu-copiæ, R. 4. Tab. V. f. 1. *Defrance, Journ. de Phys.* 1819, t. 4. f. 1–3. *De Blainville, Malacol.* 507. t. 50. f. 1. *Morris,* 121. *Nyst,* 358. t. 35. f. 10. Patella cornu-copiæ, *Lam. Ann. du Mus.* v. 1. 311. v. 6. t. 45. f. 4. Pileopsis cornu-copiæ, *Lam. Hist. Nat.* v. 6. pt. 2. 19. *Desh.* v. 2. 25. t. 2. f. 13–16.	. . . .	Grignon. Parnes. Mouchy. Montmirail. Hauteville. Kreygelberg, près Louvain.
Infundibulum trochiforme, C. *Morris,* 148. Trochus apertus et opercularis, *Brander,* f. 1–3. Calyptræa trochiformis, *Lam. Ann. du Mus.* v. 1. 385. v. 7. t. 15. f. 3. *Desh.* v. 2. 30. t. 4, f. 1–4, 11–13. *Nyst,* 360. Infundibulum spinulosum, *Min. Con.* t. 97. f. 6.	Barton. Bognor. Highgate, &c. Kingston. Reading. Southampton. Stratford. Welling.	Grignon. Parnes.

BULLÆANA.

Bulla expansa, new, R. 4. Tab. VII. f. 18.

——— Edwardsii*, new, C. Tab. VI. f. 1.

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* As there are several species which have been generally treated as the same, we cannot at present quote foreign localities.

	British localities.	*Foreign localities.*
Bulla Defrancii, R. 4. Bulla lignaria, var. (Def.), *Desh.* v. 2. 44. t. 5. f. 4–6.	Barton.	Soissons.
—— attenuata, R. 4. *Min. Con.* t. 464. f. 3.	Barton.	
—— extensa, new, R. 4. Tab. VII. f. 6.	Barton.	
—— lanceolata, new, R. 4. Tab. VII. f. 7.	Barton.	
—— Sowerbyi, R. 4. *Nyst,* 456. t. 39. f. 8. B. acuminata, *Min. Con.* t. 464. f. 5. *Morris,* 140, *non Bruguière.*	Barton.	Lethen. Laeken.
—— uniplicata, new, R. 4. Tab. VII. f. 8.		

MELANIANA.

Melania costellata, C. Tab. VII. f. 41. *Lam. Ann. du Mus.* v. 4. 430. v. 8. t. 60. f. 2. *Desh.* v. 2. 113. t. 12. f. 5, 6, 9, 10. *Morris,* 15.	Bognor.	Grignon. Parnes. Chaumont.

MACROSTOMATA.

Globulus Willemettii, R. Tab. VI. f. 33. *Morris,* 147. Ampullaria Willemettii, *Desh.* v. 2. 141. t. 17. f. 11, 12.	. . . .	Mouchy. Parnes. Damerie. Courtagnon. Senlis.
——— ponderosus, R. 4. Ampullaria ponderosa, *Desh.* v. 2. 140. t. 17. f. 13, 14.	. . . .	Monneville.
——— ? labellatus, R. Tab. VI. f. 26, 27. Natica labellata, *Lam. Ann. du Mus.* v. 5. 95; *Hist. Nat.* v. 7. 552. *Morris,* 153. Natica glaucinoides, *Min. Con.* t. 5. upper fig. *Nyst,* 442. t. 37. f. 32.	Barton. Bognor. Highgate.	Grignon. Damerie. Valmondois. Belgium.
——— conoideus, new, R. 4. Tab. VI. f. 32.		
——— hybridus, R. 4. Tab. VII. f. 22. Ampullaria hybrida, *Lam. Ann. du Mus.* v. 5. t. 33; *Hist. Nat.* v. 7. 550. Natica hybrida, *Morris,* 153.	. . . .	Valmondois. Assy. Betz. Retheuil. Soissons.
——— scalariformis, R. 4. Tab. VII. f. 26. Ampullaria scalariformis, *Desh.* v. 2. 138. t. 16. f. 8, 9.	. . . .	Parnes.
——— Ambulacrum, R. 2. *Morris,* 146. Ampullaria Ambulacrum, *Min. Con.* 372.	Barton. Bognor.	

	British localities.	*Foreign localities.*
Ampullina depressa, R. 2. Tab. VI. f. 29. Ampullaria depressa, *Min. Con.* t. 5. lower fig. Globulus depressus, *Morris,* 146. Natica intermedia, *Desh.* v. 2. 177. t. 22. f. 1, 2. *Morris,* 153.	Barton ?	Retheuil. Guise-la-Mothe. Houdan.
——— patula, R. 1. Ampullaria patula, *Lam. Ann. du Mus.* v. 5. 32; *Hist. Nat.* v. 7. 549. *Min. Con.* t. 284. Globulus patulus, *Morris,* 147. Helix mutabilis, *Brander,* 57.	Barton. Bognor.	Grignon. Courtagnon. Parnes. Mouchy.
——— pachycheila, new, C. Tab. VI. f. 31.		
Natica Hantoniensis, R. 3. *Morris,* 153. Helix Hantoniensis, *Trans. Linn. Soc.* v. 7. 118. t. 11. f. 10. Natica striata, *Min. Con.* t. 373.	Barton.	
——— turgida, new, R. 4.		
——— epiglottina, C. *Lam. Ann. du Mus.* v. 5. 95. v. 8. t. 62. f. 6; *Hist. Nat.* v. 7. 552. *Desh.* v. 2. 165. t. 20. f. 5, 6 & 11. Natica similis, *Min. Con.* t. 5. middle figs. *Morris,* 153.	Barton.	Grignon. Parnes. Mouchy-le-Châtel, &c.
——— lineolata, R. 2. *Desh.* v. 2. 167. *Nyst,* 440.	. . . .	Beauchamp. Damerie. Rouge-Cloitre.
——— obovata, new, C. Tab. VI. f. 28.		
Sigaretus canaliculatus, R. 1. Tab. V. f. 9. *Min. Con.* t. 384. *Desh.* v. 2. 182. t. 21. f. 13, 14. *Morris,* 162. *Nyst,* 449. t. 39. f. 4.	Barton.	Grignon. Mouchy. Senlis. Tancrou. Rouge-Cloitre. Bruges.

PLICACEA.

Acteon simulatus, R. 1. Tab. XIII. f. 25. *Min. Con.* t. 163. *Morris,* 138. Bulla simulata, *Brander,* f. 61. Tornatella simulata, *Nyst,* 423. t. 37. f. 21.	Barton. Highgate.	Belgium.
——— sulcatus, R. 2. Tab. V. f. 8^{a}. Auricula sulcata, *Lam. Ann. du Mus.* v. 4. 434. v. 8. t. 60. f. 7; *Hist. Nat.* v. 7. 538. Tornatella sulcata, *Desh.* v. 2. 187. t. 22. f. 3, 4.	. . . .	Grignon, Parnes, &c.
Ringicula turgida, R. 4. Ringinella turgida, *Morris,* 160. Auricula turgida, *Min. Con.* t. 163. f. 4.	Highgate.	

SCALARIANA.

	British localities.	*Foreign localities.*
Eulima subulata, R. 4. Tab. VII. f. 48. *Morris,* 144. *Nyst,* 415. t. 37. f. 17.	Highgate. (In Crag, Sutton.)	France. Sicily. Italy. Austria. (*Recent,* British Ocean, Mediterranean.)
Scalaria acuta, R. Tab. VII. f. 15. *Min. Con.* t. 16. & t. 577. f. 2. *Morris,* 162.	Barton.	
——— interrupta, R. Tab. VII. f. 14. *Min. Con.* t. 577. f. 3. *Morris,* 162.	Barton.	
Delphinula Warnii, R. 4. Tab. VII. f. 23. *Lam. Hist. Nat.* v. 6. pt. 2. 232. *Desh.* v. 2. 204. t. 24. f. 12, 13.	. . . .	Hauteville. Mouchy-le-Châtel.

TURBINACEA.

Solarium patulum, R. 2. *Lam. Ann. du Mus.* v. 4. 53. v. 8. t. 35. f. 3; *Hist. Nat.* v. 7. 5. *Min. Con.* t. 11. *Desh.* v. 2. 215. t. 40. f. 14–16. *Morris,* 163. *Nyst,* 369.	Barton. Highgate.	Grignon, Parnes, &c. Mont-Panisel près de Mons.
——— spectabile, new, R. 4. Tab. VI. f. 2.		
——— pulchrum, new, R. 4. Tab. VI. f. 3^b.		
——— canaliculatum, R. 2. Tab. VI. f. 3^a. *Lam. Ann. du Mus.* v. 4. 54; *Hist. Nat.* v. 7. 5. *Min. Con.* t. 524. f. 1. *Desh.* v. 2. 220. t. 24. f. 19, 20, 21. *Morris,* 163.	Barton. Highgate. Sheppy.	Grignon, Parnes, &c. Valmondois.
——— plicatum, R. 2. *Lam. Ann. du Mus.* v. 4. 54; *Hist. Nat.* v. 7. 5. *Min. Con.* t. 524. f. 2. *Desh.* v. 2. 219. t. 24. f. 16–18. *Morris,* 163.	Barton.	Grignon, &c. Hauteville.
——— trochiforme? R. 3. Tab. VII. f. 10. *Desh.* v. 2. 217. t. 26. f. 8, 9, 10. *Morris,* 163. *Nyst,* 371. t. 35. f. 16.	Barton.	Tancrou. Grignon. Brussels.
Adeorbis planorbularis, R. 4. Tab. IX. f. 20. Turbo planorbularis, *Desh.* v. 2. 258. t. 33. f. 19–22.	. . . .	Houdan.
Phorus agglutinans, C. *Püsch, Pol. Pal.* 110. Trochus umbilicaris, *Brander,* t. 1. f. 4 & 5. Trochus agglutinans, *Lam. Ann. du Mus.* v. 4. 51. v. 7. t. 15. f. 8. *Min. Con.* t. 98. *Desh.* v. 2. 241. t. 31. f. 8–10. *Morris,* 164. *Nyst,* 376. t. 25. f. 18.	Barton. Sheppy.	France. Belgium.

	British localities.	*Foreign localities.*
Phorus extensus, R. 2. Phorus extensus, *Püsch,* 110. Trochus extensus, *Min. Con.* t. 278. f. 2, 3. *Morris,* 164. *Nyst,* 375. t. 36. f. 9.	Highgate. Sheppy.	Vliermael.
Orbis patellatus, R. 2. Tab. IX. f. 23. Solarium patellatum, *Lam. Ann. du Mus.* v. 4. 54; *Hist. Nat.* v. 7. 555. Orbis rotella? *Lea, Contrib. to Geol.* 123. t. 4. f. 112.	Isle of Wight.	Grignon. Nehou. Alabama?
Bifrontia Laudinensis, R. 3. Tab. VI. f. 34. *Desh.* v. 2. 226. t. 26. f. 15, 16. *Morris,* 139. Solarium Laudinense, *Defr. Dict. des Sci. Nat.* v. 55. 486.	. . . .	Retheuil. Laon. Soissons.
——— disjuncta, R. 3. Tab. VI. f. 35. *Desh.* v. 2. 223. t. 26. f. 21 & 22. Solarium disjunctum, *Lam. Ann. du Mus.* v. 4. 54.	. . . .	Grignon. Parnes, &c.
——— marginata, R. 3. Tab. VI. f. 36. *Desh.* v. 2. 224. t. 26. f. 19 & 20. *Nyst,* 365?	. . . .	Grignon, &c. Valognes. Jette?
——— bifrons, R. 4. Tab. VI. f. 37. *Desh.* v. 2. 222. t. 26. f. 23–25. Solarium bifrons, *Lam. Ann. du Mus.* v. 4. 55; *Hist. Nat.* v. 7. 555.	. . . .	Grignon, &c.
Rotella minuta, new, R. 4. Tab. IX. f. 19.		
Turbo plicatus, R. 4. *Desh.* 261. t. 34. f. 12–14.	. . . .	Versailles. Montmorency.
Littorina sulcata, R. 2. Tab. VII. f. 27. *Morris,* 149. Turbo sulcata, *Pilkington in Trans. Linn. Soc.* v. 7. 118. t. 11. f. 9. Turbo sculptus, *Min. Con.* t. 395. f. 2.	Barton.	
Turritella terebellata, C. Tab. V. f. 5. *Lam. Ann. du Mus.* v. 4. 218; *Hist. Nat.* v. 7. 563. *Desh.* v. 2. 279. t. 35. f. 3 & 4. *Morris,* 166. *Nyst,* 396. Turritella sulcata (Melania), *Min. Con.* t. 39.	Stubbington. Nuneham.	Grignon. Parnes. Chaumont. Belgium.
——— sulcifera, C. Tab. V. f. 2. *Desh.* 278. t. 35. f. 5, 6. t. 36. f. 3, 4. t. 37. f. 19, 20.	. . . .	Valmondois. Monneville.
——— bicincta, new, R. 2. Tab. VI. f. 19.		
——— conoidea, C. Tab. V. f. 6. *Min. Con.* t. 51. f. 1 & 4. Turritella imbricataria, *Lam. Desh. &c.*? *Morris,* 166.	Barton. Bognor.	France, &c.?

	British localities.	*Foreign localities.*
Turritella conoidea var. elongata, V.C. Tab. V. f. 10. Turritella elongata, *Min. Con.* t. 51. f. 2. Turritella imbricataria, *Morris,* 166.	Barton. Bognor.	
———— contracta, new, R. 4. Tab. VII. f. 42.		
———— fasciata, C. Tab. VII. f. 5. *Lam. Ann. du Mus.* v. 4. 217. v. 8. t. 37; *Hist. Nat.* v. 7. 562. *Desh.* v. 2. 284. t. 38. f. 13, 14, 17, 18, & t. 39. *Morris,* 166.	....	Grignon. Beyne. Parnes. Mouchy-le-Châtel. Tancrou.
———— sulcata, C. Tab. VI. f. 5. *Lam. Ann. du Mus.* v. 4. 216. v. 8. t. 37. f. 8; *Hist. Nat.* v. 7. 561. *Desh.* v. 2. 287. t. 38. f. 5–7. *Morris,* 166.	....	Grignon. Parnes. Mouchy. Courtagnon.
———— multisulcata, C. Tab. VI. f. 9. *Lam. Ann. du Mus.* t. 4. 217; *Hist. Nat.* v. 7. 562. *Desh.* v. 2. 288. t. 38. f. 1–12.	....	Grignon. Beyne. Maulle.
———— marginata, new, R. 1. Tab. VI. f. 16.		
———— nexilis, new, R. 1. Tab. VI. f. 17.		
Cerithium giganteum, R. 2. Tab. VI. f. 10. *Lam. Ann. du Mus.* v. 3. 439. v. 7. t. 14. f. 1; *Hist. Nat.* v. 7. 65 (excl. analogue vivant). *Desh.* v. 2. 300. t. 42. *Min. Con.* t. 188. f. 2. *Morris,* 141.	....	Grignon. Parnes. Betz. Valmondois, &c.
———— incomptum, new, R. 3. Tab. VI. f. 18.		
———— cornu-copiæ, C. Tab. VI. f. 5. *Min. Con.* t. 188. f. 1, 3 & 4. *Morris,* 141.	....	Hauteville. Nehou. Gourbeville, &c., in the Cotentin.
———— calcitrapoides, R. 1. Tab. VI. f. 7. *Lam. Ann. du Mus.* v. 3. 274; *Hist. Nat.* v. 7. 79. *Desh.* v. 2. 347. t. 46. f. 18, 19 & 23.	....	Grignon. Beyne. Courtagnon.
———— cristatum, R. 2. Tab. VI. f. 15. *Desh.* v. 2. 420. t. 44. f. 5–7. t. 60. f. 10, 11.	....	Grignon. Chambord. Arras.
———— hexagonum, R. 2. *Lam. Ann. du Mus.* v. 3. 271; *Hist. Nat.* v. 7. 77. *Morris,* 141. Murex hexagonus, *Chemnitz,* v. 10. 261. t. 162. f. 1554. M. angulatus, *Brander,* No. 46. Cerithium pyramidale, *Min. Con.* t. 127. f. 1.	Barton.	Grignon. Courtagnon. Houdan.

	British localities.	*Foreign localities.*
Cerithium cancellatum, new, R. 4. Tab. IX. f. 22.		
——— semicoronatum, R. 1. *Lam. Ann. du Mus.* v. 3. 344; *Hist. Nat.* v. 7. 80. *Desh.* v. 2. 306. t. 50. f. 1 & 2.	. . . .	Grignon. Beyne. Courtagnon.
——— semigranulosum, R. 1. *Lam. Ann. du Mus.* v. 3. 437. *Desh.* v. 2. 360. t. 54. f. 3–6. Cer. subgranosum, *Lam. Hist. Nat.* v. 7. 86.	. . . .	Grignon. Mouchy-le-Châtel. Senlis.
——— Turris, R. 2. *Desh.* v. 2. 335. t. 51. f. 13, 14. *Morris,* 141.	. . . .	Épernay. Lisy. Ay.
——— marginatum, new, R. 1. Tab. VI. f. 4, 6 & 16.		
——— Cordieri, R. 1. *Desh.* v. 2. 338. t. 52. f. 8, 14 & 15.	. . . .	Lachapelle. Senlis.
——— muricoides, R. 2. *Lam. Ann. du Mus.* v. 3. 349; *Hist. Nat.* v. 7. 84. *Desh.* v. 2. 426. t. 61. f. 13–16.	. . . .	Grignon. Beyne. Houdan.
——— unisulcatum, R. 2. Tab. VII. f. 4. *Lam. Ann. du Mus.* v. 3. 440; *Hist. Nat.* v. 7. 88. *Desh.* v. 2. t. 384. t. 57. f. 14–16.	. . . .	Grignon. Parnes. Mouchy. Senlis.
Pleurotoma prisca, C. Tab. VII. f. 24. *Min. Con.* t. 388. *Desh.* v. 2. 436. t. 69. f. 1, 2. *Morris,* 157. Murex priscus, *Brander,* f. 44.	Barton.	Valmondois. Tancrou. Acy. Beyne.
——— amphiconus, new, C. Tab. VIII. f. 7, 8.		
——— curvicosta, new, C. Tab. VII. f. 17.		
——— inarata, new, C. Tab. VI. f. 21. Pleurotoma rostrata, *Morris,* 157, in part.		
——— transversaria, R. 1. *Lam. Ann. du Mus.* v. 3. 166; *Hist. Nat.* v. 7. 98. *Desh.* v. 2. 450. t. 62. f. 1, 2.	. . . .	Parnes. Grignon.
——— dentata, R. Tab. VI. f. 24. *Lam. Ann. du Mus.* v. 3. 167. v. 7. t. 13. f. 1. *Desh.* v. 2. 452. t. 62. f. 3, 4, 7, 8.	. . . .	Grignon. Senlis, &c.
——— attenuata, C. Tab. VI. f. 11, 14. *Min. Con.* t. 146. f. 1. *Morris,* 157. *Non Desh.*	Barton.	
——— exorta, C. *Min. Con.* t. 146. f. 2. *Morris,* 157. Murex exortus, *Brander,* f. 32.	Barton.	

	British localities.	Foreign localities.
PLEUROTOMA INFLEXA, R. 2. *Lam. Ann. du Mus.* v. 3. 267; *Hist. Nat.* v. 7. 101. *Desh.* v. 2. 475. t. 66. f. 11–13; t. 67. f. 12–14.	. . . .	Grignon. Mouchy.
———— GENTILIS, new, C. Tab. VI. f. 25.		
———— OBSCURATA, new, C. Tab. VII. f. 19.		
———— PLEBEIA, new, C. Tab. VI. f. 23.		
CANCELLARIA EVULSA, R. 2. Tab. VII. f. 40. *Min. Con.* t. 361. f. 2–4. *Desh.* v. 2. 503. t. 79. f. 27, 28. *Morris,* 141. *Nyst,* 477. t. 39. f. 13. Buccinum evulsum, *Brander,* f. 14.	Barton.	Grignon. Senlis. Rétheuil. Baeselle. Antwerp. Boom.
———— COSTULATA ? R. 1. *Lam. Ann. du Mus.* v. 2. 63; *Hist. Nat.* v. 7. 117. *Desh.* v. 2. 499. t. 79. f. 22, 23.	. . . .	Grignon, Parnes, Mouchy, &c.
———— QUADRATA, R. 1. *Min. Con.* t. 360. *Morris,* 141. *Nyst,* 480. t. 39. f. 15.	Barton. Sheppy.	Vliermael.
FASCIOLARIA UNIPLICATA, C. Tab. V. f. 11. Fusus uniplicatus, *Lam. Ann. du Mus.* v. 3. 385. *Desh.* v. 2. 536. t. 96^{bis}. f. 1, 2.	. . . .	Grignon, Parnes, &c.
————? BIPLICATA, new, C. Tab. V. f. 7.		
FUSUS PYRUS, C. Murex Pyrus, *Brander,* f. 52, 53. Fusus bulbiformis, *Lam. Ann. du Mus.* v. 2. 387; *Hist. Nat.* v. 7. 135. *Desh.* v. 2. 570. t. 78. f. 5–10, 15–18. *Min. Con.* t. 291. f. 1, 2, 5, 6. *Morris,* 145.	Barton. Nuneham.	Grignon. Parnes. Rétheuil. Epernay. Soissons. La Manche.
—— BULBUS, R. 1. Murex Bulbus, *Brander,* f. 54. Pyrula lævigata, *Lam. Ann. du Mus.* v. 2. 390; v. 6. t. 46. f. 7; *Hist. Nat.* v. 7. 571. *Desh.* v. 2. 579. t. 78. f. 3, 4, 11–14. *Morris,* 160. Fusus Bulbiformis, *Min. Con.* t. 291. f. 4.	Barton.	Grignon. Courtagnon. Valmondois. Betz. Senlis. Monneville.
—— LONGÆVUS, R. 1. *Lam. Ann. du Mus.* v. 2. 317; *Hist. Nat.* v. 7. 133. *Desh.* v. 2. 523. t. 74. f. 18–21. *Min. Con.* t. 63. *Nyst,* 490. t. 39. f. 20. *Morris,* 146. Murex longævus et deformis, *Brander,* f. 37, 38, 40, 73, 93^{a}.	Barton.	Grignon. Parnes. Soissons, &c. Lovenjoul near Louvain.
—— NOÆ, R. 2. *Lam. Ann. du Mus.* v. 2. 316. t. 46. f. 2; *Hist. Nat.* v. 7. 134. *Desh.* v. 2. 528. t. 75. f. 8, 9, 12, 13. *Nyst,* 492.	. . . .	Grignon. Parnes. Chaumont. Damery. Rouge-Cloître. St. Josse-ten-Noode.

	British localities.	*Foreign localities.*
Fusus regularis, R. 1. *Min. Con.* t. 187. f. 2. t. 423. f. 1. *Desh.* v. 2. 559. t. 76. f. 35, 36. *Morris,* 146. Murex antiquus, *Brander,* f. 74.	Barton. Nuneham.	Rétheuil. Guise-Lamothe. Soissons.
—— rugosus, R. 1. Tab. V. f. 8. *Lam. Ann. du Mus.* v. 2. 316. t. 46. f. 1; *Hist. Nat.* v. 7. 134. *Desh.* v. 2. 519. t. 73. f. 4–7, 10, 11.	Sheppy.	Grignon. Mouchy. Courtagnon, &c.
—— porrectus, R. 1. *Min. Con.* (*Index*) t. 274. f. 8, 9. *Morris,* 146. Murex porrectus, *Brander,* f. 35.	Barton. Hampstead.	
—— unicarinatus, C. Tab. VII. f. 25. *Desh.* v. 2. 515. t. 72. f. 11, 12.	. . . .	Rétheuil. Soissons. Guise-Lamothe.
—— gothicus, R. 2. *Desh.* v. 2. 518. t. 74. f. 9, 10.	. . . .	Parnes. Mouchy.
—— incultus, new, R. 1. Tab. VII. f. 32.		
—— errans, R. 1. Tab. VII. f. 31. *Min. Con.* t. 400. *Nyst,* 497. t. 39. f. 22. *Morris,* 146. Strombus errans, *Brander,* f. 42.	Barton. Highgate. Primrose Hill. Sheppy.	Brussels.
—— errans var. tenuistriata, new, R. 4.		
—— undosus, new, C. Tab. VII. f. 39.	Sheppy. Bognor.	
—— parvirostrum, new, R. 4. Tab. VII. f. 30.		
—— læviusculus, new, C. Tab. VII. f. 34.		
Strepsidura turgida, R. 1. Tab. VI. f. 12, 13. Murex turgidus, *Brander,* f. 51? Murex ficulneus, *Chemnitz,* v. 2. 301. t. 212. f. 3004, 3005. Fusus ficulneus, *Lam. Ann. du Mus.* v. 3. 386; *Hist. Nat.* v. 7. 135. *Desh.* v. 2. 572. t. 73. f. 21–26. *Min. Con.* t. 291. f. 7. *Morris,* 146. Strepsidura costata, *Swainson, Lardn. Cab. Cyclop. Malacology,* 308. Fusus turgidus, *Nyst,* 498.	Barton. Colville Bay.	Grignon. Parnes. Valmondois. Tancrou. Betz, &c. Groenendael. Rouge-Cloître. St. Josse-ten-Noode.
—————— armata, new, R. 4. Tab. VII. f. 11.		
Pyrula nexilis, R. 3. *Lam. Ann. du Mus.* v. 2. 391; *Hist. Nat.* v. 7. 572. *Min. Con.* t. 331. *Desh.* v. 2. 582. t. 79. f. 1–7. *Morris,* 160. Murex nexilis, *Brander,* f. 55. Pyrula tricarinata, *Lam. Ann. du Mus.* v. 2. 391; *Hist. Nat.* v. 7. 571 (*fide Desh.*). Fusus nexilis, *Nyst,* 506. t. 39. f. 26.	Barton. Highgate.	Grignon. Parnes. Senlis. Laon. Vliermael.

	British localities.	*Foreign localities.*
Pyrula tricostata, C. *Desh.* v. 2. 584. t. 79. f. 10, 11.	Chalk Farm.	Rétheuil. Guise-Lamothe.
Murex asper, R. 1. *Brander,* f. 77–80. *Morris,* 151. Murex tricarinatus, *Min. Con.* 416. f. 1. *Non Lam.* Murex tricuspidatus, *Desh.* v. 2. 600. t. 81. f. 22, 23.	Barton.	Valmondois.
——— minax, C. Tab. V. f. 13. *Brander,* f. 62. *Min. Con.* t. 229. f. 2. *Morris,* 152. Fusus Minax, *Lam. Hist. Nat.* v. 7. 135. *Desh.* v. 2. 568. t. 77. f. 1–4.	Barton. Highgate.	Valmondois. Senlis. Tancrou. Betz.
Triton argutus, R. 1. Tab. VII. f. 12. *Min. Con.* t. 344. *Morris,* 164. *Nyst,* 553. t. 42. f. 14. Murex argutus, *Brander,* f. 13.	Barton.	Baesele. Boom. Gremittingen. Lethen. Cassel.
——— expansus, new, R. 3. Tab. V. f. 15.		

ALATÆ.

Rostellaria ampla, C. *Nyst,* 556. t. 43. f. 5. Strombus amplus, *Brander,* f. 76. Murex oblitus, *ib.* f. 41. Rostellaria macroptera, *Lam. Ann. du Mus.* v. 2. 220; *Hist. Nat.* v. 7. 193. *Min. Con.* t. 298–300. *Desh.* v. 2. 620. t. 83. f. 1. t. 84. f. 1. t. 85. f. 10. *Morris,* 161.	Barton. Highgate.	Grignon. Parnes. Chaumont. Rétheuil. Laon. Groenendael. St. Gilles. Forêt.
——— lucida, C. Tab. V. f. 21. *Min. Con.* t. 91. f. 1–3. *Morris,* 161.	Highgate. Hampstead. Chalk Farm.	
——— arcuata, R. 1. Strombus fissurella, *Linn. Gmel.* 3518, in part. Rostellaria fissurella, *Lam. Ann. du Mus.* v. 2. 221; *Enc. Méth.* t. 411. f. 3; *Hist. Nat.* v. 7. 194. *Desh.* v. 2. 622. excl. syn. t. 83. f. 2, 3, 4. See *Min. Con.* v. 1. 205.	. . . .	Grignon. Courtagnon.

PURPURIFERA.

Cassidaria ambigua, R. 4. Tab. VII. f. 44. *Nyst,* 566. t. 43. f. 8. Buccinum ambiguum, *Brander,* f. 56. Cassidaria striata, *Min. Con.* t. 6. 4 *lower figs. and Index.*	Highgate. Barton. Bognor.	Gremittingen. Vliermael. Ronca.

	British localities.	*Foreign localities.*
CASSIDARIA NODOSA, C. Tab. V. f. 3, 4. Tab. VII. f. 43. Cassidaria nodosa, *Nyst,* 563. Buccinum nodosum, *Brander,* f. 131. Cassidea carinata, *Bruguière, Enc. Méth.* v. 2. 439. Cassis carinata, *Lam. Ann. du Mus.* v. 2. t. 169. Cassidaria carinata, *Lam. Hist. Nat.* v. 7. 217. *Min. Con.* t. 6. 3 *upper figs. and Index. Desh.* v. 2. 633. t. 85. f. 1, 2, 8, 9. t. 86. f. 7. *Morris,* 141.	Barton. Highgate. Nuneham.	Grignon, &c. Valmondois. Tancrou. Brussels.
——— CORONATA, R. 2. Tab. VI. f. 22, 30. *Desh.* v. 2. 635. t. 85. f. 11, 12. *Morris,* 141.	. . . .	Tancrou.
BUCCINUM STROMBOIDES, R. 1. Tab. VII. f. 33. *Lam. Ann. du Mus.* v. 2. 164; *Hist. Nat.* v. 7. 279. *Desh.* v. 2. 647. t. 86. f. 8–10.	. . . .	Grignon. Soissons. Courtagnon, &c.
———— ? JUNCEUM, C. Tab. VII. f. 47. *Min. Con.* t. 375. *Morris,* 139. Murex junceus, *Brander,* f. 26.	Barton. Highgate.	
PSEUDOLIVA OVALIS, new, R. 3. Tab. VII. f. 13.		
———— OBTUSA, C. Tab. VIII. f. 11. *Min. Con.* t. 622. *Morris,* 159. Buccinum obtusum, *Desh.* v. 2. 657. t. 88. f. 1, 2.	Nuneham. Basingstoke.	Chaumont. Payta in Peru.

COLUMELLATA.

MITRA MONODONTA, R. 1. Tab. VII. f. 20, 21. *Lam. Ann. du Mus.* v. 2. 58; *Hist. Nat.* v. 7. 324. *Desh.* v. 2. 671. t. 88. f. 24–26.	. . . .	Grignon. Parnes. Mouchy. Hauteville.
——— PARVA, R. 4. *Min. Con.* t. 430. f. 1.	Barton.	
VOLUTA CITHARA, C. Tab. V. f. 17. *Lam. Ann. du Mus.* v. 1. 476; v. 17. 74. (V. Harpa, ex errore); *Hist. Nat.* v. 7. 348. *Desh.* v. 2. 681. t. 90. f. 12. *Min. Con.* 625. f. 1–3. *Morris,* 167. *Nyst,* 590.	. . . .	Grignon. Parnes. Courtagnon. Brussels. Mons.
——— BULBULA, R. 1. Tab. VII. f. 35. *Lam. Ann. du Mus.* v. 1. 478. *Desh.* v. 2. 685. t. 90. f. 13, 14. *Nyst,* 591. Fasciolaria Bulbula, *Defr. Dict. des Sci. Nat.* v. 16. 97.	. . . .	Grignon. Parnes. Rouge-Cloître.
——— CALVA, new, R. 3. Tab. VII. f. 28.		
——— RECTICOSTA, new, R. 3. Tab. VII. f. 18.		

	British localities.	*Foreign localities.*
VOLUTA SPINOSA, C. Tab. V. f. 16. *Lam. Ann. du Mus.* v. 1. 477; *Hist. Nat.* v. 7. 348. *Min. Con.* t. 115. f. 2. *Desh.* v. 2. 690. t. 92. f. 7, 8. *Morris,* 168. *Nyst,* 589. Strombus spinosus, *Linn. Gmel.* 3518. Strombus Luctator, *Brander,* f. 65.	Barton.	Grignon. Parnes. Courtagnon. St. Josse-ten-Noode. St. Gilles. Forêt. Affligheim.
——— SPINOSA var. PLATYSPINA, R. 4. Tab. VII. f. 29.		
——— NODOSA, C. Tab. V. f. 23. *Min. Con.* t. 399. f. 2. t. 613. f. 1.	Barton. Highgate.	
——— CRENULATA, C. Tab. V. f. 22. *Lam. Ann. du Mus.* v. 1. 478. v. 17. 77; *Hist. Nat.* v. 7. 351. *Desh.* v. 2. 693. t. 93. f. 7–9.	. . . .	Grignon. Parnes. Courtagnon.
——— LABRELLA, C. Tab. V. f. 12, 14. *Lam. Ann. du Mus.* v. 1. 478. v. 17, 78; *Hist. Nat.* v. 7. 353. *Desh.* v. 2. 694. t. 91. f. 1–6. *Min. Con.* t. 614. f. 2. *Morris,* 167.	. . . .	Valmondois. Lissy. Assy. Tancrou.
——— MURICINA, C. Tab. V. f. 20. *Lam. Ann. du Mus.* v. 1. 477. v. 17. 75; *Hist. Nat.* v. 7. 350. *Desh.* v. 2. 697. t. 91. f. 18, 19. t. 93. f. 3, 4. t. 94. f. 3, 4. *Min. Con.* t. 626. f. 4–6. *Morris,* 168.	. . . .	Grignon. Parnes. Mouchy. Courtagnon.
——— ANGUSTA, C. Tab. V. f. 19. Tab. VII. f. 37. *Desh.* v. 2. 697. t. 94. f. 5, 6. *Min. Con.* t. 626. f. 1–3. *Morris,* 167.	. . . .	Rétheuil. Guise-Lamothe. Soissons.
——— COSTATA, R. 1. Tab. V. f. 24. *Brander,* f. 45. *Min. Con.* t. 290. f. 1, 2, 4. *Morris,* 167.	Barton.	
——— UNIPLICATA, new, R. 3. Tab. VII. f. 45, 46.		
MARGINELLA EBURNEA, R. 1. *Lam. Ann. du Mus.* v. 2. 61. v. 6. t. 44. f. 9; *Hist. Nat.* v. 7. 359. *Brongn. Vicent.* 64. *Desh.* v. 2. 707. t. 14–16, 20–22.	. . . .	Grignon. Parnes. Mouchy, &c. Val de Ronca.
——— DENTIFERA, R. 1. *Lam. Ann. du Mus.* v. 2. 61; *Hist. Nat.* v. 7. 359. *Desh.* v. 2. 707. t. 94$^{\text{bis}}$. f. 27–29.	. . . .	Grignon.
——— OVULATA, R. 1. Tab. VII. f. 38. *Lam. Ann. du Mus.* v. 2. 61; *Hist. Nat.* v. 7. 359. *Desh.* v. 2. 709. t. 95. f. 12, 13.	. . . .	Grignon. Parnes, &c.

CONVOLUTA.

	British localities.	*Foreign localities.*
Cypræa Coombii, new, R. 3. Tab. VIII. f. 6. Cypræa tuberculosa, *Morris,* 143.		
——— Bowerbankii, new, R. 1. Tab. VIII. f. 1, 2.		
——— inflata, C. Tab. VIII. f. 4, 5. *Lam. Ann. du Mus.* v. 2. 116. v. 6. t. 34. f. 1. *Desh.* v. 2. 724.	....	Grignon. Parnes. Mouchy.
——— globosa, new, R. 4. Tab. VIII. f. 3.		
Ancillaria buccinoides, C. Tab. VIII. f. 14. *Lam. Ann. du Mus.* v. 16. 305; *Hist. Nat.* v. 7. 414. *Desh.* v. 2. 730. t. 97. f. 11–14. Ancillaria subulata, *Lam. Ann. du Mus.* v. 16. 305; *Hist. Nat.* v. 7. 415. *Min. Con.* t. 333. f. 1–4. *Morris,* 138.	Barton.	Grignon. Parnes. Rétheuil. Valmondois. Betz. Tancrou. Hauteville. Belgium.
——— fusiformis, new, R. 1. Tab. VIII. f. 16.		
——— obtusa, new, R. 4. Tab. VIII. f. 15.		
——— canalifera, R. 3. *Lam. Ann. du Mus.* v. 16. 306; *Hist. Nat.* v. 7. 415. *Bast. Desh.* v. 2. 734. t. 96. f. 14, 15. *Nyst,* 599. t. 45. f. 9. Ancilla canalifera, *Lam. Ann. du Mus.* v. 1. 475. v. 6. t. 44. f. 6. Oliva canalifera, v. 16. 327; *Hist. Nat.* v. 7. 439. Ancilla (Oliva) turritella, *Min. Con.* t. 99. f. 1, 2. Oliva canalifera, *Morris,* 154.	Barton.	Grignon. Parnes. Mouchy. Assy. Courtagnon. Bordeaux. Dax. Lethen.
Terebellum fusiforme, R. 1. *Lam. Ann. du Mus.* v. 16. 301; *Hist. Nat.* v. 7. 411. *Min. Con.* 287. *Desh.* v. 2. 738. t. 95. f. 30, 31. *Morris,* 163.	Barton.	Rétheuil. Parnes. Mouchy.
Conus deperditus, C. Tab. VIII. f. 9. *Lam. Ann. du Mus.* v. 15. 441; *Hist. Nat.* v. 7. 528. *Desh.* v. 2. 745. t. 98. f. 1, 2. *Min. Con.* t. 623. f. 1, 2. *Morris,* 143.	....	Grignon. Parnes, &c.
——— diversiformis, C. Tab. VIII. f. 10. *Desh.* v. 2. 747. t. 98. f. 9–12. *Min. Con.* t. 623. f. 3, 5. *Morris,* 143.	....	Parnes. Mouchy.
——— pyriformis, new, R. 1. Tab. VIII. f. 18.		
——— velatus, R. 4. Tab. VIII. f. 17. *Min. Con.* t. 623. f. 7. *Morris,* 143.		

	British localities.	*Foreign localities.*
Conus corculum, R. 4. *Min. Con.* t. 623. f. 8, 9. *Morris,* 142.		

MOLLUSCA CEPHALOPODA.

BELOSEPIARIA.

	British localities.	*Foreign localities.*
Belosepia Cuvieri, C. Tab. IX. f. 11. Belosepia, *Voltz, Mém. sur les Belemnites.* Beloptera sepioidea, *Blainville, Malacol.* 622. Sepia Cuvieri, *D'Orb. Ann. des Sci. Nat.* v. 7. 157. *Min. Con.* t. 591. f. 1. *Desh.* v. 2. 758. t. 101. f. 7, 8, 9. *Nyst,* 610. t. 46. f. 1. Beloptera Cuvieri, *Blainville, Mém. sur les Belemnites,* t. 1. f. 2.		Grignon. Parnes. Courtagnon. Brussels. Ghent.
——— Blainvillii, C. Tab. IX. f. 10? 16, 17. Sepia Blainvillii, *Desh.* v. 2. 758. t. 101. f. 13, 14, 15.	Sheppy.	Valmondois. Tancrou.
——— longispina, R. Tab. IX. f. 12. Sepia longispina, *Desh.* v. 2. 757. t. 101. f. 4, 5, 6.		Parnes.
——— longirostris, C. Tab. IX. f. 15. Sepia longirostris, *Desh.* v. 2. 757. t. 101. f. 10, 11, 12. Beloptera longirostrum, *Morris,* 178.		Parnes. Mouchy.
——— Owenii, new, R. 1. Tab. IX. f. 13.		
——— brevispina, new, R. 2. Tab. IX. f. 14.		
Beloptera belemnitoidea, R. 3. Tab. IX. f. 18. *Blainville, Malacol.* 622. t. 1. f. 8. *Min. Con.* t. 591. f. 3. *Desh.* v. 2. 761. t. 100. f. 4, 5, 6. *Nyst,* 612. t. 46. f. 2. Sepia parisiensis, *D'Orb. Ann. des Sci. Nat.* v. 7. 157. Beloptera parisiensis, *Blainville, Traité de Belemnitologie,* 111. t. 1. f. 3.		Grignon. Parnes. Mouchy. Chaumont. Abbecourt. Laeken.

NAUTILACEA.

Nautilus imperialis, R. 1. *Min. Con.* t. 1. & t. 627. f. 4. *Morris,* 182. Nautilus Lamarckii, *Desh.* v. 2. 767. t. 100. f. 1, 2?	Bognor. Sheppy. Highgate. Chalk Farm. (Upper beds.)	Grignon? Parnes? Courtagnon?

	British localities.	*Foreign localities.*
Nautilus centralis, R. 1. Tab. XIV. f. 28. *Min. Con.* t. 1. & t. 627. f. 6. *Morris*, 182.	Hyde Park. Chalk Farm.Richmond. Sheppy. Bognor.	
——? (Clymenia?) ziczac, R. 3. Tab. VIII. f. 19. *Min. Con.* t. 1. *Desh.* v. 2. 765. t. 100. f. 2, 3. *Morris*, 183. *Nyst*, 614. t. 46. f. 4. Nautilus Deshayesii, *Koninck*, *Bull. de la Soc. Géol. de Fr.* v. 5. 437. Ammonites Wapperi (fide *Nyst*), *Van Mons*, *L'Institut, année* 1833, 272; *Bull. de l'Acad. de Bruxelles*, v. 1. 113 & 118. Nautilus Aturi, *Basterot*, *Mém. de la Soc. d'Hist. Nat.* v. 2. 12, 17.	Highgate. Sheppy.	Houdan.Rétheuil. Dax. Laeken.

Subkingdom VERTEBRATA.

Class PISCES.

Subclass Cartilaginei, *Cuvier*.

Placoidei, *Agassiz*.

Order PLAGIOSTOMI, *Cuv*.

SQUALIDÆ.

Lamna elegans, V.C. Tab. X. f. 28, 29, 30, 31. *Agass.* v. 3. 289.	Sheppy.	
Otodus obliquus, V.C. Tab. X. f. 32, 33, 34, 35. *Agass.* v. 3. 267. t. 31, 36.	Sheppy. Bognor.	Grignon. Dax. Bordeaux. Italy.
——— lanceolatus, C. Tab. XI. f. 20, 21. *Agass.* v. 3. 269. t. 37. f. 19, 23.		
Selache? new, R. 4. Tab. XI. f. 25.		
Galeocerdo latidens, R. 2. Tab. XI. f. 22, 23. *Agass.* v. 3. 231. t. 26. f. 22, 23.	. . . .	Paris Museum.

	Localities.
Carcharodon heterodon, R. 1. Tab. XI. f. 19. *Agass.* v. 3. t. 28. f. 11, 16.	Southampton.

RAIIDÆ, *Agassiz.*

Pristis Hastingiæ, C. Tab. XII. f. 6, 7, 8.	Sheppy.
——— distortus, new, R. 3. Tab. XII. f. 9, 10.	
Myliobates Dixoni, C. Tab. X. f. 1, 2; Tab. XI. f. 14; Tab. XII. f. 3. *Agass.* v. 3. 319.	
——— toliapicus, C. Tab. X. f. 3, 4, 5; Tab. XII. f. 4. *Agass.* v. 3. 321. f. 15, 20.	Sheppy.
——— irregularis, new, R. 3. Tab. XI. f. 15.	
——— striatus, R. 3. Tab. XII. f. 2. *Agass.* 320.	Sheppy. Hampshire.
——— Edwardsii, new, R. 3. Tab. XI. f. 16.	
——— contractus, new, R. 3. Tab. XI. f. 17.	
Ætobates irregularis, C. Tab. X. f. 6, 7, 8; Tab. XII. f. 2, 3, 4. *Agass.* v. 3. 327. f. 3, 5.	Sheppy.
——— marginalis, new, R. 4. Tab. XII. f. 1.	
——— rectus, new, R. 2. Tab. XI. f. 8.	
——— convexus, new, R. 2. Tab. XI. f. 5.	
——— subconvexus, new, R. 3. Tab. XI. f. 6.	
——— subarcuatus, R. 2. f. 7. *Agass.* v. 3. 328.	Sheppy. Barton.

EDAPHODONTIDÆ, *Owen.*

Edaphodon Bucklandi, R. 3. *Agass.* v. 3. 351. t. 40^{d}. f. 1, 4, 9, 12, 19, 24.	Bagshot.
——— Eurygnathus, R. 1. Tab. X. f. 18, 19, 22; and Tab. XII. f. 5. *Agass.* v. 3. 352.	Bagshot.
——— leptognathus, R. 1. Tab. X. f. 20, 21. *Agass.* v. 3. 352. t. 40^{d}. f. 5, 8, 13, 18.	Bagshot.
Elasmodus Hunteri, R. 4. Tab. X. f. 11, 12. *Egerton.* *Agass.* v. 3. 350.	Sheppy.

Subclass Ossei, *Cuvier.*

Order GANOIDEI, *Agassiz.*

PYCNODONTIDÆ.

Periodus Koenigii, R. 4. Tab. X. f. 13. *Agass.* v. 2. 201. t. 72. f. 61, 62.	Sheppy. Southampton.

Order MALACOPTERYGII, *Cuvier.*

SILURIDÆ.

Localities.

Silurus Egertoni, new, R. 3. Tab. XI. f. 11, 12, 13.

Order ACANTHOPTERYGII.

SPHYRÆNIDÆ.

Sphyrænodus tenuis, new, R. 4. Tab. XI. f. 24.
———— priscus, R. 4. *Agass.* v. 5. 98. t. 26. f. 4, 6. Sheppy.

XIPHIOIDES, *Agassiz.*

Cœlorhynchus rectus, C. Tab. X. f. 14, 15, 16, 17; Tab. XI. f. 26. *Agass.* v. 5. 92. Sheppy.

LABRIDÆ?

Platylæmus Colei, new, R. 2. Tab. XII. f. 11, 12, 13; Tab. X. f. 23.

Class REPTILIA.

Order CROCODILIA.

Gavialis Dixoni, new, R. 3. Tab. XII. f. 22, 23, 24, & woodcut.

Order OPHIDIA.

BOIDÆ? (*CONSTRICTORS*).

Palæophis toliapicus, C. woodcut. Southampton.
———— typhæus, new, R. 2. Tab. XII. f. 14. & woodcut.
———— porcatus, new, R. 3. woodcut.

Order CHELONIA.

MARINA.

	Localities.
CHELONE CONVEXA, C. Tab. XIII. f. 2 & 3.	Sheppy.
——— TRIGONICEPS, new, R. 4. Tab. XIII. f. 4, 5 & 6.	
——— LONGICEPS, R. 3. Tab. XIII. f. 9.	
———, SP. INDETERM. Tab. XII. f. 16, 17, 18, 19.	

PALUSTRIA.

TRIONYX, SP. INDETERM. C. Tab. XII. f. 15.	Hordle.

Class MAMMALIA.

Order PACHYDERMA.

TAPIROIDA.

LOPHIODON MINIMUS, R. 4. Tab. XI. f. 27, 27^a & 27^b.

BOGNOR FOSSILS.

ANNELIDA.

	British localities.	Foreign localities.
Serpula flagelliformis, R. 2. *Min. Con.* t. 634. f. 2 & 3.	Bracklesham Bay.	

CIRRHIPEDA.

Xiphidium quadratum, new, R. 2. Tab. XIV. f. 3^b & 4. Pollicipes, *Geol. Trans.* 2nd ser. 5. t. 8. f. 5–9. *Morris*, 68.	Hampstead. Highgate.	

CRUSTACEA.

Astacus Bellii, new, R. 4. Tab. XV. f. 3 & 4.		
Cancer Leachii, R. 4. Tab. XV. f. 5. *Brong. Crust. Foss.* t. 8. f. 5. *Weth. Phil. Mag.* v. 9. 468. *Morris*, 72.	Chalk Farm. Highgate. Sheppy. Isle of Wight.	

CONCHIFERA BRACHIOPODA.

LINGULACEA.

Lingula tenuis, C. Tab. XIV. f. 18. *Min. Con.* t. 19. f. 3. *Mantell, Geol. Suss.* 271. *Mant. Geol. Trans.* 203. *Weth. Phil. Mag. & Journ.* v. 9. 464. *Morris*, 122.	Finchley. Hampstead. Highgate. Chalk Farm.	

CONCHIFERA DIMYARIA.

PHOLADARIA.

	British localities.	*Foreign localities.*
Pholas Pechellii, new, R. 4. Tab. XIV. f. 10.		
Teredo antenautæ, V.C. Tab. XIV. f. 1. *Min. Con.* t. 102. f. 1, 2, 4–8. *Morris,* 102. Teredo Burtini, *Auct.* ?	Bracklesham. Barton. Chalk Farm. Highgate. Newnham. Sheppy.	Brussels ?
——— personata, R. 1. Tab. XIV. f. 5 & 5^a. Fistulana personata, *Lam. Ann. du Mus.* v. 7. 429; v. 12. t. 43. f. 6 & 7; *Hist. Nat.* v. 5. 438. Teredina personata, *Desh.* v. 1. t. 1. f. 23, 26 & 28. *Morris,* 102. Teredo navalis, *Mant. Suss.* 273.	Highgate. Sheppy.	Courtagnon. Epernay.

SOLENACEA.

Cultellus affinis, R. 2. Tab. XIV. f. 6. *Min. Con.* t. 3 & 643. Solen affinis, *Morris,* 101.	Bracklesham, &c.	

MYARIA.

Panopæa intermedia, C. Tab. XIV. f. 9. *Mant. Geol. Trans.* 2nd ser. v. 3. 203. *Min. Con.* t. 602. *Morris,* 96. *Nyst,* v. 1. 54. t. 1. f. 10. Panopæa Deshayesii, *Valenciennes,* p. 20. t. 4. f. 2. Corbula dubia, *Desh.* v. 1. 59. t. 9. f. 13 & 14.	Plumstead. Watford. Reading.	Soissons.
——— puella, new, R. 1. Tab. XIV. f. 14.	Barton.	
——— corrugata, new, C. Tab. II. f. 12.	Bracklesham.	
Thracia oblata, R. 4. *Morris,* 102. *Min. Con.* t. 632. f. 1. Lutraria oblata, *Min. Con.* t. 536. f. 3. *Mantell, Geol. Trans.* 2nd ser. v. 3. 203*.	Herne Bay. Pegwell Bay.	
Pholadomya margaritacea, R. 1. *Min. Con.* t. 297. f. 2. & t. 630. f. 3. *Mantell, Geol. Trans.* 2nd ser. v. 3. 203. *Wetherel, Phil. Mag. & Journ.* v. 9. 464. *Morris,* 98*.	Barton. Bognor. Brentford. Chalk Farm. Isle of Wight. Richmond. Southampton.	
——————— Dixoni, R. 2. *Min. Con.* t. 620. f. 2. Pholadomya Koninckii, *Nyst, Foss. de Belg.* v. 1. 50. t. 1. f. 9.	. . . .	Lincent near Landen. Jemappe. Tournay, &c.

	British localities.	*Foreign localities.*
Pholadomya virgulosa, R. 1. Tab. XIV. f. 31. *Min. Con.* t. 630. f. 1.		
CORBULACEA.		
Corbula globosa, R. 2. *Min. Con.* t. 209. f. 3. *Morris*, 83.	Bracklesham, &c. Wandsworth.	
CONCHACEA (MARINE).		
Cyprina planata, R. 1. Tab. XIV. f. 11. *Min. Con.* t. 619. *Morris*, 86.	Brentford. Nuneham.	
——— ? nana, new, Tab. XIV. f. 8.	Sheppy.	
Cytherea obliqua, R. 1. Tab. II. f. 5. *Desh.* v. 1. 136. t. 21. f. 7 & 8. Venus tenuistriata, *Geol. Trans.* 2nd ser. v. 5. t. 8. f. 8. Cytherea tenuistriata, *Morris*, 87.	Barton. Bracklesham, &c.	Abbecourt. Bracheux. Noailles.
——— suberycinoides ? R. 4. only a cast.	Barton. Bracklesham.	Mouchy, &c.
CARDIACEA.		
Cardium semigranulatum, R. 4. *Min. Con.* t. 144. *Morris*, 82.	Primrose Hill. Hyde Park.	
——— . . . . . . ?, *Mant. Geol. Trans.* 2nd ser. v. 3. 203 ?		
Cardita Brongniartii, V.C. Tab. XIV. f. 33. Venericardia Brongniartii, *Mant. Geol. Trans.* 2nd ser. v. 3. 203. *Morris*, 103.		
——— quadrata, C. new, Tab. XIV. f. 12.		
ARCACEA.		
Pectunculus brevirostris, V.C. Tab. XIV. f. 32. *Min. Con.* t. 472. f. 1. *Mantell, Geol. Trans.* 2nd ser. v. 3. 203. *Morris*, 97. P. pulvinatus, *Mant. Geol. Suss.* 273.	Reading.	
——— decussatus, V.C. Tab. XIV. f. 7. *Min. Con.* t. 27. f. 1. *Mant. Geol. Trans.* 2nd ser. v. 3. 203. *Morris*, 97.	Highgate.	

MYTILACEA.

	British localities.	Foreign localities.
Modiola simplex, new, C. Tab. XIV. f. 16.		
———— elegans, V.C. Tab. XIV. f. 13. *Min. Con.* t. 9. *Mantell, Geol. Suss.* 273. *Mant. Geol. Trans.* 2nd ser. v. 3. 203. *Morris,* 91.	Barton. Bracklesham. Highgate. Richmond.	
Pinna margaritacea, R. 1. *Lam. Ann. du Mus.* v. 6. 218. v. 9. t. 17. f. 8. *Desh.* v. 1. 280. t. 41. f. 15. *Nyst, Foss. Belg.* 274. t. 20. f. 9.	Highgate. Bracklesham. Bognor.	France. Belgium.
——— affinis, V.C. *Min. Con.* t. 313. f. 2. *Nyst, Foss. Belg.* 275. *Mant. Geol. Trans.* 2nd ser. v. 3. 203. *Weth. Phil. Mag. & Journ.* v. 9. 464. *Morris,* 98. Pinna margaritacea, *Mant. Geol. Suss.* 272?	Barton. Highgate.	Limbourg.

CONCHIFERA MONOMYARIA.

OSTRACEA.

Ostrea Elephantopus, new, C.	Bracklesham.	
——— cariosa, C. *Desh.* v. 1. 137. t. 54. f. 5 & 6. t. 61. f. 5, 6 & 7. *Nyst, Foss. Belg.* v. 1. 315. t. 25. f. 7ª. O. edulis, *Mant. Suss.* 273.	. . . .	Belgium. Chaumont. Mouchy.
——— tabulata, new, V.C.		
Anomia tenuistriata, V.C. Tab. XIV. f. 17. *Desh.* v. 1. 377. t. 65. f. 7–11. Anomia ephippium, *Def. Dict. des Sci. Nat.* v. 2. A. striata et lineata, *Min. Con.* 425. *Mant. Geol. Trans.* 2nd ser. v. 3. 203. *Weth. Phil. Mag. & Journ.* v. 9. 464. *Morris,* 106.	Barton. Bracklesham.	Grignon. Senlis. Soissons. Valognes. Brussels?

MOLLUSCA GASTEROPODA.

DENTALIACEA.

Dentalium? incrassatum, V.C. Tab. XIV. f. 2, and also D. planum, *Min. Con.* t. 79. f. 1, 3 & 4. *Mant. Geol. Suss.* 272. *Morris,* 143.	Barton. Chalk Farm. Isle of Wight. Highgate. Reading. Richmond. Sheppy.	

	British localities.	*Foreign localities.*
Vermetus Bognoriensis, V.C. Tab. XIV. f. 3^a. *Min. Con.* t. 596. f. 1, 2 & 3. *Weth. Phil. Mag. & Journ.* v. 9. 465. *Morris,* 167. *Mant. Geol. Trans.* 2nd ser. v. 3. 203. Vermicularia Bognoriensis, *Mant. Geol. Suss.* 272*.	Highgate. Sheppy.	

CALYPTRACEA.

Infundibulum trochiforme, C. Tab. XIV. f. 27. Trochus apertus, *Brand.* 9. t. 1. f. 1 & 2. Infundibulum spinulosum, *Min. Con.* t. 97. f. 6. Calyptræa trochiformis, *Lam. Ann. du Mus.* v. 1. 385, v. 7. t. 15. f. 3. *Desh.* v. 2. 30. t. 4. f. 11–13. *Mant. Geol. Suss.* 273. *Nyst,* 360. Calyptræa lævigata, *Desh.* v. 2. 31. t. 4. f. 8, 9 & 10.	Barton. Bracklesham. Kingston. Plumstead. Stratford. Reading. Welling.	Belgium. Epernay. Grignon.

NATICACEA.

Globulus patulus, V.C. Tab. XIV. f. 19. *Min. Con.* t. 284. Helix mutabilis, *Brand.* 28. f. 57, 58 & 59 ? Ampullaria patula, *Lam. Ann. du Mus.* v. 5. 32; *Hist. Nat.* v. 7. 549. Natica patula, *Desh.* v. 2. 169. t. 21. f. 3 & 4. *Mant. Geol. Suss.* 273. *Mant. Geol. Trans.* 2nd ser. v. 3. 203. *Morris,* 147.	Barton. Bracklesham.	Grignon, &c.
——— sigaretinus, C. *Min. Con.* t. 284. *Morris,* 147. Ampullaria sigaretina, *Lam. Ann. du Mus.* v. 5. 32, v. 8. t. 6. f. 1. *Mant. Geol. Trans.* 2nd ser. v. 3. 203. Natica sigaretina, *Desh.* v. 2. 170. t. 21. f. 5 & 6.	Barton. Highgate.	Grignon, &c.
———? labellatus, V.C. Natica labellata, *Lam. Ann. du Mus.* v. 5. 95; *Hist. Nat.* v. 7. 552. *Desh.* v. 2. 164. t. 20. f. 3 & 4. *Morris,* 153. Natica glaucinoides, *Min. Con.* t. 5.	Bracklesham.	

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* We have not noticed any of the *Foraminifera* attached to this fossil at Bognor, which have been noticed by N. Wetherel, Esq., as occurring on the Highgate specimens.

	British localities.	*Foreign localities.*
Natica Hantoniensis, R. Tab. XIV. f. 22. Helix Hantoniensis, *Trans. Linn. Soc.* v. 7. t. 2. f. 10. *Morris*, 153. Natica striata, *Min. Con.* t. 273.	Barton. Bracklesham.	
——— microstoma, new, R. 2. Tab. XIV. f. 24.		
——— epiglottina, R. 2. *Lam. Ann. du Mus.* v. 5. 95. v. 8. t. 62. f. 6; *Hist. Nat.* v. 7. 552. *Desh.* v. 2. 165. t. 20. f. 5, 6 & 11. Natica similis, *Min. Con.* t. 5. *Mant. Geol. Suss.* 271. *Mant. Geol. Trans.* 2nd ser. v. 3. 203. *Morris*, 153.	Barton. Bracklesham.	

PLICACEA.

Acteon simulatus? R. Tab. XIV. f. 25. *Min. Con.* t. 163. f. 5–8? *Morris*, 138? Bulla simulata, *Brander*, f. 61?	Barton? Highgate? Bracklesham.	

TURBINACEA.

Solarium bistriatum, R. 3. Tab. XIV. f. 20. *Desh.* v. 2. 215. t. 25. f. 19 & 20.	. . . .	Rétheuil. Laon. Guise-Lamothe
Littorina sulcata, R. 4. Tab. XIV. f. 23; Tab. VII. f. 27. *Morris*, 149. Turbo sulcata, *Trans. Linn. Soc.* v. 7. t. 11. f. 9. T. sculptus, *Min. Con.* t. 395. f. 2.	Barton. Bracklesham.	
Turritella conoidea, V.C. Tab. V. f. 6. *Min. Con.* t. 51. f. 1 & 4. *Morris*, 166.	Bracklesham. Barton. Highgate.	Grignon.
——— scalarioides, Casts R. Shell R. 4. Tab. XV. f. 10. *Wetherel MSS.*	Highgate.	

CANALIFERA.

Buccinum? . . . . R. 2. Tab. XIV. f. 22. A cast.		
Pleurotoma prisca? R. 4. Tab. XIV. f. 30. *Min. Con.* t. 386. *Desh.* v. 2. 436. t. 69. f. 1 & 2. *Morris*, 157. Murex priscus, *Brand.* 16. f. 25 & 44.	Barton. Bracklesham. Brentford. Sheppy.	Beyne. Valmondois, &c.
Fusus tuberosus, R. 3. Tab. XIV. f. 29. *Min. Con.* t. 229. f. 1. *Morris*, 146.	Highgate. Nuneham.	

	British localities.	*Foreign localities.*
Fusus undosus, new, R. 3. Tab. VII. f. 39.	Bracklesham.	
Pyrula Smithii, V.C. Tab. XV. f. 6 & 6^a. *Min. Con.* t. 578. f. 1–3. *Morris*, 160.	Brentford. Isle of Wight. Maida Hill. Southampton.	

ALATÆ.

Aporrhais Sowerbii, C. Tab. XIV. f. 21. Rostellaria Sowerbii, *Mant. Trans. Geol. Soc.* 2nd ser. v. 3. 203. *Min. Con.* t. 349. f. 1, 2 & 3. *Weth. Phil. Mag. & Journ.* v. 9. 465. *Morris*, 162. R. Margerini, *Koninck, Mém. Acad. Roy. Brux.* v. 2. t. 3. f. 1.	Hedgerley. Herne Bay. Highgate. Sheppy. Watford. Southampton.	Brussels.

PURPURIFERA.

Cassidaria ambigua, R. 2. Tab. XV. f. 9; Tab. VII. f. 44. Buccinum ambiguum, *Brander*, f. 56. Cassidaria striata, *Min. Con.* t. 6.	Chalk Farm. Highgate. Bracklesham.	
———— nodosa, C. Tab. XV. f. 8; Tab. VII. f. 43. *Nyst*, 563. Buccinum nodosum, *Brander*, f. 131. Cassidaria carinata, *Min. Con.* t. 6. *Lam. Ann. du Mus.* v. 2. 169; *Hist. Nat.* v. 7. 217. *Desh.* v. 2. 633. t. 85. f. 8 & 9, t. 86. f. 7. *Morris*, 141.	Barton. Bracklesham. Highgate. Nuneham.	Grignon, &c. Valmondois, &c.
Pseudoliva semicostata, R. 3. Tab. XIV. f. 26. Buccinum semicostatum, *Desh.* v. 2. 657. t. 88. f. 3 & 4.	. . . .	Soissons.

COLUMELLATA.

Voluta denudata, V.C. Tab. XV. f. 7. *Min. Con.* t. 613. f. 3. *Morris*, 167.	Brentford.	
———, Fragments of various species.		

MOLLUSCA CEPHALOPODA.

NAUTILACEA.

Nautilus imperialis, R. 1. *Min. Con.* t. 1, & t. 627. f. 4. *Morris*, 182. *Weth. Phil. Mag. & Journ.* 465. Nautilus Lamarckii, *Desh.* v. 2. 767. t. 100. f. 1?	Highgate. Sheppy. Bracklesham.	Grignon, &c.?

	British localities.
Nautilus regalis, C. *Min. Con.* t. 355. *Weth. Phil. Mag. & Journ.* v. 9. 465. *Morris,* 183.	Chalk Farm. Islington. Hyde Park. St. Katherine's Dock. Sheppy.
——— Sowerbii, C. Tab. XIV. f. 15. *Weth. Phil. Mag. & Journ.* v. 9. 466; *Trans. Geol. Soc.* 2nd ser. v. 5. *Morris,* 183. *Min. Con.* t. 627.	Chalk Farm. Sheppy.
——— centralis, C. Tab. XIV. f. 28. *Min. Con.* t. 1. *Weth. Phil. Mag. & Journ.* v. 9. 465. *Morris,* 182.	Chalk Farm. Richmond. Sheppy. Bracklesham.

VERTEBRATA.

PISCES.

Otodus obliquus, R. 4. Tab. XV. f. 11. *Agassiz,* v. 3. 267. t. 31.	Bracklesham. Sheppy.

REPTILIA.

SAURIA.

Crocodilus Spenceri, R. 4. A part of the skeleton, Tab. XV. f. 1.	
———, Caudal vertebra, Tab. XV. f. 2. C. Spenceri, *Buckland, Bridgw. Treat.* v. 1. 251. t. 25. f. 1.	Sheppy.

TESTUDINATA.

Chelone longiceps, R. 4. See woodcut.	Sheppy.
——— planimentum, R. 4.	Harwich.

In the 'Quarterly Journal of the Geological Society' for 1847, Joseph Prestwich, jun., Esq., has communicated a very interesting and scientific paper on the Eocene formations of London and Hampshire (including also Bracklesham Bay), and their probable relations with those in the vicinity of Paris. This is what many years ago I had anticipated might be the result of accurate local descriptions, and at page 22 of this work the same hope is expressed. I do not at present think the Eocene strata of our own country and those of foreign localities sufficiently explored to establish correct opinions. The French geologists have drawn their conclusions too much from their own neighbourhood, though the formations in the vicinity of Paris are not so disturbed and dislocated as those of England, which, as Mr. Lyell has truly observed, are almost exclusively of mechanical origin. I have taken this extensive view of the subject, as many new localities of the Eocene period have been lately discovered in Europe and America, and are now undergoing very careful examination. I agree with Mr. Prestwich in many of his remarks as to the relations of our deposits with those near Paris, and particularly with his observations on Barton. The beds at Bracklesham vary exceedingly, and are much disturbed. Mr. Prestwich has considered the Bracklesham sands as synchronous with those of Bagshot, which may be correct; but the true London clay, with its fossils (*Nautili* and other *Cephalopoda*), is here extensively developed; and Palæontologists must bear this in mind in examining the contents of this interesting locality. Many fishes are found also similar to those of Sheppy, though by far the greatest number of shells belong to the calcaire grossier deposits of France which have been noticed many years ago. I subjoin Mr. Prestwich's very valuable tables, which show at one view the distribution of species in several districts of England, as far as they have yet been published.

The shells at Bognor are sometimes converted either wholly or in part into crystallized carbonate of lime, giving them a beautiful appearance, and occasionally they are covered with most brilliant cubic crystals of sulphuret of iron. *Teredines* and the chambers of the *Nautilus* occur in this latter state; and *Nautili*, when divided through the centre, often exhibit the chambers and siphuncle in the most perfect preservation.

Many of the Bognor fossils occur at White Cliff and Alum Bay in the Isle of Wight, and also at Southampton. Mr. Prestwich mentions that a similar series has been discovered at Clarendon Hill near Salisbury, and there can be no doubt that in many other parts of England the shells are of the same species as those of Bognor: it is also a remarkable fact, and shows the great extent of this portion of the Eocene formation, that Sir R. I. Murchison procured at Antipofka in Russia many fossils identical with those of Bognor.

1. *Table showing the Superposition and Synchronism of the several Formations constituting the Tertiary Systems of* London, Hampshire, *and* Paris.

LONDON SYSTEM*.	Average thickness.	HAMPSHIRE SYSTEM.	Average thickness.	PARIS SYSTEM†.	Average thickness.
	feet.		feet.		feet.
....		....		Calcaire d'eau douce supérieure	40
....		....		Grès et Sables supérieurs (*Fontainebleau*)	80
....		....		Calcaire d'eau douce inférieure (*Gypseous series*)	150
....		....		Grès et Sables moyens (*Beauchamp*)	50
....		Fluvio-marine and Freshwater series	350	Calcaire grossier and Glauconie grossière	100
.... ?		Barton clays	300		
Bagshot sands	400	Bracklesham sands	700		
London clay	350	London clay (*Bognor beds*)	250	*Part of the* Sables inférieurs, *including probably the* Lits Coquilliers	100
Mottled clays and sands	80	Mottled clays and sands	150	*Lower part of the* Sables inférieurs, *more especially the* Argile plastique	60

* This refers to the district west of London only: eastward there are further subdivisions under the *London clay.*

† As in no part of this district there is a complete vertical sequence of the whole of the series, the several deposits overlapping one another from the lowest in the north to the highest in the south, the thickness of the strata varies most materially. A rough approximation of that of each deposit at its point of average development is all that can be given.

2. *Table showing the number of described Species of Testacea found in each of the marine divisions of the English Eocene Series, the proportions in which the Testacea of any one division are distributed in others, and their range in the French Series.*

	Total number.	Peculiar to each.	Species common in the English Series to				‡ Species common to the French Series in the		
			Barton and Bracklesham.	Barton and London.	London and Bracklesham.	Barton, Bracklesham, and London.	Gres Moyens.	Calcaire grossier.	Lits Coquilliers and Sables inferieurs.
Barton clays	209	108	...	...	...	...	22	70	30
Bracklesham Bay series	193	95	55	11	8	35	36	126	40
London clay	133	79	...	...	...	...	7	20	33

‡ I can only give these as some slight approximation.

DESCRIPTIONS

OF

THE FOSSILS

FROM

BRACKLESHAM BAY, SELSEY AND BOGNOR.

ZOOPHYTA.

A FEW words may be interesting on the peculiar structure of Coral, as the small creatures or Polypes which excrete this substance seldom come under consideration, though their influence on the earth's surface is not inferior to that of any class of animals. The coral islands and reefs in the Pacific and other tropical seas are the monuments of their past and present industry, or, in other words, the accumulation of their calcareous skeletons. Mr. Darwin, speaking of the great durability of these islands, which are able to resist the most violent action of the waves, beautifully observes in his 'Journal,' p. 548:—"It is impossible to behold these waves without feeling a conviction that an island, though built of the hardest rock, let it be porphyry, granite, or quartz, would ultimately yield and be demolished by such irresistible forces. Yet these low, insignificant coral islets stand and are victorious; for here another power, as antagonist to the former, takes part in the contest. The organic forces separate the atoms of carbonate of lime one by one from the foaming breakers, and unite them into symmetrical structure. Let the hurricane tear up its thousand huge fragments; yet what will this tell against the accumulated labour of myriads of architects, at work night and day, month after month? Thus do we see the soft and gelatinous body of a polypus, through the agency of the vital laws, conquering the great mechanical power of the waves of an ocean, which neither the art of man, nor the inanimate works of nature could successfully resist." Large formations of fossil limestone are the result of the prodigious multiplication of *Polypiferous* animals continued over untold ages.

It appears that the animal has usually the power of excreting from the inferior portion of its surface a large quantity of calcareous matter, which is deposited under and around its body; the mesogastric folds of the abdominal cavity, constituting the cell or polypidom, into whose hollows the tenant can partially or wholly retire. The secreting process, however, by which the calcareous matter is separated and retained for the service of the polype, greatly depends upon the extension or limitation internally and externally of the soft parts, being often more applied laterally or to the outer surface or walls than at the lower extremity. "The stony substances so formed are called corals; the upper surface is very generally furnished with radiating plates, which were deposited by the mesogastric folds of the stomach: when these plates do not reach the centre, there is a vacant space in the middle between them."—"The cells are either single or cupped, or they are branched like a tree, or they are aggregated together so as to resemble a cauliflower, or even imitate the brain; all these variations resulting from the manner in which the animal emits from the whole surface, or from a particular part of the sides of the body, the bud by which the new individuals of the general mass or society are produced." For a further inquiry into the physiological characters of these extraordinary beings consult the works of Ehrenberg, Milne-Edwards, Dujardin, Farre, Lister, Grant, &c.

Ehrenberg has separated the coral animals into two divisions, the Bryozoa and Anthozoa. The principal corals figured and described from Bracklesham are radiated Polypes, or Anthozoa, having a greater diversity of structure than the Bryozoa.

Corals are rare fossils at Bracklesham Bay, except the *Siderastræa Websteri.* The Anthozoa are more numerous in the Paris basin, and other calcareous eocene deposits. The nearest recent types of their genera are found in shallow seas, and in a much warmer climate than that of England at the present day.

Notes on the Species, by Mr. LONSDALE.

CLASS ANTHOZOA.

Family FUNGINA.

Turbinolia sulcata, Lamarck. (Tab. I. fig. 1 and 1*.)

Inversely conical, ribbed externally, number and range of ribs variable; interspaces deep, crossed by ridges variously united or simple; lower extremity a union of ribs; lamellæ 12–24 (48 ?), unequal, single, or united in groups of three, sides studded with tubercles; centre an axis connected nearly throughout with the broad lamellæ; terminal cup formed by upper edges of lamellæ, convex on the outer half, concave on the inner, central boss more or less prominent, round or compressed, coated with minute tubercles.

Lamk. Anim. s. Vert. ed. 1. t. ii. p. 231, 1816; ed. 2. t. ii. p. 361, 1836. Schweigger, Beobach. t. vii. f. 65. Expl. Plates (*Turb. elliptica* ?). Cuv. et Brongniart, Oss. Foss. nouv. ed. t. ii. p. 269. pl. 8. f. 3, 1822. Lamx. Exp. Méth. p. 51. pl. 74. f. 18–21, 1821. Goldfuss, Petref. p. 51. pl. 15. f. 3, 1826–33. De France, Dict. Sc. Nat. t. lvi. p. 93, 1828. De Blainville, Man. d'Act. p. 341 (Atlas, pl. 57. f. 2 ?), 1830–34. Michelin, Iconog. p. 151. pl. 43. f. 4, 1844–45.

The Bracklesham collection included two *Turbinoliæ* referable to this species; and they are both represented in Tab. I. fig. 1 & 1*, for the purpose of showing variations in form, where vertical dimensions are similar. The more slender specimen (fig. 1) was apparently older than the other, the secondary or narrow lamellæ being fully developed and united to the six broadest plates; while in the thicker coral (fig. 1*) they were only rudimentary. In the latter case, the interior as well as the exterior had been subjected to friction; but the edges of the incipient lamellæ were sharp, and most prominent near the margin of the cup. Another character may perhaps be worthy of consideration as indicative of the number of lamellæ, which may exist in some specimens. The ribs are generally of unequal downward extent, or alternately of great length and shorter dimensions, the latter agreeing in position with the narrow lamellæ (fig. 1 *b* & 1* *b*), and being apparently precursory developments, existing sometimes greatly anterior to the first signs of the corresponding internal plates, as in the wider coral (fig. 1*), where they commence near the base. In a beautiful, finely-preserved French *Turb. sulcata*, 5 lines in height, kindly lent me by Mr. Pratt, F.G.S., twenty-four ribs, answering to the twenty-four lamellæ, had a similar range to those in the thick Bracklesham example (fig. 1*); but near the upper extremity twenty-four short intermediate ribs were displayed. There was not the slightest indication of an accompanying internal plate, but it was conceived that such a structure would have been produced, had the specimen attained its full dimensions; and then the terminal star would probably have been perfectly symmetrical, or composed wholly of three-plated groups. The cross-bars between the ribs were imperfectly shown in the English specimens; and, where best preserved, they differed somewhat from the ordinary characters, having even less regularity and boldness than is usual, and partaking to a much greater extent of the nature of those which precede the introduction of new ribs.

The lower end of the slender specimen displayed not the least trace of a pedicle or of a cicatrice, consisting of intersections of sharp ridges. The wider coral was worn over the whole surface, and the extremity exhibited the same amount of rounding as the ribs, but the union of the latter could be detected at the very point. Mr. Pratt's fine specimen, before noticed, was similarly terminated. It is believed that this base was produced at the earliest stage of the polype's existence, all signs of additional structures occurring successively upwards; for in the French example 5 lines in height, the interpolated ribs were thinnest at the commencement, but afterwards of persistent solidity; and the other external structures had an almost perfect uniformity of character as respected strength from the base to the margin of the cup: moreover there were no indications of overlying secretions, or fillings up from without or from within; and the wall of the coral was also, so far as could be ascertained, imperforate. If the above inference be correct, it would follow that the polypidom was free from the very earliest period of production.

Doubts have been expressed whether the *Turbinolia dispar* of M. De France (Dict. Sc. Nat. t. lvi. p. 93) should be specifically separated from *T. sulcata*, the distinctive characters of the former depending, according to that authority and M. Michelin (Icon. p. 152), on greater dimensions, more numerous striæ or ribs and lamellæ; also in the absence of pores between the striæ, as separately noticed by M. De France; as well as in the axis being compressed and scarcely attaining the height of the margin, as additionally mentioned by M. Michelin. These characters, without the aid of specimens, might lead to considerable doubts, the Bracklesham examples of *T. sulcata*, partly perfect at the upper extremity, being only 3 lines in height; Mr. Pratt's, probably not full-grown, 5 lines; and Goldfuss's natural-size figure, 9 lines. Mr. Pratt's specimen again had, at the upper end, forty-eight ribs, the usual number being twenty-four. M. De France in describing *Turb. dispar* says, "Le nombre des stries longitudinales est quelquefois de plus de soixante." If the additional ribs in the French *Turb. sulcata* were precursors of lamellæ, as in earlier stages of growth, then it promised to have forty-eight: *Turb. dispar*, according to M. De France, has about forty (*loc. cit.*). Dimensions and numbers, therefore, are not sufficient to establish specific distinctions. Mr. Lyell's cabinet, however, contains specimens of a *Turbinolia* from Hauteville (one of M. Michelin's localities for *Turb. dispar*), of similar general shape to *Turb. sulcata*, but possessing many structural peculiarities. A beautifully preserved example, only 2 lines in height and about 1 in diameter, had between fifty and sixty ribs or striæ, the interpolations being very irregular, and the range of the longest being slightly affected to admit them. The interspaces between the ribs were necessarily narrow, and the " pores " or cross-processes were difficult to detect, but chiefly on account of irremoveable matrix: where the groove had been cleared, the bars were perfectly distinct, but simple, with quadrangular hollows between them, totally unlike the equivalent structure in the true *Turb. sulcata.* The terminal star differed also markedly from that of the species just mentioned. There was not a perfect agreement in position between the lamellæ and ribs, the former amounting to about thirty, the latter to between fifty and sixty; and a similar want of concord is deducible from M. De France's numbers. The star, therefore, instead of exhibiting a very definite wheel-like composition, with a simple periphery, displayed analogous rays or spokes, with a thin, crenulated boundary-margin. Other peculiarities were observed, but they do not demand attention in this notice. Slightly worn specimens, firmly beset with matrix, agreed very nearly with the figure of *Turb. dispar* given by M. Michelin (Iconog. pl. 43. f. 5). From these differential characters, therefore, it is inferred that two species of *Turbinoliæ* occur in the same or equivalent strata, resembling in general characters, but varying in details of structure, one of them being certainly *Turb. sulcata*, and the other believed to be *Turb. dispar.*

Family Ocellina.

Oculina raristella, De France. (Tab. I. fig. 2.)

Incrusting, expanded, lobed or branched; stellular tubes, sometimes distant, sometimes aggregated, projecting or immersed; lamellæ 12 broad, 12 rudimentary in lower part of tubes, more numerous in upper part, sides hispid, outer edge not connected structurally with surrounding composition, inner edge blended with central reticulation, plates seldom united in range towards the centre, often contorted; central area relatively large, formed of reticulated and foraminated plates, boundary-wall hispid on the inner surface, separable from investing structure; terminal cup deep, lined by very narrow, hispid and jagged lamellæ, centre projecting points or edges of reticulated plates, margin of cup sharp, crossed by the lamellæ; intertubular substance compact in more advanced states, in younger, traces of a close reticulation, traversed in both stages by innumerable microscopic tubuli, exterior surface more or less covered with tubercles, often arranged lineally, the whole being closely and minutely foraminated; additional tubes developed laterally from pre-existing tubes, or in expansions of the mantle.

Oculina raristella, De France, Dict. Sc. Nat. t. xxxv. p. 356, 1825. De Blainville, Man. d'Actinol. p. 381, 1830–1834. Milne-Edwards, ed. 2. Lamarck, t. ii. p. 458, 1836. Michelin, Iconog. Zoophytol. p. 163. pl. 43. fig. 16, 1845. (*Lithodendron virgineum*, Goldf. Petref. p. 44. pl. 13. fig. 1; according to M. Michelin, p. 163, not p. 64.)

The Paris basin *Oculinæ* have not been described or figured in sufficient detail to enable a satisfactory opinion to be formed respecting their characters, or whether the specific determinations admit of full acceptance. The Bracklesham coral, however, could not be referred to the recent *Oc. virginea*, which is stated by some authorities to occur in the Paris basin; nor could it be precisely identified with M. Michelin's figures, drawn apparently with great care, of the polypidom assigned by him to that species (Iconog. pl. 13. fig. 6, *a*, *b*). An examination of a specimen of *Oc. Solanderi*, obligingly lent to the compiler of these notes by Mr. Pratt, F.G.S., led also to the inference, so far as it admitted an opinion to be formed, that the fossil under consideration was distinct from it; and M. De France's original notice of *O. Solanderi* (Dict. Sc. Nat. t. xxxv. p. 355), as well as M. Michelin's figure (Iconog. pl. 43. fig. 15), appeared likewise to justify the conclusion. With respect to the third species, *Oc. raristella* (De France, *op. cit.* p. 356), the fine Bracklesham specimen represented in Tab. I. fig. 2. of this work exhibited a great general agreement with M. Michelin's figure of the French coral (Iconog. pl. 43. fig. 16) in the distribution of the tubular openings and branched or lobed and incrusting modes of growth: the extreme narrowness of the lamellæ in the terminal cup accorded also with the "minute lamellæ" of that authority (*op. cit.* p. 163), and the lineal arrangement of the small tubercles with M. De France's "très-légères stries qu'on n'aperçoit qu'à la loupe." (*loc. cit.*)

Among the interesting specimens submitted for examination was one from Mr. Edwards's cabinet, which exhibited a thin base layer incrusting a water-worn, rounded chalk-flint (fig. 2 *a*). It occupied an irregularly circular area, nearly 2 inches in diameter. The stellular tubes diverged obliquely outwards, and projected unequally, but within the marginal band of the layer they had a perfectly-formed circular mouth; and in a few instances additional polype-cavities had been developed on the side or between the most advanced previously existing tubes. The terminal cups were, for the greater part, not deep, and the lamellæ occupied more space than in maturer specimens. The intertubular substance was thin, but its surface was irregular, and it ascended to the margin of the cup. Its exterior was more or less studded with minute tubercles variously arranged. Around the margin of the specimen it thinned off generally to a very fine edge, in some places slightly reflected upwards; but it did not form a continuous layer in advance of the immature tubes. In this portion traces of a reticulated structure were detected. In the development of marginal tubes a semicircular projecting edge was first formed, lined by a few indistinct lamellæ, and from its base a thin lamina was subsequently expanded and traversed by lamellæ. During this process the bounding edge was extended, and ultimately formed into a more or less protracted oval or oblique section of the future tube—the central reticulation not appearing in the middle, but under the first-developed semicircular edge. In one instance a lengthened oval was divided transversely by a wall into two unequal partitions; the first, occupying the earlier-formed portion of the whole area, being round, and, though relatively small, regular in structure, including a central reticulation; while the second, composed of the larger and later-produced division, was semi-oval in outline as well as irregular in structure, consisting solely of obliquely extended lamellæ. Other indications of a similar process were observed, and analogous examples are alluded to in noticing the mode of unfolding additional tubes in mature specimens.

The fine specimen represented in Tab. I. fig. 2. had a central cavity throughout its whole extent; but the body by which it was once occupied had clearly perished before the development of the coral ceased, one extremity of the hollow being lined internally by an overlapping extension of intertubular matter. A third specimen of nearly equal magnitude and similar mode of growth partly incrusted small *Ostreæ*, but had also partly surrounded a perishable body. Each had fragments of oysters attached to the surface. Other much smaller specimens consisted wholly of separated branches or lobes variously united.

The points of chief interest not obvious in figure 2. were those connected with the intertubular substance, and the mode of producing additional stellular cavities. The outer side of the tubes was separable from the surrounding matter, and defined, in ordinary sections, by a circular line; but it was not composed of a continuous lamina, being intersected, more or less deeply, by vertical fissures, and intermediately by others bent downwards. Between the circle defining the limits of the tube and the exterior of simple lobes or branches, no other indications of concentric, separable, perfect surfaces were detected, though traces were noticed of curved lines parallel to the centre, marking probably renewals of deposit: where, however, branches anastomosed, irregular extensions of the mantle apparently took place, and perfect, papillated exteriors were overlaid by layers either exactly moulded to them, or with irregular narrow interstices. These layers, of unequal thickness, were in some instances repeated more than once, as if certain parts of the animal membrane had successively perished, and permitted other portions to expand laterally: they proved also the destruction of the polypes belonging to the incrusted branch. The structure of the intertubular substance was rarely detectable, sections of older branches exhibiting a nearly compact body, and in those of younger portions it was generally very obscure. Where best shown, it consisted of relatively coarse, rounded fibres diverging outwards, but variously anastomosed, and forming the internal equivalents of the surface papillæ. Between these fibres fine irregular elongated cavities occurred, and but for the rounded outline of the former, they would bear the aspect of small contorted channels permeating an homogeneous substance. The fibres were penetrated by numerous microscopic tubuli; also internal representatives of the minute pores which beset the exterior papillæ and the connecting matter. No larger foramina were detected in the surface.

Many examples of immature, additional tubes were observed, either on the side of pre-existing, or in irregular extensions of intertubular layers. Among the former was a subdivisional case partially analogous to that mentioned in the brief notice on the development of marginal polype-cavities, but it differed in the separation having been effected by an irregular lamina unprovided with even rudiments of lamellæ on the side towards the principal portion of the division, or that which included the central structure; the severed part agreed, nevertheless, with that of the marginal example in being semi-oval and traversed by obliquely-disposed lamellæ. Other somewhat similar cases were noticed, but they were accompanied by more or less decided signs of great irregularities in the secreting processes, or of the polypes having been injured during growth. The interesting fractured surface exhibited in fig. 2 *b* (Tab. I.) gave several instances of lateral developments, but all under nearly equivalent conditions, owing to the intersection having occurred deep in the lobes. Near the cross (×) is an outer smooth impression of a shoot at the very line of divergence. This case presents no irregularities in the lamellæ of the parent-tube at the side nearest the offspring; and the distance between the two polype-cavities at the base of the cast did not apparently exceed the thickness of an ordinary wall. In the other instances, on account of divergence in the shoot and the structures being fully exhibited, the distance is relatively considerable, or the side of the mature tube greatly augmented. In the example marked with two crosses (fig. 2 *b*), a gradual lessening may be traced in this structure, till it acquires at the part most distant from the shoot the usual thickness of a wall. The tube, unaccompanied by an offset, has a uniformly slender boundary. Of still earlier stages of development no satisfactory examples were observed. The characters displayed by polype-cavities produced in extended intertubular matter differed not from those in the marginal expansion of a base or first layer before noticed; but their form was often very irregular in consequence of uneven subjacent surfaces, or the growth of the polype having been affected by want of room *.

The protrusion or immersion of the tubes depended chiefly on the amount of thickening in the interspaces, though sometimes a horn-like extension occurred, and seemed destined to project permanently. Occasionally the intermediate matter swelled above the adjacent terminal cups, having continued to increase after the tubes had apparently ceased to lengthen. Where this character existed, no signs, however, of change in the nature of the stellular cavities were visible; and only those openings were encroached upon, or covered over by a papillated layer, which had evidently ceased to be occupied by a living polype.

The proofs of filling up in the lower part of the tubes were not so decided as in recent *Oculinæ*, but indications of such a process were noticed.

Oculina? dendrophylloïdes, sp. n. (Tab. I. fig. 3.)

Incrusting, variously lobed or branched; tubular openings irregularly distributed, in general slightly projecting above the adjacent surface, rarely extended in distinct branches, no definite walls; lamellæ numerous, unequal, irregularly grouped, hispid on the sides, blended at the outer edge with the surrounding structure, at the inner with central reticulation; terminal cup shallow, margin scarcely raised; intertubular structure, composed of anastomosed, unequally coarse fibres or contorted laminæ, constituting a more or less dense reticulation, not separable from the stellated cavities; surface, variously bent and blended ridges, with intermediate transverse processes, and pits or foramina, ridges penetrated by numerous microscopic channels, termi-

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* For farther illustrations of lateral developments consult also Tab. I. fig. 2 *c*, and the enlarged portion fig. 2 *d*.

nating on the exterior in minute pores; additional polype-cavities developed on the side of pre-existing or in the intertubular substance.

Ehrenberg has united the *Dendrophyllia* of M. de Blainville to *Oculina* (Beiträge, p. 78), and the fossil under consideration presents structural details which would apparently justify the union; while *Dend. ramea*, De Blainville's typical species, and some tertiary polypidoms exhibit essential differences and partially support M. Milne-Edwards's remark, that "this innovation ought not to be adopted, though the limits between *Oculinæ* and *Dendrophylliæ* are a little uncertain." (2nd edit. Lamk. t. ii. p. 454, 1836.)

In mode of growth, the Bracklesham coral agreed completely with *Oc. raristella*, and the differences in the intertubular reticulation existed only in the relative fineness or coarseness of the component parts: in the grouping of the lamellæ, however, and in the mode of blending with the surrounding structure, there were no resemblances, but, on the contrary, an almost perfect similarity with the recent *Dend. ramea* as well as the fossil *Dend. digitalis.* (Consult M. Michelin's excellent figure, Icon. pl. 10. f. 10.) The latter agreements nevertheless must be regarded, in the present case, of less importance than the habit of growth, which in the Bracklesham coral, as in *Oculina*, is intimately connected with the reproductive processes. In the two *Dendrophylliæ* just mentioned a lamelliferous master-tube pervades the centre of the main stems, and in the recent species, which has secondary stems or branches, these also are similarly provided, the additions in every instance arising from marginal expansions in the boundary of the stellular cavity. So far as the describer's practical knowledge extends, traces of these master-tubes may always be detected, though the interstices are very frequently so far filled up, that a transverse fracture presents an apparently compact centre, resembling that of *Oculinæ*; and, as many deviations from a normal condition must occur by dismemberments and the subsequent coating over of the fractured surfaces by animal secretions, still farther external accordances with that genus may occasionally be exhibited. Examples of the regular mode of growth in *Dend. ramea* are excellently given by Solander and Ellis or Lamouroux (Nat. Hist. Zoophytes, pl. 38, or Exp. Méthodiq. pl. 38. Consult also Esper, Pflanzenthiere, Madrep. pl. 9); and of more or less marked deviations from it by Esper (*op. cit.* Madrep. pl. 10 A), Marsilli (Hist. de la Mer, tab. 31. fig. 144), Pallas (Elenchus, Germ. Trans. tab. 16. fig. 54), and Lochner (Mus. Besler. tab. 25, centre figure, quoted by

Lamarck as a variety of *Oc. virginea*, but Lochner compares the specimen represented with the Mediterranean coral or *Dend. ramea).* In no case however do stellular cavities appear to have been developed in the animal substance which permanently invested the coral, or in irregular extensions of the mantle*.

In well-known *Oculinæ*, on the contrary, no persistent central lamelliferous cavities occur at any period of growth, normal or otherwise; and Ehrenberg states, that the essential mode of developing young tubes is by a swelling in the parent-tube. In *Oc. pallens*, a separation from *Oc. hirtella* made by that authority, the additional polype-receptacles are, however, produced on the side of those previously existing, and are usually so crowded together at the extremity of the branches as to occupy nearly the whole intervening spaces: they originate also clearly in the mantle, or external animal substance. In the same species, extensions of this outer covering take place where the original polypes have been destroyed, and young tubes are freely developed in the expanded portions. In these respects there are considerable agreements with the Bracklesham coral under immediate examination; but it must be stated that Ehrenberg is of opinion, that the slender variety of *Oc. pallens*, believed to be the one just noticed, "draws near" to his genus *Stephanocora*, established on a coral found in the Red Sea, and possibly not yet figured (*op. cit.* pp. 76, 78). In mode of growth that polypidom agrees moreover with *Oculina virginea*, as defined by Ehrenberg, *Oc. pallens* and the Bracklesham coral, forming both branches and expanded or overlying gemmiferous layers; and still farther, a

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* *Dendrophyllia cornigera*, M. de Blainville's third recent species, agrees with *Dend. ramea* in being permeated by central lamelliferous tubes; but it differs apparently in the whole of the exterior not being constantly covered, while living, by animal matter. On this account, it is presumed, the coral should be removed to Ehrenberg's genus *Cladocora* (Beiträge, p. 85). A comparison of the structures of *Dend. ramea* with those of a polyparium believed to be *Dend.* (*Clad.*?) *cornigera* led to the detection of subordinate distinctions, valuable nevertheless in the study of imperfect fragments of analogous fossils. In *Clad.*? *cornigera* the centre of the stem is not rapidly consolidated, or but partially; the open stellated structure is traversed by numerous well-developed diaphragms; and the exterior is not thickened by continuously applied secretions, except at the base, or near the union of a branch with a principal stem. The additional polype-cavities are produced by germs (Ehrenb. *loc.cit.*) on the side of the parent branch, but a certain limited connexion apparently exists for a time between the interior of each. The fossil figured by M. Michelin under the same name (*Dend. cornigera*, Icon. pl. 10. fig. 9) agrees perfectly in generic characters with *Clad.*? or *Dend. cornigera.* It is also believed that the extinct coral, *Dend. irregularis* of M. de Blainville, is generically if not specifically identical with M. Michelin's fossil.

comparison of the English fossil with the *Lithodendron gibbosum* of Münster (consult Goldfuss, Petref. tab. 37. f. 9), which Ehrenberg observes may be a *Stephanocora*, will point out some structural agreements. Notwithstanding, however, this amount of resemblances, it has been deemed advisable to consider the Bracklesham polypidom provisionally an *Oculina*, as it wants the peculiar centre dwelt upon by Ehrenberg; and the placing it even doubtfully in *Stephanocora* would entail a severance from *Oc. raristella* with which it is connected in all essential structures, as well as an inquiry into the characters of very many other allied corals—an undertaking which the compiler of these imperfect memoranda is not prepared to commence.

So far as the describer is aware, this fossil is distinct from any published species.

The series submitted to examination included, besides the fine specimen figured (Tab. I. fig. 3), another, belonging to Mr. Edwards's cabinet, of rather greater size, and part of a third, which probably, when perfect, possessed nearly equal dimensions. They all exhibited a large but not perfectly medial cavity that penetrated their whole length, and represented clearly the position of a perishable extraneous body, around which the coral formed, and not a hollow due to the decomposition of a central structure in the polypidom itself, the only perfect termination, with a limited portion of the adjacent interior, being coated by the intertubular reticulated substance. The thickness of the polype-structure surrounding the cavities varied greatly, as was well shown in the figured specimen; and the fragment above-mentioned, which was more regular in the general surface, had at the intersected extremity a thickness in the broadest part of 9 lines, and in the narrowest of 4, while at the other end, the length being only 2 inches, the thickness nowhere exceeded 2 lines. Some portions believed to be detached lobes or branches had a flattened palmated form. Neither of the large, nearly perfect specimens exhibited any signs of a base or expanded foot, but each apparently derived its chief support from the body around which it was developed.

The tubular openings varied in diameter from 1½ to 2 lines, and the terminations, as shown in figure 3 *a* (Tab. I.), were in general very slightly depressed in the centre; but in a detached branch which gave a series of extremities with perfect margins, the middle was deeply cup-shaped. The extension above the adjacent intertubular surface will also be found by reference to the same figure to have varied greatly, and sometimes to have extended into horn-like lobes (fig. 3).

The lamellæ could not be reduced to symmetrical groups within any single area, and considerable inequalities existed in adjacent tubes; but there was a tendency in the broader plates to converge and unite in pairs with an intermediate narrower one, and sometimes two of the latter occurred and formed a similar inner junction. No case was observed of a tube having been wholly filled up towards its lower extremity, but many were noticed in which the spaces between the lamellæ were greatly narrowed, and a few in which they were partially obliterated. The intertubular substance varied in texture, the reticulation being sometimes open or coarse, but sometimes replaced by a nearly compact mass, and without any reference to position as respected the surface or relative age. In the fragment mentioned as having formed portion of a third large specimen, the intertubular composition, at the narrow extremity, was almost uniformly compact, faint concentric lines being the principal indications of structure. The microscopic canals which permeated the reticulated fibres or laminæ could readily be detected by a Codrington lens (fig. 3 *b*); and they were very distinct on slightly weathered portions of the general surface.

Many instances of additional polype-cavities produced on the side of previously existing tubes or near their base were noticed. Those in the latter position were distinguished from adjacent fully-grown stars by the small number of lamellæ as well as other signs of immaturity; and little doubt could be entertained of their having originated, as in *Oculina pallens*, in the mantle or common animal envelope. The additional side-cavities were also apparently produced in the substance of the animal matter which formed and thickened the walls of the older tube, but there were indications of a connexion between the base of the former and the interior of the latter. In all cases the lamellæ-plates were equally developed around the area; and the termination of the cavities was in the same plane with the surface. Instances of what might be considered as double tubes, resulting from two cavities developed so near each other as to intermingle structure, were likewise noticed, and without care they might be regarded as having resulted from a subdivisional process. Polype-receptacles formed in expansions over destroyed surfaces displayed characters strictly analogous with those mentioned in the account of a base-layer of *Oc. raristella* *.

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* On the surface of the Bracklesham molluscous remains and rolled flints, a stellated coral not unfrequently occurs either singly or grouped. At first it was conjectured to be the base of the fossil referred doubtfully to *Dendrophyllia*, but Mr. Dixon having obligingly forwarded to the describer

Dendrophyllia? (Tab. I. fig. 4, and Tab. IX. fig. 26, 28, 30.)

Stems simple?, slightly conical or compressed, expanded and fixed at the base; surface traversed by fine, minutely-tubercled ribs, with narrow, intermediate furrows; lamellæ very numerous, grouped, hispid on the sides, blended outwardly with peripheral structure, inwardly with middle area; boundary a spongeous network; centre, variable amount of reticulated laminæ; terminal cup not deep.

Three specimens of this coral were examined, the one figured belonging to Mr. Dixon's collection, the others to Mr. Edwards's series. They varied in height from half an inch to an inch and a half, but the diameter of the longest slightly exceeded the major axis of the specimen delineated. In general composition they resembled *Dendrophyllia*, particularly the largest individual; and they might readily be regarded as elongated base-portions of *Dend. cariosa* (Michelin*), stated to be found in the lower beds of the *calcaire grossier*. It would, however, be clearly incorrect to consider the Bracklesham specimens as belonging either to the Paris basin species or even to the genus *Dendrophyllia*, as it is impossible to determine whether they are young or lower portions of a branched coral, or whether in their perfect development they would be simple. The figures 4 and 4 *c* given in Tab. I., and the references in the note, will, it is hoped, enable the discoverer of other specimens to determine satisfactorily the generic characters.

In the upper portion of the figure 4 the ribs are correctly shown to have lost their distinctness, but in Mr. Edwards's fossil (fig. 4 *c*), nearly twice the height, they preserved throughout the same definite outline. In that specimen the central area also was much greater, in consequence possibly of a less compressed form, and it resembled perfectly in its nature the boundary reticulated structure; but the termination was much more imperfect than in figure 4.

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other and more illustrative specimens, he is induced to infer, from the mode of grouping and the great solidity displayed in the best exposed attached portions, that some at least of these stellated corals should be regarded as the earliest stage of *Oculina? dendrophylloides*. Fig. 30. Tab. IX. exhibits the porous nature of the very base of the *Dendrophyllia?*; and in four other specimens the structure was equally foraminated. Fig. 26 displays two stellated corals, and several others were scattered over the same shell. The great relative solidity of the interior is shown at letter *a*, and it was equally conspicuous in other specimens. A similar character is noticed in alluding to a specimen of *Ocul.? dendrophylloides*, which exhibited, in the upper part, the portion that once rested immediately on the original support.—*Nov.* 1846.

* Iconog. Zoophytog. pl. 43. f. 10; consult also Goldfuss, Petref. *Lithod. cariosum*, tab. 13. f. 7, and Guettard, Mém. tome iii. tab. 58. figs. 3, 6, 7, 9; also the Grignon fossil, pl. 26. fig. 3, same work.

Siderastræa Websteri. (Tab. I. fig. 5.)

Incrusting, hemispherical, or spherical; stars polygonal, united by a reticulated structure of variable width; lamellæ 24, six single and broad, with six intermediate groups, composed of one broad and two converging narrower plates, outer edge blended with the boundary reticulation, inner edge of the twelve broad lamellæ blended with the central structure, sides sharply and thickly tuberculated, more or less foraminated; centre a complex, highly perforated reticulation; terminal cup shallow, nearly filled up at one period of growth; additional stars interpolated.

Astræa Websteri, Bowerbank, Mag. Nat. Hist. New Series, vol. iv. p. 26, fig. *a*, *b*, 1840.

This fossil agrees in general aspect with the corals to which the term *Astræa* is usually applied, but it differs essentially in its mode of developing additional stars from those polypidoms to which Ehrenberg has beneficially restricted the genus*,—that process being effected in the fossil under consideration, not by a subdivision within the area of the mature star, but by the production of stellular cavities in interspaces due to radiation. In all the leading structures, as well as in the developing of intermediate stars, the Bracklesham fossil agrees perfectly with M. de Blainville's subgenus *Siderastræa*†, adopting, for the sake of actual comparison, his second species (*Ast. galaxea*) as its type‡, both corals being composed of stars without distinct boundary-walls, and united by a reticulated structure; the lamellæ likewise of both being similar in characters, also in the mode of blending with the peripheral and central portions of the star, as well as in the general manner of grouping. From the genus *Porites*, the fossil as well as the recent polypidom is markedly separated by the lamellæ exceeding twelve, though there is a resemblance in the prevailing aspect of the surface. For the above reasons therefore, it is deemed correct to consider the Bracklesham coral as a species of *Siderastræa*; it will however be necessary to regard M. de Blainville's dismemberment no longer as a subgenus, but as a rightful genus, which must

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* Beiträge zur Kenntniss der Corallenthiere, &c., p. 95, 1831–34; also Berlin Transactions for 1832.

† Manuel d'Actinologie, p. 370, 1830–34.

‡ Ehrenberg suggests that *Madrepora galaxea* of Solander and Ellis, or *Siderastræa galaxea* of De Blainville, may be identical with *Astræa astroites* (consult Esper, Madrep. tab. 35); but such a generic determination it is considered would be inadmissible for the reasons stated in the text, and the coral exhibiting clear proofs of a distinct mantle between the stars (Beiträge, &c. pp. 82, 95).

moreover be removed from Ehrenberg's family *Dædalina*, characterized by the subdivisional process, to that of *Ocellina*, in which reproduction is effected by germs or developments in the mantle (*op. cit.*).

Among the tertiary fossils assigned by M. de Blainville to *Siderastræa*, the only species which bears an approximate resemblance to the Bracklesham coral is the *Astræa crenulata* of Goldfuss as represented by M. Michelin*, but the stars of that polypidom are stated to be separated by a groove†, a structure which does not occur in the English coral at any period of growth; and according to Prof. Goldfuss's delineation of the same species, from apparently an aged or fully developed Piacenza specimen‡, the two polypidoms differ essentially, at that stage, in the nature of the lamellæ and in the mode of union of adjacent stars. Among the other Paris basin corals described and figured by M. Michelin, *Astræa Ameliana* of De France§ (*Ast. muricata*, Goldfuss‖) and *Ast. hirtolamellata* (Michelin¶) resemble generally the fossil under consideration, particularly in its earlier states of growth. *Ast. Ameliana*, however, is described as having all the lamellæ equal, whereas in *Siderastræa Websteri* they are unequal and more or less grouped in specimens of apparently equivalent age with that figured by M. Michelin; and M. de Blainville refers *Ast. Ameliana* or *muricata* to his subgenus *Dipsastræa*, an assemblage of very differently constructed anthozoa. With regard to *Ast. hirtolamellata*, the other assumed analogous coral, M. Michelin states that it is also a *Dipsastræa***, and so far as the characters have been illustrated, there are no means of determining satisfactorily the process by which additional stars were produced.

The fine series of *Siderastræa Websteri* submitted to examination included interesting examples of growth, and of the mode by which interpolated germs advanced towards maturity. The beautiful specimen represented in part by figure 5 *a*. Tab. I., formed one of six groups of stars of unequal lateral and vertical dimensions. The greatest diameter of the smallest group was only 3 lines, but the patch was very nearly united to another by the extension of the base-lamina, and the larger assemblages afforded proofs of similar junctions. No case was noticed of an isolated, immature star, such as might have arisen from a single transported germ; but the small group above alluded to had most pro-

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[*] Iconographie, Paris Basin Series, p. 156. pl. 44. fig. 1.

[†] Goldfuss, Petref. p. 71, and Michelin (copied), p. 156.

[‡] *Op. cit.* pl. 24. fig. 6.

[§] Dict. Sc. Nat. tome xlii. p. 384.

[‖] *Op. cit.* p. 71. pl. 24. fig. 3.

[¶] Iconog. p. 162. pl. 44. fig. 5.

[**] Iconog. *loc. cit.*

bably sprung from that source, and as it exhibited six stars imperfectly formed with respect to the lamellæ and boundaries, and was surrounded by a narrow flim or base-lamina traversed by tubercles, the first rudiments of additional stars, it proved clearly that before any one of the polypes had fully constructed its own domicile, or had arrived at maturity, the work of developing others was in active progress. The portion of a larger group represented in Tab. I. fig. 5. exhibited an advanced state, the stars which constituted the general surface being perfectly defined, and the margins sharp, though without any separating structure ; the terminal cups, relatively deep, were also lined by well-formed lamellæ, broad and narrow plates alternating regularly, and the latter occasionally uniting to the intermediate broader ones. Around the margin of the patch, as shown in the figure, were stars variously advanced towards maturity, the structures nearest those perfected being most complete ; while without this belt was a narrow band of the base-lamina more or less traversed by rows of tubercles, the rudiments, as before mentioned, of lamellæ, regular passages being displayed from continuous plates to interrupted ridges, and thence to single tubercles. In other specimens additional stages towards maturity were displayed, the lamellæ attaining their full number and dimensions ; the interspaces between adjacent stars, particularly at the angles or smallest sides, also increasing, but not precisely according to the size of the mass, the radiation having been sometimes greatest in smaller specimens ; and the interpolated young stars becoming numerous where the divergence in the old lamellæ-columns had been most considerable. Figure 5 represents what was considered to be a mature state ; and it exhibits likewise additional intermediate stars. To what extent the coral grew after it had attained this condition, no information was obtained. Mr. Bowerbank states that a specimen in his possession 3¼ inches long and 2¼ inches wide, was 3½ inches in height* ; and the greatest vertical dimension in the series submitted to examination was 2 inches 1 line, the diameter at the base of that portion being 1 inch 2 lines, and at the widest part more than 2 inches ; but neither of those specimens gave apparently the full size. Of the changes dependent upon what might be regarded as the limits of growth, the information obtained was also not satisfactory. In Mr. Edwards's cabinet is a fragment about 1½ inch in width and 1 inch in height from the smooth base-surface. The exterior exhibited not the least signs of abrasion, but the terminal cups were nearly filled up over the whole surface, and the structure of the stars was frequently in-

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* Mag. Nat. Hist. New Series, vol. iv. p. 26, 1840.

distinct (fig. 5 *e*), presenting a confused reticulation somewhat similar to that of the interspaces; while in the upper portion of the fragment a thin calcareous pellicle, of animal origin, sometimes extended over the edges of the lamellæ and across the intervening spaces. How far these characters can be considered as indicative of a natural cessation of development and of structural changes dependent upon such a condition, or upon local injury, the study of additional specimens can alone determine; but it may be stated that analogous appearances have been observed in other genera under circumstances which proved that the variations were not accidents, but regular consequents due to the age of the polype *.

Respecting the progressive characters of interpolated stars, only a short notice will be necessary. In the earliest observed condition, an irregular star, composed of a few defective lamellæ, appeared in the reticulated interspace; but so far as they were produced, they were equal in dimensions on each facet. This character is deemed worthy of attention, affording one means for distinguishing interpolated stars from those produced by subdivision. In the latter cases the earliest stage exhibits unequal lamellæ, those on the outer side of the subdivided star, or that side which is a prolongation of the previous boundary of the undivided star, having full dimensions, in consequence of the secreting organs of the bi-separated polype having in that part preserved the previously perfected powers; while along the line marking the subdivision the lamellæ are rudimentary, the necessary vessels for elaborating them not being matured. The boundaries also of interpolated stars are similarly composed on all sides, the surrounding full-grown polypes having equally contributed to their formation; whereas in divided stars they are dissimilar, and for the same reason, that the lamellæ are unequal. In noticing the mode of forming marginal stars, it was stated that they were most advanced on the sides next the more nearly perfected structures; but in cases of interpolation, considering the manner of development to be the same, the progressive increase must be uniform on every facet. Sometimes the young stars appeared singly, as in the case figured, but not unfrequently two or three were grouped in different ways, and in those instances there was an intermingling of structures. It is not necessary to detail the steps by which these polype-cavities arrived at maturity; some of them were shown in specimen figure 5, and every intermediate stage was noticed.

The internal characters of the Bracklesham coral agreed closely, as before-

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* Journal Geol. Soc. vol. i. p. 498.

mentioned, with those of *Sid. galaxea.* The lamellated tubes extended continuously throughout the vertical section 2 inches in height. They exhibited no signs of interrupted and renewed growths, nor were they partitioned by transverse diaphragms, which would have limited partially or wholly the downward range of the polype: on the contrary, the animal during life possibly occupied the tube to some depth, and enjoyed, by means of the perforated lamellæ, central and boundary structures, access to every part of its construction, as well as a perfect community of existence with the other polypes dwelling in the same specimen.

Note to Siderastræa Websteri.

In the collection of tertiary corals for which I am indebted to M. Michelin, and received since the notice on *Siderastræa Websteri* was written, are two beautifully preserved specimens of "*Astræa Ameliana*" of M. De France, less in size, but agreeing in shape with the one represented in pl. 44. fig. 3 of the 'Iconographie Zoophytologique.' In all the characters which may be considered generic, there are no differences between the two corals, and the specific distinctions, if such they may be deemed, consist in the lamellæ being more delicate and closer together, also in their extremely hispid nature and the great number of foramina, whereby the interior of the coral presents a structure very analogous to that of ordinary *Porites.* It is considered advisable however to retain the specific name of *Websteri* for the Bracklesham coral, until it shall be fully ascertained that specimens of equal development—young, mature and aged—of each fossil agree in all essential characters.

Mr. Dixon has also obligingly lent the describer a larger specimen of *Siderastræa Websteri* than he had previously seen: it measured more than 4 inches in length, about 3 in its greatest breadth, and nearly 1½ in thickness. The stars exhibited mature but not aged characters, and no variations were noticed from the structures mentioned in the text.

Family MADREPORINA.

Stylophora monticularia, Schweigger. (Tab. I. fig. 6.)

Incrusting, polymorphous; stars polygonal, very unequal in size and outline, surmounted by conical, lamellated mounds; lamellæ within the stars 12, sides tuberculated, united in the lower part to the axis, disconnected in the upper;

intermediate transverse diaphragms irregular; axis small; boundary of stars composed of reticulated plates; terminal cup including projections deep; conical mounds seated chiefly on the angles, sometimes on the margins of the sides; form variable as well as number of radiating lamellæ-plates; additional stars interpolated.

Styl. monticularia, Schweigger, Beobachtungen auf Naturhistorischen Reisen, taf. 6. fig. 62, explanation of Tables, and Systematic Table 5, 1819.

Astræa hystrix, De France, Dict. Sc. Nat. t. xlii. p. 385, 1826. Michelin, Iconographie Zoophytologique, p. 160. pl. 45. fig. 1, 1844–1845.

Astræa (*Cellastræa*) *hystrix*, De Blainville, Manuel d'Actinologie, pp. 377, 385–6; Atlas, pl. 54. fig. 5?, 1830–1834.

The genus *Stylophora* was established by Schweigger (*op. cit.*) for two polyparians, a Grignon fossil (*Styl. monticularia*), and a recent coral (*Styl. pistillaris*, *Madrepora pistillaris*, auct.), but possessed apparently of very different structures. It has not been retained, so far as the compiler of these notices is aware, by any subsequent authority, except M. de Blainville *, and by him only for the fossil species, which, he says, is an *Astræa*, the *Ast. hystrix* of M. De France (*op. cit.* p. 386). M. Milne-Edwards, however, alludes in his edition of Lamarck's 'Animaux sans Vertèbres' to the genus having been admitted into the 'Manuel d'Actinologie,' and he gives M. de Blainville's characters for it, but without offering an opinion respecting the propriety of its being adopted (*op. cit.* t. ii. p. 437, notes, 1836).

Confining the attention to the characters of the fossil species, or *Styl. monticularia*, Schweigger's type, and considering the Bracklesham coral, which agrees very nearly with that author's unmagnified figures, as well as M. Michelin's delineations of *Ast. hystrix* (*loc. cit.*), as specifically identical, it is necessary, in the first place, to inquire, whether we are justified in adopting the genus.

In the notice on *Siderastræa Websteri*, Ehrenberg's definition of *Astræa* is considered to be the best hitherto proposed, being founded primarily on the subdivisional mode of developing additional stars. Another important character not alluded to in that instance, a reference to it being unnecessary as respected the fossil then under consideration, is, that the number of lamellæ in those

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* Man. d'Actinol. p. 385. In the article on the genus, *Styl. pistillaris* has been accidentally given for *Styl. monticularia*, though in the subsequent remarks, M. de Blainville, as stated above, confines the genus to the fossil species. Schweigger's fig. 62 is also associated with *Styl. pistillaris*, though in the original work it is stated to represent *Styl. monticularia*, from Grignon.

Astrææ always exceed twelve. By reference to the specific characters of *Styl. monticularia*, the true lamellæ, or those within the star, will be found not to exceed twelve, and the additional polype-cavities to have resulted from interpolations. The data for these characters are given in a subsequent paragraph. It is clear, therefore, that so far as this inquiry is concerned, and Ehrenberg's classification is considered to be the best, the Grignon and Bracklesham fossil cannot be regarded as an *Astræa*, though De France and other authorities might have been justified, according to the systems adopted or proposed by them, in considering it as truly belonging to that genus.

On extending the investigation to those corals which have only twelve lamellæ, and constitute Ehrenberg's families *Madreporina* and *Milleporina*, not one of the genera or subgenera will be found to possess the peculiarities of the fossil under examination, and consequently it is inferred, that Schweigger's genus may be rightly adopted.

The true position of *Stylophora* in a general classification is plainly in the family *Madreporina*, and near the *Heteropora* of Ehrenberg (*Madrepora*, auct.). To this conclusion Schweigger came (see description of figure 62, *op. cit.*), rightly comprehending the agreement between some, at least, of the peculiarities of his Grignon fossil, and the structures of ordinary *Madreporæ*. De Blainville also placed the genus among 'les Madrepores' (Man. d'Actinol. pp. 382, 385)*.

With respect to the specific designation, Schweigger's is adopted, having prior claim (1819) to that employed by De France (1826). Of other allied corals, as the *Ast. decorata* of M. Michelin (Iconog. p. 161. pl. 44. fig. 8), no observations are required, nor could any be rightly offered without the aid of specimens. For the same reason, reference only can be made to the fossil described by Prof. Goldfuss under the appellation of *Ast. Stylophora*, but identified by M. Michelin with *Ast. emarciata* (Petrefacten, p. 71. pl. 24. fig. 4; Iconographie, p. 158, where it is stated that the coral has no doubt been assigned by mistake to the chalk of Meudon).

The series of Bracklesham specimens submitted to inspection were brittle and much beset with the sandy matrix, which could not safely be removed. The following remarks, therefore, must be regarded as defective, having been de-

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* Ehrenberg in the Index to his 'Beiträge' gives *Stylophora*, referring the reader to his subgenus *Porites*; but as he notices only the recent species under the designation of *M. Porites pistillata* (*op. cit.* p. 115), it was deemed unnecessary to allude to the determination except in a note, the extinct and existing polypidoms being generically distinct.

duced from the characters of limited portions, and not from an investigation of the whole surfaces.

The finest specimen is represented in Tab. I. fig. 6, of the natural size. It was partially compressed, but had evidently been produced around a perishable cylindrical body. Schweigger's figures exhibit a similar contour, with a central cavity, and he notices likewise the indications of an encrusting growth; M. De France also alludes to the latter characters, but he states that the fossil assumes various forms (Dict. Sc. Nat. t. xlii. p. 385), a necessary consequent in a parasitic zoophyte. The thickness of the coral layer at the lower extremity of the specimen did not exceed $1\frac{1}{2}$ line, and at the upper it was barely 1 line; another specimen in Mr. Edwards's cabinet, 1 inch 2 lines in length and 5 lines in diameter, had a layer nearly 2 lines thick; and Schweigger's specimens had also a thin polype-crust.

The stars in the Bracklesham specimens rarely if ever exceeded a line in the greatest width, and they were often much less; their form also was seldom regular, having evidently been subjected to considerable interference during growth; and the general surface exhibited, as a result apparently of such intervention, a confused aggregate of small polygonal cavities, surmounted by conical projections. The more regular, mature stars had nearly straight sides, as correctly given in M. Michelin's magnified figure (Iconog. pl. 45. fig. 1 *b*), and not a rounded outline as exhibited by Schweigger (Beob. taf. 6. fig. 62 *d*); nevertheless, instances occurred in which the sides were curved and the angles ill-defined. The lamellæ, which issued directly from the inner surface of the walls, were so often broken, that it was difficult to ascertain their full number; but they never exceeded twelve, and not a trace was detected of intermediate, rudimentary plates. M. De France, in his account of *Ast. hystrix*, gives the number as 6–8 (Dict. Sc. Nat. t. xlii. p. 385), and M. Michelin as 6–12 (Iconog. p. 160). The perfect lamellæ at the junction with the walls were relatively thick, the interspaces being arched, but they became thinner as they ranged towards the centre, and were occasionally waved. In the lower part they were united to the axis, though free in the upper. This character was clearly shown in a fracture transverse to the cylinder, or through the polype-layer. The horizontal diaphragms between the lamellæ were relatively thick, but irregular in position and number, so far as their nature could be ascertained; and they probably had extended half-way up the stellular cavity. The axis was rarely visible, and even when exposed in a perfect state it did not verify Schweigger's fig. 62 *d*, nor support his generic character, '*Cellulæ centro in stylum elongato*' (*op. cit.* Syst. Tables, sheet 5), or generic name. It is carefully given by M. Michelin (Iconog. pl. 45. fig. 1 *b*). At the upper end it was very small, gradually increasing in its downward course, and it presented, when fully exposed in a vertically fractured star, an elongated cone surrounded, towards the base, by the edges of broken lamellæ. The internal composition was not clearly ascertained, but it was probably solid. The immediate lining to the polype-cavities was a thin lamina, with an uneven surface, and microscopically punctured. The interspaces between the stars had generally little width, and were occupied by vertical and transverse plates, more or less perforated by large foramina, and variously united, forming the substructure of the projecting mounds.

These surmounting cones were occasionally well-preserved, but were more frequently fractured or entirely removed, and sometimes not wholly developed, especially on the sides of the stars. In the perfect, completely produced state, they were united at the base, constituting an expanded, many-plated, superior cup. Respecting their origin, the fine specimen represented in Tab. I. fig. 6. proved, at its upper extremity where the stars themselves had scarcely any depth, that the cones had been boldly produced, and had taken precedence in structural importance of the stellular cavities. The specimen did not afford evidence of the mode of earliest development either of these conical interspacetial bodies or of the stars; but it was inferred, that the process was probably similar to the one mentioned in the account of the immature margins of *Siderastræa Websteri*, namely by a lateral extension of the general animal substance. The cones which surmounted the deeper, older stars were upward extensions of those first formed; and the reticulated structures between the stars, modifications of the latter produced by additions to the edges of the component laminæ. The mounds varied in form and dimensions according to the nature of the subjacent areas, being generally circular at the angles and elongated on the sides of the stars. The lamellæ-plates of which they were chiefly composed, decreased in breadth, but not in thickness, as they ranged towards the apex. Their characters were most fully shown in a specimen belonging to Mr. Edwards's cabinet, represented by fig. 6 *a*, and magnified by fig. 6 *b*. Tab. I. They were generally straight and single, but sometimes spirally twisted; occasionally also a short oblique plate united near the base to another which was longer, or two of nearly equal height converged and met; in some instances likewise a bifurcation occurred, a short lamina springing from the side of one of full dimensions. At the junction of two cones an intermingling was noticed in a few cases. The outer edge was often rounded or smooth near the apex, but where perfect, it was studded with minute tubercles ; the sides also were occasionally coated with similar points, the rudiments of the transverse layers or bars in the substructure. So far as could be ascertained, no direct connexion existed between these plates and the lamellæ within the stars, though in a few cases there was an apparent union. In composition the dissimilarity was very great, and in the number of each an important discrepancy. Thus, the plates were very numerous, and they had great relative and persistent thickness, as well as apparent strength ; while the lamellæ, limited to twelve, were of unequal substance, and for the greater part thin and fragile. The centre of the mounds consisted of a reticulated and foraminated nucleus, though the apex, probably from friction, generally indicated a nearly solid axis.

With respect to the mode of producing additional stars within the surface-area of a specimen, fig. 6 *c.* gives an illustrative example of one of the earlier stages. A small hollow is shown, raised above the surrounding level, and formed by the union, nearly to the summit, of mounds belonging to four stellular cavities. On the outer side of the hollow the conical plates were boldly exhibited, but on the inner they were nearly wanting ; or, as it was inferred, were concealed by the lining of the polype-receptacle having been commenced. No structure, except a few thin rudiments or broken edges of laminæ, occupying, however, the situation of true lamellæ, was detected within the area. That the hollow exhibited an early state of a star, no doubt could be entertained ; nor that it was an interpolation, its position being above the general level, and its periphery being defined by the union of mounds belonging to four adjacent mature stars. The large specimen represented by fig. 6. exhibited other instances of small-starred cavities above the ordinary surface lined with true lamellæ, and sometimes so associated with others of maturer growth as to indicate that the whole group had been produced in a similar manner ; but the mounds and other associated structures were not so fully preserved as in the specimen just noticed.

Stylophora emarciata. (Tab. IX. fig. 25.)

Incrusting, polymorphous ; stars polygonal, sides generally unequal ; true lamellæ not exceeding twelve, breadth variable, broadest, usually eight in number, united to the axis, sides beset with minute points ; intermediate transverse laminæ few ; axis small ; lateral walls of adjacent stars for the greater part in close contact; the angles frequently occupied by laminated cones, laminæ extending downwards within the terminal cup and often obliquely; terminal cup deep, lined by the true lamellæ, upper margin slightly thickened; additional stars interpolated.

Astræa emarciata, Lamarck, Anim. s. Vert. ed. 1. t. ii. p. 266, 1816; ed. 2. p. 417. no. 29, 1836. De France, Dict. des Sc. Nat. t. xlii. p. 386, 1826. Michelin, Iconographie Zoophytologique, p. 158. pl. 44. fig. 6, 1845?

Ast. (*Cellastræa*) *emarciata*, De Blainville, Man. d'Actinol. p. 377, 1830–1834.

The *Astræa Stylophora* of Goldfuss (Petrefacta, p. 71. t. 24. fig. 4, 1826–1833) is identified by two of the above authorities with *Ast. emarciata*, but in the 'Petrefacta,' neither Lamarck nor De France is referred to; and the coral figured in that work apparently possesses even something more than a specific difference, eight rudimentary lamellæ alternating regularly with eight very broad; moreover not a vestige of a cone is given, or, supposing those projections to have been removed by abrasion, of any plates on the sides of the terminal cups, which could be considered as downward extensions of the laminæ of destroyed cones. In the text (p. 71) Meudon is given as the locality, but a competent authority doubts the accuracy of the assignment (Icon. Zoophyt. p. 158). In the absence, therefore, of full information, it has been deemed right not to include *Ast. Stylophora* as a positive synonym. The reference in the 2nd edition of Lamarck (*loc. cit.*) to a Russian fossil described by M. Fischer de Waldheim in his 'Oryctographie de Moscou' (p. 154), originated evidently in that author quoting the 1st edition of Lamarck; but there is no agreement between the Russian and French or English fossils, either zoologically or as respects geological position. (See vol. i. App. A. p. 603 of Sir Roderick Murchison, M. de Verneuil and Count Keyserling's work on Russia, 1845.)

Since the notice on *Styl. monticularia* was written, M. Michelin has most liberally presented the compiler of these memoranda with a series of tertiary corals, carefully labelled; and he has thus been enabled to compare an authentic French specimen of *Ast.* (*Styl.*) *emarciata* with the one from Bracklesham Bay (obligingly lent by Mr. Edwards), and without detecting any marked differences. In all the leading essential structures, this fossil agrees perfectly with *Styl. monticularia*; and it is hoped the remarks on the generic characters of that species, with their applicability to the coral under consideration, will be deemed sufficient to warrant the removal from *Astræa* to *Stylophora**.

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* Mr. Dana, in his recent great work on Zoophytes (p. 515), includes *Stylophora* of Schweigger

The form, size and general characters of the Bracklesham specimen are given in Tab. IX. fig. 25. It consisted apparently of half a small irregular, ovoid mass. On the fractured or opposite side, closely aggregated columns radiated from a semicylindrical groove or intersected tube, not quite a line in diameter, and traversed the specimen completely in a curved direction. Part of another cylindrical cavity, but with a transverse range, was also noticed. The wall of the groove was a thin, nearly smooth layer, which totally concealed the lower terminations of the polype-columns. A French specimen exhibited similar, irregular or branched cavities with one enlarged end; the whole being lined, so far as could be ascertained, with a detachable, very calcareous layer, about one-fourth of a line thick, and composed of irregular cells with circular openings. (Cortical portion of a *Plexaura*?)

The columns, as exhibited in the fractured surface, diverged from the groove in all directions, but not to a uniform extent, the thickness in one part being half an inch, while in the opposite portion it did not exceed a quarter. The columns were so intersected that it was difficult to trace their outline or range satisfactorily, but they appeared, where the thickness was greatest, to extend continuously from the groove to the outer surface; and the walls were throughout in close contact, except at the angles, where the downward course of the conical projections was visible. In some conditions of growth more or less of interspace, however, probably existed between the sides of the stars*. (Consult M. Michelin's figure 6 *a*, pl. 44, *op. cit.*)

The number of sides in stars of greatest area was generally six, but sometimes seven, and in those of less dimensions it varied from three to six. The diameter of the largest star was about 1 line.

The true, broad lamellæ were chiefly limited to eight, but nine and ten were noticed at the bottom of one or two terminal cups: very narrow or unequal

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in *Sideropora* of De Blainville, and *Styl. pistillaris*, Schw., is considered as probably a variety of *Sideropora elongata*, De Bl. (p. 517). No allusion to the fossil species of Schweigger (*Styl. monticularia*) has been observed in Mr. Dana's important work; and it is believed that the tertiary fossils referred to *Stylophora* possess many essential differences from the recent corals which form the genus *Sideropora*. Should palæontologists think otherwise, it should still be remembered that Schweigger's name (Beobachtungen, &c. 1819) has a prior claim to that of M. de Blainville (Man. d'Actinol. 1830 –1834).

* M. Lamarck considered this fossil to have contiguous stars, but M. De France regarded the stars as separated, on account of the lamellæ in those immediately adjacent not blending (Dict. Sc. Nat. t. xlii. p. 386).

plates also occasionally issued from the walls, and were quite distinct from those belonging to the downward range of the cones. The fully-produced lamellæ were very thin, even at their junction with the wall; and they were often bent in their range towards the centre. On the sides of the terminal cup they were generally narrow, and in the best-preserved instances jagged on the edge; but near the base they expanded with a concave outline, and after uniting with the axis they ranged upwards and formed the projection occasionally visible on the side of that structure.

The interior of the terminal cup did not present any indication of an inner distinct lining, but a few bladder-like plates were observed in one of M. Michelin's French specimens. The walls as well as the sides of the lamellæ were studded with minute points.

The axis was very small, and often, when broken, only a simple union of lamellæ was exhibited without any marked central thickening. In the more nearly perfect state, it formed a compressed, apparently solid style, traversed by narrow plates or projecting points, the rudiments of future extensions of lamellæ.

The conical mounds did not form a marked feature, being almost inconspicuous to the unassisted eye; but in the specimens examined by M. De France, they had "quelquefois 4—5 lignes (French) de longueur." (*op. cit.* p. 386.) The greatest observed downward range of a cone, within the body of the Bracklesham coral, was about 3 lines, and the greatest extension above the least abraded surface was 1 line. The mounds were generally situated at the angles, but in many cases they appeared to have sprung from a side or even from another angle, as they often crossed obliquely the intervening wall (fig. 25 *a*); and the projecting portion had also sometimes a slight inclination. In a very few cases, a more or less perfect cone was situated at each angle; but the majority of the stars had two, frequently difficult to detect, and some only one. The exact number of lamellæ-plates or ridges could rarely be determined; in some instances, however, it exceeded seven. The thickness of the plates far surpassed that of the true lamellæ, and the edges were rounded and smooth, or papillated. In their downward course within the terminal cup, these ridges could readily be distinguished by the characters just noticed, as well as by their occasional oblique direction; and when they had this range, the true lamellæ were farther easily discerned by their thin laminæ crossing vertically the diagonal ridges: in a few cases, where the position of the two structures coincided, the lamellæ formed a fine edge on the broad margin of the plate belonging to the cone. The mounds which traversed a side obliquely were equally displayed in both the adjacent stars; and without any visible coating, due to an independent lining in the polype-cavity. They were wholly situated towards the most developed side of the specimen, and were all inclined in that direction, as if they had been affected by the cause which favoured the locally-prolonged growth of the columns. A somewhat similar parallelism of inclination was noticed in the French specimens (consult M. Michelin's fig. 3 *b*. pl. 44. *op. cit.*). The only visible, perfect, lower termination within the body of the coral tapered gradually to a fine point, some of the ridges thinning off, and others extending to the extreme end. The apex or free portion was broken, but the preserved portion was about 3 lines in length; and the inferior termination was nearly 2 lines from the longitudinal furrow or base of the adjacent columns. So far as the interior of the mounds could be ascertained, it consisted apparently of a union of the ridges with an intermediate filling up.

No changes occurred in the lower part of the columns from additional animal secretions, the minute hispid points on the walls and the lamellæ being perfectly sharp; nor were any changes, dependent upon age, noticed in the upper part of the specimen.

Not a trace of a subdivisional process was noticed, nor of a germ developed within the area of a mature column; all the small or young stars appearing at the junction of three or more which were fully grown. They were not surrounded by mounds, nor raised above the general surface of the coral, but no doubt could be entertained of their interpolated position. In M. Michelin's Paris basin specimens, young stars similarly situated were very numerous, and they exhibited most beautifully the delicate lamellæ equally produced on every side of the individual star.

Family CELLEPORINA.

Cellepora? petiolus, sp. n. (Tab. I. fig. 10.)

Disc-shaped, attached by a very short, cylindrical, hollow pedicle, situated on edge of disc; cells in opposite layers, no dorsal, intermediate lamina; rows in each layer radiating from centre, irregularly alternate; form of cells globular, boundary a deep groove; mouth large, round or oval; margin sharp or thickened; gemmuliferous? vesicles numerous, covering proximal portion of cell, large, semiglobular, affecting more or less size of cellular mouth; opening into vesicle within the cell, deeply seated; lower parietal lamina thin, slightly concave, nearly on level with mouth of cell; surface sometimes provided with a minute tubercle near distal edge.

The marked peculiarity of this coral is the hollow cylindrical pedicle, which was detected in every case of a perfect edge (fig. 10 *b*). About twenty-five specimens belonging to Mr. Dixon and Mr. Edwards's cabinets were examined. The diameter of the largest was 3 lines, and of the smallest 1 line. The shape was generally circular, and the surface flat, but sometimes slightly contorted. The pedicle was easily detected on the edge of the disc by its distinct circular wall, and deep, regular hollow, also by its occupying the whole thickness of the coral; and it was readily recognized at the margin of the disc as well as for a more or less limited range towards the centre by its relatively coarse, reticulated structure (fig. 10 *a*). It was probably the first-formed portion of the polypidom, and progressively extended as the disc expanded. In the specimen only 1 line in diameter, it was as distinct as in that which had three times the linear dimensions; and in some instances an irregularity or a fine furrow could be traced from the exposed portion of the pedicle nearly to the centre of the specimen, while in others the footstalk was clearly overlaid in part by cells near the margin of the coral.

No clear case was detected of more than two opposite rows, and the position of the cells conformed to the outline of those next adjacent, whether in the same layer or in the opposite, having no interspaces. So far as observation extended, the walls of contiguous cells were not separable. The mouths near the circumference of the disc had sharp, fine margins, but in the central area of some specimens they were often thickened, and occasionally the apertures were closed, the general surface presenting an irregular, confused structure. From this circumstance the layers probably never exceeded two*.

The supposed gemmuliferous vesicles or chambers gave the cells to which they appertained a semiglobular projecting surface (fig. 10 *a*, near ×). In their

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* In some respects the Bracklesham coral resembles the *Orbitolites macropora* of Lamarck, as figured by Goldfuss (Petref. pl. 12. fig. 8), and stated by De France to occur at Maestricht, but by Goldfuss in the sandy beds of the calcaire grossier near Grignon. The fossil under consideration is most manifestly not an *Orbitolites*, nor is there any sufficient structural agreement to warrant the supposition that the two fossils are generically identical, whatever may be the true nature of the coral figured in the 'Petrefacten.'

(The generic assignment of the Bracklesham coral must also be considered provisional.—Note, 1848.)

proximal position they accorded perfectly with those which belong to well-known *Celleporæ*. The opening of the vesicle was easily detected by looking obliquely into the mouth of the cell.

Family TUBULIPORINA.

Idmonea coronopus? (De France). (Tab. IX. fig. 24.)

Bifurcated; branches diverged excentrically, more or less rounded on the back; transverse rows of tubular openings blended along the medial line, forming a crest; crest less in height than the depth of reverse portion of the branch.

De France, Dict. des Sc. Nat. t. xxii. p. 565. De Blainville, Man. d'Actinol. p. 420 (1830–34). Milne-Edwards, ed. 2. Lamk. Anim. sans Vert. t. ii. p. 281, Notes (1836); also, Recherches sur les Polypes, Mém. sur les Crisies, &c. p. 23· pl. 12. f. 3 (1838); or Annales des Sc. Nat. 2nd Series, Zoologie, t. ix. pl. 12. f. 3. Michelin, Icon. Zooph. p. 172. pl. 46. f. 16 (1845?).

The characters of this coral were so imperfectly ascertained, even with respect to the specimen examined, that the above notice and following remarks must be considered as indicative of only a small portion of the actual structures. In the attempt to identify it with published tertiary species of equivalent geological position, great difficulty was also experienced in the endeavour to ascertain the exact or full characters of either *Idm. coronopus* or *Idm. gradata*, the two Paris basin species originally described by M. De France (*opus cit.*). With regard to the first, the statement, "cellules rhomboïdales et disposées en rangées opposées sur une des surfaces du Polypier, ou la réunion de ces rangées forme une sorte de crête," might be readily assumed as expressing the structure of the Bracklesham coral; but M. De France did not accompany his description with figures, nor were any afterwards added by M. de Blainville in his 'Manuel d'Actinologie.' Dr. Milne-Edwards, it is believed, was the first author by whom the species was illustrated; but his delineations of it cannot easily be made to accord with the original notice just quoted. By reference to the 'Annales des Sciences Naturelles,' or 'Recherches sur les Polypes,' it will be found that the transverse rows of tubuli instead of *uniting* and forming "une sorte de crête," are widely separated along the medial line: nor is M. Edwards successful in reconciling the difference. The branches are farther shown to be triangular, and the rows of tubuli to extend backwards nearly to the dorsal surface. These representations agree perfectly with his description; but a simple comparison of either with the

English fossil would forbid all thought of identifying the two corals with each other. Referring in the next place to M. Michelin's figure of the same species (*Idm. coronopus,* Icon. Zooph. pl. 46. f. 16), the dorsal surface will be found to be round as well as the oral, giving to the lower portion of the specimen in part not a triangular, but an oval outline; the innermost tubes of the transverse rows are also so disposed as to constitute a medial or longitudinal series of apertures, and might be considered as "une sorte de crête." In the mode of branching, the specimens delineated by Dr. M.-Edwards (*loc. cit.* f. 3. nat. size) and M. Michelin (*loc. cit.* f. 16) agree almost perfectly, the offshoots springing uniformly from one and the same side; and they differ therefore, to the extent exhibited, markedly from the English fossil, in which the amount of divergence to the right and left is equal at each bifurcation, and in accordance with M. Edwards's magnified figure 3 *a.* An examination, however, of tolerably large specimens of the nearly allied genus, *Hornera,* will prove that in corals of this family the mode of branching cannot be adopted as a specific distinction (consult 'Mém. sur les Crisies,' &c. pl. 9. f. 1). It must farther be stated that Dr. Milne-Edwards, in his description of *Idm. coronopus,* assigns to it the Grignon fossil, regarded by M. De France as a variety of the *Idm. triquetra* of Lamouroux (Expos. Méthodique, p. 80. pl. 79. f. 13–15), an oolitic species. If the figures of the tertiary coral given in the Atlas to the 'Dictionnaire des Sciences Naturelles' (Polyp. pl. 46. f. 2), or in the 'Manuel d'Actinologie' (pl. 68. f. 2), be consulted, additional varieties of structure will be found, as well as of growth.

Respecting *Idm. gradata,* the other Paris basin species, it is perhaps sufficient to state that Dr. Milne-Edwards was inclined (1838) to consider it also as only a variety of *Idm. coronopus,* but without having examined specimens, and that it has not yet been noticed by M. Michelin.

The foregoing allusions to differences in published figures have not been made to raise a doubt respecting the correctness of the determinations; on the contrary, it is believed that the fossils thus represented may all be referred to one species, exhibiting merely different conditions of growth or of outline, due to progressive thickening of the branches; and the want of perfect accordance has been noticed chiefly to justify the doubtful assignment to the same species of the Bracklesham coral.

Fig. 24. Tab. IX. displays fully the general mode of growth of the English specimen, and the divergence from a centre was even more marked before a branch was detached from one of the intervals to obtain a cellular surface. The spe-

cimen, moreover, proved that *Idmonea* agrees with *Hornera*, occasionally at least, in having the tubular openings on the inner side of the branch, a character, it is believed, not previously exhibited (for other agreements consult Dr. M.-Edwards's Memoir on *Hornera*, &c., *op. cit.*). Though the distance between the bifurcations varied from a line to less than half a one, yet the length of the pairs of shoots, as respects the points of re-bifurcation, was curiously symmetrical, only one marked want of coincidence appearing. This character nevertheless should be regarded possibly as of only local interest. The breadth of the shoots immediately after subdivision differed sometimes very slightly from that of the preceding entire branch; in general, however, a slight increase of width occurred towards the points of divergence, and then a small difference was visible. The imperfect state of the oral surface frustrated any attempt to ascertain the characters attendant on the bifurcations; but the tubuli comprising the interior and back of the coral regularly inclined outwards, though a few of those along the line of separation appeared in one instance not to have been prolonged into the offsets; an operation, however, insufficient of itself to account for the branching *.

The rounding of the dorsal side prevailed throughout the specimen, but the degree of curvature varied slightly. This surface was very generally preserved, and displayed relatively broad, opake white, longitudinal bands, microscopically punctured, forming the exterior of the outer layer of tubuli; also fine, sometimes slightly projecting, less opake laminæ, which ranged inwards, occupying the intervals between the tubes. No trace of a distinct uniform or solid outer layer was noticed. In transverse sections the whole of the interior was penetrated by vertical, cylindrical tubuli with exceedingly thin walls, the outer series, where preserved, being somewhat regularly disposed, but the remainder were confusedly associated.

The characters of the oral surface may be better gleaned from fig. 24 *a* than a description. The existence of a decided crest not quite equal in breadth at the base to the diameter of the branch was clear; transverse rows of tubuli could also be detected, though only in their abraded remains; and one perfect mouth was also noticed situated at the outer or dorsal extremity of a row. It was large, circular, and slightly raised.

Bath, 1846.

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* The reader is referred to Mr. Dana's large work on Zoophytes for valuable observations on the bifurcation of corals (1846).

Porites? panicea. (Tab. I. fig. 7.)

Expanded in vertical or contorted layers, also variously lobed; stars, small, developed from central lines or axes, no definite walls, irregularly disposed on opposite surfaces or around the lobes; lamellæ 12, unequal in breadth, thick near the periphery of the star, thin in range towards the centre, composed of continuous plates, with hispid sides; centre union of lamellæ no distinct axis; interstitial structure plates and elongated tubercles or filaments variously united and reticulated, also intersected, parallel to the surface, by limited laminæ or layers; surface sometimes partially occupied by a similar lamina studded with small points; terminal cup shallow with or without a raised margin, edges of lamellæ when perfect jagged, sometimes a minute central boss; additional stars developed in substance of polype-mass.

Heliopora panicea, De Blainville?, Manuel d'Actinol. p. 393 (*Heliolithe irrégulière*, Guettard, Mém. t. iii. p. 502. pl. 47. f. 5, 6. Calc. tertiaire, Valmondois), 1830–34.

Astræa panicea, Michelin, Iconog. Zoophytologiq. p. 160. pl. 44. f. 11 (Paris Basin Series, Auvert), 1844–45.

Two specimens of a Bracklesham coral, believed to be specifically identical with the *Ast. panicea* of M. Michelin, were examined. The larger was part of a thin vertical layer $2\frac{3}{4}$ inches in breadth, $1\frac{3}{4}$ in height, and about 4 lines in thickness, where most uniform; on one side it was nearly flat, but on the other the surface was irregular and lobed, or gave off ramose projections, often displaced. The second specimen consisted also in part of a vertical layer of less area, but thicker and uneven on both sides, one being connected with numerous branches confusedly intermixed.

M. de Blainville does not describe the coral to which he gave the name of *Hel. panicea*, merely referring to Guettard's figures and notices; and it would be difficult from these alone to determine whether that coral is identical with the one delineated and described by M. Michelin; but as the latter authority entertains no doubt, and the Bracklesham specimens agree very nearly with the figures and account in the 'Iconographie,' it is necessary to explain first, why M. de Blainville's genus is not retained; and secondly, why M. Michelin's also is not adopted.

The English fossil differed from *Heliopora cærulea*, the recent type, in the lamellæ being limited strictly to twelve; in being fully produced, extending to the centre of the star; in the shallowness of the star or indistinct range of the cavity destined to receive the more important organs of the polype; in the interspaces between the stars being reticulated and not tubular; and in the laminæ parallel to the surface, whereby a side fracture exhibited irregular lines indicative of renewed growths.

From the *Astrææ* of Ehrenberg the fossil was distinguished by the limited number of lamellæ, by the stars not being necessarily in contact, and by the mode of developing additional stars; differences of great importance, though few in number.

The reasons for considering the Bracklesham coral a Porites, rested on the lamellæ being limited to twelve and forming complete stars; also on the general internal composition; and on the manner in which additional stellular cavities were developed within the area of the specimens. The lamellæ consisting of slightly foraminated plates, and not of filaments, presented a distinction from the characters usually assigned to the genus; but a specimen of *Porites clavaria* gave somewhat analogous lamellæ, or irregular plates largely foraminated, hispid on the sides and jagged on the upper edges, where the progress of development had been suddenly interrupted. This plate-like feature is well given by Solander and Ellis or Lamouroux (Exp. Méthodique, pl. 47. fig. 2). Ehrenberg has proposed a subgenus, *Phyllopora*, for corals allied to *Porites*, but '*lamellis integris*'; the want however of figures or specimens forbids a perfect understanding of its structures*. Though the Bracklesham fossil therefore did not afford that amount of conformity which would justify its being decidedly considered a Porites, yet its general composition appeared to warrant its being provisionally assigned to the genus.

As respects the identification with M. Michelin's description and figures, portions of the English coral might be selected which would differ considerably from the delineations in the 'Iconographie Zoophytologique,' while other parts would afford a great agreement; the lamellæ also, though generally unequal,

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* Ehrenberg includes in his family *Madreporina* two genera containing recent species, *Heteropora*, equivalent to *Madrepora* of all other authorities, and *Madrepora*, the latter consisting of two subgenera, *Phyllopora* and *Porites*. This nomenclature appears to be objectionable, *Heteropora* consisting essentially of Lamarck's restricted *Madrepora*, and including nearly all his species, some undescribed corals being also added. De Blainville's *Heteropora* was probably proposed about the same time as Ehrenberg's, but for polypidoms belonging to a very different group; and it has been adopted by subsequent authorities. To use Ehrenberg's application of the word would lead, even if a new generic name were required, to great confusion.

were apparently less so than in the French specimens; it must also be stated that M. Michelin does not allude to the diverging mode of growth, or to studded laminæ. The lobated or ramose processes could not alone be assumed as a specific distinction, analogous offsets sometimes occurring, sometimes not, in other corals, as *Heliopora cærulea*; and it must be remembered that *Ast.* or *Porites panicea* was a polymorphous polypidom. (Iconog. Zoophytol. p. 160, Observ.)

The stars irregularly distributed on the tabular surfaces (fig. 7) had a prevailing diameter of about half a line, but they varied considerably in characters. Frequently all signs of a definite boundary were wanting, the edges of the lamellæ blending with plates of the reticulated structure, and not being connected by curved laminæ as in persistent walls. These apparently growing stars were either on a level with the surrounding surface, or slightly raised above it (fig. 7 *a*). In other instances the stellular cavities had a bold yet unequal boundary, and the lamellæ were united by arches; while the terminal cup varied in depth, though its contents were not observed to rise above the margin. Surfaces, believed to exhibit different stages of development in the intermediate structure, consisted of thick points variable in shape and size, and occasionally blended into irregular vermiform plates of limited range. The intervals between the points or plates were very narrow, and generally occupied by matrix or iron pyrites. They had little extent, but within their limits they composed apparently solid layers, which conformed to the variable level of the specimen, and concealed all subjacent structures. The small points were sometimes lineally arranged, but more often irregularly disposed. In side fractures or sections, these laminæ were more or less exposed, ranging for short distances, and without any definite position; but in one instance four successive layers were exhibited about a quarter of a line from each other (fig. 7 *a*), and the points were lengthened into filaments which extended from one lamina to the next. The tabular surfaces presented also occasionally a perfect blending of structures, by which the stars were so commingled with the interspaces as to be imperfectly distinguished, and sometimes there was a general thickening of the exterior, due probably to abrasion.

The best vertical section (fig. 7 *b*) exhibited fully the diverging mode of growth; but the central line had apparently been occupied, to a considerable extent, by an extraneous body, and another similar cylindrical cavity existed elsewhere. The component structure was very confused, consisting chiefly of irregular, short, curved, outwardly inclined plates, largely foraminated or connected by transverse processes, and of filaments varying in thickness, the whole being unequally traversed by the laminæ parallel to the surface. The traces of stellular cavities were few and indistinct and of limited range, consisting principally of plates with hispid sides. No clear proofs were obtained of stars intersected by studded laminæ, or of the latter penetrating within the terminal cup, though they sometimes coated the margin.

The ramose or lobated processes (fig. 7) were occasionally dislocated, but they were frequently in connexion with the tabular masses, swelling out in some cases near the lines of junction; and their structural agreement proved that the whole had resulted from one polypiferous body. So far as could be ascertained, the branches projected nearly at right angles to the surface which gave them off, and in two or three instances to the extent of 6 or 8 lines; but they often inosculated or diverged in various directions. If the specimen were so placed that the tabular portion would represent an upper expanded surface, then the lobes would bear somewhat the character of stems or supports; but the diverging mode of growth, already mentioned in noticing the side section, led to the inference that the processes were truly lateral shoots. The surfaces were occupied to a much greater extent than in the tabular planes by interstitial structure, and frequently to the total exclusion of stellular cups, as if the lobe had been developed by animal matter in which no polype-mouths or digestive cavities had been produced. One branch exhibited numerous stars, which agreed perfectly with those on the expanded surfaces. Internally the lobes were composed of reticulated irregular plates similar to those already noticed in the side section; but no studded laminæ or filaments were observed.

Respecting the origin of additional stars in the general surface, small circular areas were detected, fringed by projecting points or traversed by irregular lamellæ, and they bore the aspect of having been developed in the intermediate animal substance, and in no respect of having sprung from the adjacent mature stars.

Class BRYOZOA, *Ehrb.*

Family Asterodiscina.

Lunulites urceolata ?, Lamx. (Tab. I. fig. 8.)

Obtusely conical; cells in parallel rows easily separated; form irregularly hexagonal or imperfectly oval; surface open; margin sharp; interior rounded, punctured by a few minute foramina; distal extremity slightly overlying; walls between the rows smooth; thickness of coral slightly exceeding depth of cell; intermediate chambers lozenge-shaped; size variable, not dependent on position; concave surface ribbed, largely foraminated.

Lamk. Animx. sans Vertb. t. ii. p. 195. ed. 1816; t. ii. p. 300. ed. 1836. Lamx. Exp. Méthod. p. 44. tab. 73. fig. 9–11. Goldf. Petref. p. 41. tab. 12. fig. 7. Michelin, Iconog. Zoophytog. p. 175. pl. 46. fig. 6.

A specimen obligingly lent the describer by Mr. Edwards supplied the above characters, but as it was imbedded with the cellular surface downwards, and they were chiefly supplied by a fragment accidentally detached from the edge, they are necessarily very imperfect, and most probably refer to only one condition of growth. To the extent that a comparison could be attempted, the nearest resemblance appeared to be with *Lun. urceolata*, particularly as delineated by Prof. Goldfuss (Petref. tab. 12. fig. 7), whose figure represents a less deeply cupped or thimble-shaped outline than is usually assigned to the species, and therefore approached the form which the Bracklesham coral evidently possessed in a perfect or uncompressed state. The shape of the intermediate chambers agreed also with that given by Goldfuss (*loc. cit.*) and M. Michelin (Iconog. Zoophytol. pl. 46. fig. 6 *b*); and it is probable that Lamouroux's character, "pores en losange, très-grand, disposés en quinconce" (Exp. Méthodiq. p. 44), was derived from an approximation to an hexagonal form in the cells, and from the intermediate chambers being considered also as cells. It would however be manifestly incorrect, from such imperfect data as the fragment afforded, to assign the specimen to the Paris basin species otherwise than doubtfully. The coral is figured in Pl. I. figs. 8, 8 *a*, 8 *b*, that the reader may draw his own conclusions.

Two other Lunulites accompanied the above-noticed specimen, but they were also both imbedded with the cellular surface downwards, and their fragile nature did not permit the matrix to be even partially removed. The ribs on the concave surface were smoother than in the preceding case, and the foramina were much smaller, resembling those in Prof. Goldfuss's figure of *Lun. radiata* (Petref. pl. 12. fig. 6). The larger specimen is represented in Tab. I. fig. 8*, 8 *a**, 8 *b** of this work; the smaller had about half the linear dimensions, or a diameter of 2 lines.

Family Escharina.

Eschara Brongniarti?, Milne-Edwards. (Tab. I. fig. 9, 9*.)

Foliaceous; cells symmetrically placed in the opposite layers, not overlaid at either extremity, pear-shaped, bounded by a row of foramina; surface-area small, nearly solid; mouth in same plane with surface, large, semi-oval, curved margin slightly raised, straight or proximal margin flat, slightly inclined inwards; one or two foraminated vesicles at proximal angles of mouth; interior of cells nearly similar in shape to exterior; lateral connecting foramina numerous, near base of wall, terminal two; dorsal surface of opposite layers not separable, extremely thin; walls of adjacent cells separable, glossy but uneven.

Eschara Brongniarti, Milne-Edwards?, Annales des Sc. Nat. 2nd series, Zool. t. vi. pl. 11. figs. 9–9 *b* (1836), or Recherches sur les Polypes, Mém. sur les Eschares fossiles, 1838, Paris basin.

The fossil which afforded the above characters forms part of Mr. Edwards's collection, and agreed sufficiently with the figures and notice given in the 'Annales des Sciences Naturelles' to warrant a doubtful assignment to the Paris basin coral. The points of chief difference in the Bracklesham specimen were a much smaller surface-area, and a sharper proximal extremity; while those of agreement consisted in the general form of the cell and oral aperture, the occurrence of one or two foraminated vesicles at the angles of the mouth, and the boundary of the cells being defined by a row of foramina.

The small specimens which were examined presented only mature conditions of growth, but two of them exhibited cells which differed greatly in form and other characters, as well as in position, from those which constituted the largest fragment. Both modes of growth are represented in figs. 9 *a* & 9* *a*. Tab. I. On comparing the delineation of the irregularly-grouped specimen with *Eschara celleporacea* of Count Münster, as depictured by Prof. Goldfuss (Petref. pl. 36. fig. 10), a certain amount of agreement will be noticed, and if only that specimen had been examined, doubts might have been entertained respecting the genus; but it is believed the variations were only irregularities of local growth, and that the Bracklesham coral is a true *Eschara*, and not allied to those polypidoms which, like Count Münster's species, have essentially an irregular mode of accumulating cells in two opposite directions†.

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† The descriptions of the corals do not quite agree with the arrangement of the Catalogue. The family *Tubuliporina* should have been inserted before *Idmonea coronopus*; but these errors are easily seen.

Notes and Descriptions of New Species, by J. DE C. SOWERBY.

FORAMINIFERA*.

These mostly microscopic fossils occur in vast numbers in the sandy bed which contains the Beloptera. The calcareous rocks that are situated opposite Selsey and Bracklesham are composed almost entirely of these minute shells, being analogous to the Milliolite limestone of the Paris basin (see p. 13). The genera and species are numerous; a few of the most frequent only are selected and named; two of these appear to be new.

Alveolina fusiformis. (Tab. IX. fig. 5.)

SPEC. CHAR.—Elongate fusiform, small, length four times its diameter, extremities rather pointed; length 3 or 4 lines.

A small species, easily distinguished by its form. Occurs abundantly in the Beloptera bed.

Rotalia obscura. (Tab. IX. fig. 6.)

SPEC. CHAR.—Above conical, smooth; beneath convex, margin obtusely keel-formed. Lower surface obscurely granular in the centre, and indistinctly reticulated.

Diameter 1 line, height $\frac{3}{4}$ of a line.

In the same sandy bed as the former.

Biloculina . . . . . (Tab. IX. fig. 9^a.)

A *Biloculina*, the species of which is doubtful, as the individuals seem to vary and are not well preserved, is represented on the Plate but is not mentioned in the List.

Beloptera bed.

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* The descriptions of *Foraminifera* ought to have preceded those of the Corals, as they are so arranged in the Catalogue, but their real affinities are still unsettled.

ARTICULATA.

ANNELIDA.

Serpula ornata. (Tab. IX. fig. 21.)

Spec. Char.—Partly free, tortuose, slowly increasing, surface marked with many slightly elevated thread-like ridges, the alternate ones more prominent; ridges crossed by numerous, transverse, sharp, less prominent elevations or plates of growth; aperture circular; apex spiral?

This has very much the appearance of a *Vermilia*, but the specimens are not sufficient to satisfy us that it is one.

From the Collection of Mr. F. E. Edwards.

MOLLUSCA.

The chemical composition of the hard parts or skeletons of fossil Mollusca is the same as in recent, being of lime and carbonic acid, called carbonate of lime, similar to chalk. In America much of the mortar used for building is made from burnt shells; and in England, particularly in the crag districts, shells form a good manure. Molluscous animals have the power of increasing their habitations as their bodies enlarge, first, by successive additions of membrane to the surface, and secondly, by the hardening of that membrane by earthy matter secreted from their food. Nature, in the coverings of this extensive class of beings, seems to have no end of variety: yet how wonderful it is that these apparently insignificant creatures, working in silence and unseen, construct their shells on the most mathematical principles, and in the best manner suited for their peculiar wants: they have also the power of repairing fractures, and extending certain portions of their shell to secure their attachments to objects within their reach. It may be truly said from this adaptation, and the great beauty and variety of colour which many of them possess, that no work of man's hands, no temple of Solomon can compare with the pearly lustre of their habitations*.

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* "We here find that a principle, which has only of late years been recognised and applied to the building of ships, namely, the diagonal arrangement of the frame-work, and the oblique position of the timbers, is identical with that which from the beginning of creation has been acted upon by nature in the construction of shells."—*Dr. Roget's Bridgewater Treatise,* vol. i. p. 234.

Time and circumstances have in most instances destroyed in fossil shells the membranous portion, and with it their colour and nacrous character; but there can be no doubt that many of them were as beautiful as those of the present day. The Cones and Cowries might vie with the most splendid recent species, the Tellens and other bivalves, in the delicate painting of their fabric; and the Nautili with the finest examples from tropical regions. I have seen in a few instances, more especially on the Cones and Tellens from Bracklesham, slight traces of their original colour.

Shells are univalve, bivalve, or multivalve, according as they consist of one, two or more pieces. Univalve shells have generally a spiral form; some Mollusca have internal shells for the defence and support of particular organs.

The fossil shells of Selsey and Bracklesham, owing to their constant exposure to the sea-water, are soft and require much care; they are often perforated by parasitic worms. At Barton the Volutes in particular, which come under the class denominated porcellaneous, are very hard and oftentimes transparent, the lime being replaced by silex.

CONCHIFERA DIMYARIA.

Clavagella coronata. (Tab. II. fig. 17 & 19.)

The specimens are small and extremely tender; they retain their pearly lustre. The form of the tube is very variable.

Gastrochæna Corallium. (Tab. II. fig. 27.)

Spec. Char.—Broad ovate, anterior extremity small, truncated, terminating in a point.

This is a broader-formed shell than most of its congeners, and less curved, but the opening for the foot is nevertheless very large and is terminated anteriorly by a sharp angle.

A very frequent inhabitant of *Siderastræa Websteri*, boring it in all directions; it is so thin and tender that it is very seldom perfect specimens can be extracted from the holes, which are generally filled with sandy and ferruginous clay.

Panopæa corrugata. (Tab. II. fig. 12.)

Spec. Char.—Transversely ovate-elongated, nearly cylindrical, rather compressed, surface much undulated concentrically; extremities rounded, almost closed; beaks slightly prominent, blunt, near the anterior extremity: length 5, height 3.

Whether this be a species or only a variety of *P. intermedia*, Tab. I. f. 2, altered in form by living in clay or mud, not clear sand, may be a question; it is abundant at Bracklesham in the sandy clay; and it is also found near Bognor in clay, while the *P. intermedia* is in the sandstone. The position of the beaks, nearer the anterior side than in *P. intermedia*, might at first be taken for a distinguishing character, but it is not constant.

Cardilia læviuscula. (Tab. II. fig. 6^a.)

Spec. Char.—Obovate, ventricose, almost globose, smooth, with a few irregular furrows on the posterior portion, and many fine elevated lines radiating from the beaks; lines of growth conspicuous.

A very curious little shell belonging to a remarkable genus instituted by Deshayes, and of which only two other species are known, one recent and one fossil. The internal plate or septum, by which it is at once recognised, only occurs in one other genus, *Cucullæa*, of a totally different form and structure. The spoon-shaped pit for the internal ligament, and the equal valves point out that it belongs to the family of *Mactracea*.

Mr. F. E. Edwards is the fortunate discoverer and possessor of this rarity.

Corbula costata.

The shell named *C. revoluta* in 'Mineral Conchology' not being that species, we are under the necessity of giving it a new name; it is one of the few shells which occur at Bracklesham as well as Barton, and like several other shells which are found at both places, it is common at Barton but rare at Bracklesham.

Psammobia compressa.

Specimens in the Collection of Mr. Edwards, who has been very successful in clearing out his fossils, have the hinges perfect, and show that this is not a *Sanguinolaria* as it was formerly supposed to be.

Tellina donacialis. (Tab. III. figs. 8 & 9.)

The two shells figured differ so much in outline, that they may not be thought to be the same species; but as intermediate forms occur, and they agree with the two varieties given by Deshayes, except in size, it is not desirable to separate them.

Tellina craticula. (Tab. III. fig. 4.)

Spec. Char.—Ovate orbicular, compressed, posteriorly pointed and obliquely truncated, ornamented with many concentric, erect, rather distant laminæ; beaks central; marginal fold small, near the hinge-slope.

The more elevated and distant laminæ and less-marked fold distinguish this shell from *T. scalarioides* of Lamarck, but they are so nearly alike, that Mr. Edwards is unwilling to consider them different; and he may be right; but we are anxious to mark a difference between the English and French shells when it occurs, rather than hastily to unite them.

Lucina serrata. (Tab. III. fig. 7.)

Spec. Char.—Orbicular, with a rather straight hinge-line, convex; surface ornamented with oblique doubly-arched striæ which produce serratures on the superior margin; the two curves of the striæ unite at a sharp angle rather nearest to the anterior margin of the shell; lunette indistinct.

Lucina serrata is one of several species belonging to a section of the genus which is distinguished by angularly bent concentric ridges. They have all usually been comprehended under the name *Lucina divaricata.* The fossil species are more numerous than the recent, of which there are however several, but all different from any of the fossil ones. The *L. divaricata* of 'Mineral Conchology' is not the same as any of the French species, unless it be the *L. undulata* of Lamarck, which Deshayes gives as only a variety. The species before us is the smallest known; it is well marked by the sharpness of the angle at which the two curves of the striæ meet; in other species they are either joined by a short straight line or by a regular curve.

We are indebted to the careful researches made by Mr. Edwards for this pretty little fossil.

Fig. *a*, natural size. Fig. *b*, magnified.

Lucina immersa. (Tab. III. fig. 24.)

Spec. Char.—Subpentagonal, irregular, convex, smooth; lunette flat, lanceolate, sunk deep beneath the pointed beaks, which are curved forwards;

posterior lobe slightly indicated; muscular impressions small, elongated, the posterior one twice the length of the other.

This nearly resembles *L. callosa* of Deshayes; the deep lunette, incurved beaks and muscular impressions are however striking marks.

From the Cabinet of Mr. Edwards.

Diplodonta dilatata. (Tab. III. fig. 16.)

This has been separated from the genus *Lucina*, a genus distinguished not only by the teeth, which would be insufficient, as many species of *Lucina* have teeth in the hinge which are not permanent, while in others the number varies, but also by the form of the shell and characters of the animal.

Cytherea lucida. (Tab. III. fig. 6.)

Spec. Char.—Subtriangular, with a very circular base; disc most convex near the small beaks, flattened towards the lower edge; surface polished, marked with few lines of growth; lunette lanceolate; posterior hinge-tooth in the right valve broad, triangular, bifid; sinus in the palleal impression elliptical.

An elegant shining shell often marked with brown, as if stained by the remains of a thick epidermis; it is distinguished from *C. nitidula* and *obliqua* by the form of the posterior tooth in the hinge (fig. 6 *a*), which is narrow in all the varieties of both those species (fig. 13 *a*).

Cytherea obliqua. (Tab. II. fig. 5.)

There are several varieties of this shell differing in form and roughness of surface. The *Venus tenuistriata*, found at Highgate, is regularly obovate and gibbose, a form not common at Bracklesham. The more triangular and flatter form is frequent there, where also shells of an intermediate shape are very abundant. The lunette varies in form with the shell, and the least convex are generally the smoothest; all the varieties however may be distinguished by the hinge-teeth from the allied species.

Cytherea suberycinoides. (Tab. II. fig. 15.)

There are two varieties of this shell common at Bracklesham Bay, one furrowed, the other very nearly even, and therefore resembling the *C. lævigata* of Lamarck; intermediate varieties are also found.

Cardium Hippopæum.

A rare shell at Bracklesham, of which only fragments have been discovered. It is important as marking the close relationship of the Bracklesham beds with those of Chaumont, Parnes, &c. of France.

Cardium semigranulatum. (Tab. II. fig. 20.)

Barton, London, and Bracklesham Bay have each their peculiar variety of this shell. The granulated portion in the Barton variety is gradually rounded into the smooth part of the surface, and forms a very wide angle on the margin, so that the outline is nearly circular; that portion of the London shell, on the other hand, is flattened, and forms a ridge at its junction with the rest of the surface; its edge is also nearly straight or rather concave, and the base line being but little curved the shell has a rhomboidal contour. The Bracklesham shell is between the two, and has the granulated surface convex, but not so gradually rounded into the smooth part as in the London variety; on the margin it forms a right angle, and the base line being very much curved the outline is irregularly orbicular.

Specimens often occur at Bracklesham considerably larger than the figure, but the largest are found at Barton.

Cardium porulosum.

The variety found at Bracklesham is that without pores through the elevated laminæ; the specimens are frequently large; the Barton variety has pores.

Cardium alternatum. (Tab. III. fig. 14.)

Spec. Char —Cordiform, posteriorly truncate, surface covered by forty or more smooth ribs; those on the posterior area broad, ornamented with V-shaped plates whose angles are directed towards the beak; on the middle portion of the surface the ribs are narrow, alternately furnished with thick lunate scales; on the anterior portion nearly all the ribs are naked.

This beautiful little shell, which much resembles in form the common Cockle, is seldom above half an inch long, and is very rarely found perfect. The ribs are very regular, with deep narrow channels between them; those on the posterior portion are concave in the middle, the others round. The scales upon them are thick, regular, and nearer together than they are long; on the central portion they in general occupy every alternate rib; but sometimes one rib will be missed, and then there are three ribs together without scales.

Cardium ordinatum. (Tab. III. fig. 17.)

Spec. Char.—Suborbicular, convex, posteriorly obliquely truncated, ornamented with numerous rounded costæ, which are regularly covered by thick lunate scales.

The costæ on this neat shell are about thirty-six in number; they increase slightly in size towards the posterior extremity, and are largest and widest apart upon the boundary of the posterior area. The thick scales or granules are very numerous and regular.

Found with the last at Bracklesham Bay by Mr. Edwards.

Cardita planicosta. (Tab. II. fig. 14.)

The shell here figured has the furrows very deep and the ribs square, and maintains that character in some individuals which are so large that they can hardly be thought to be the same species as that shown at fig. 18, which has the furrows shallow and the edges of the ribs rounded; but upon examination it will be found that near the beaks, the furrows are like those in fig. 14; and the distance from the beak where they become shallow is so various in different individuals, that it must be admitted that one is only a younger shell than the other of the same species.

Cardita elegans. (Tab. III. fig. 15.)

This shell is found in light-coloured sand, and generally in such a decayed state, that it is doubtful whether it be rightly named.

Byssoarca Branderi. (Tab. III. fig. 23.)

Arca Branderi of 'Mineral Conchology' appearing to be a young shell of *A. hiantula* of Deshayes rather than *A. biangula*, Deshayes, it is thought necessary to retain that name for the *A. hiantula*. The Bracklesham specimens are as large as the French ones, and even larger. This species differs from *A. biangula*, Deshayes, in having a much less acute keel.

Pectunculus globosus. (Tab. III. fig. 20.)

Spec. Char.—Subglobose, with a small posterior lobe, smooth and nearly even; hinge-line arched with about twenty large teeth; muscular impressions deep, the posterior one round, the other ovate; margin irregularly circular, toothed.

A well-defined irregularly heart-shaped species. I have a foreign specimen precisely resembling it, but not named, I therefore presume it to be undescribed.

Nucula serrata. (Tab. II. fig. 9.)

Spec. Char.—Transversely ovate, elongated; ornamented with many reflected concentric plates or ridges, which form teeth upon the edge of the anterior area, which is very narrow, smooth, and has in each valve a ridge along its middle; beaks central; anterior extremity pointed, elongated.

About twice as long as high.

In the Cabinet of Mr. Edwards.

Nucula bisulcata. (Tab. II. fig. 13.)

Spec. Char.—Elliptical, compressed, smooth; anterior extremity angular; posterior slope marked with two deep longitudinal furrows in each valve; beaks near the anterior extremity; teeth in the anterior portion of the hinge five or six.

Height and length as 8 to 13.

A handsome species well characterized by the furrows in the large posterior slope. From the Cabinet of Mr. Edwards.

Limopsis granulata. (Tab. III. fig. 19.)

Limopsis is a genus distinguished from *Pectunculus* by a triangular pit in the hinge between the two sets of teeth. It was named *Trigonocœlia* by Galeotti and Nyst in 1835, but we are informed that the name *Limopsis* given by Sassi has the priority.

The shell before us is a remarkable instance of the difference between the Barton and Bracklesham beds, and the similarity of the latter to those of Grignon; for this is the same species that occurs at Grignon, while another species of the same genus (*Limopsis scalaris*) is found at Barton, but neither at Bracklesham nor at Grignon. They both occur in Belgium, but in different localities.

Lithodomus Deshayesii. (Tab. II. fig. 28.)

Mytilus Lithophagus, Linn., is a recent shell, the animal of which corrodes holes in limestone*, and the fossil before us strongly resembles it; but as its margins are not so parallel to each other and the sides are a little flattened, which make it less cylindrical than the recent shell, and as it does not appear to acquire so large a size, we think we are warranted to consider it a distinct species, and therefore name it after M. Deshayes, who appears to be the first author who has noticed the fossil distinctly.

Our example was discovered in a mass of *Siderastræa Websteri*, into which it had bored; Deshayes's specimen had inserted itself into a *Cerithium giganteum*; in both cases the masses were too small to have held a larger species, and belong to the same age.

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* That the holes in which this and several other genera of bivalved Mollusks, and a few other marine animals live, are corroded by a fluid emitted from the animal (possibly not a peculiar secretion for the purpose, but, in consequence of its position, highly charged with carbonic or some organic acid), is proved by the holes being shaped to fit the shells, as in *Petricola*, that is, being more or less oval in the section, and having a ridge opposite to the furrow between the beaks, so that the animals cannot turn round; those animals are also always found in calcareous stones or corals. It is in some cases, as in *Gastrochæna* (page 164, Tab. II. fig. 27), observable that the fluid loaded with lime as it passes out of the cavity deposits a portion near the opening, forming a tube with a more or less perfect septum along it to suit and protect the passage of the tubes of the animal (see fig. 27 *a*). In *Lithodomus Dactylus* this deposit is made also upon the surface of the epidermis of the shell near the opening of the tube, and forms a kind of beak; the presence of an alkaline carbonate in the water may facilitate this process if the solvent be an organic acid. This substitute for shell by an earthy deposit not organized, is a manifest link between the animal and mineral kingdoms, and one of the many proofs a naturalist meets with, of a unity and reciprocality of design in the works of Creation, which only an infinitely good and wise Power could execute. *Pholas*, *Teredo*, and allied animals, actually drill tubes for their habitations by means of the toothed edges of their shells, which are renewed as they wear away (see 'Mineral Conchology,' vol. i. p. 230); the motion in the segment of a circle by which this is done, is produced by the aid of proper muscles attached to the ligulate processes within the shell, and to the sides of the foot; the alternate action of these muscles with the foot as a fulcrum produces the oscillating motion required, the foot shifting its place from time to time as the hole is enlarged. In this way the *Pholas* cuts not only into wood and chalk, but into sandstone whose texture is loose while wet; and *Teredo* bores into wood, leaving the marks of the teeth, which marks are often visible in fossils. *Saxicava rugosa*, some species of *Byssoarca* and even of *Pecten*, &c., live in holes ready formed, and to which they are obliged to fit their shells, being only able to maintain an open passage for their tubes.

Pinna margaritacea.

This seems to differ from *Pinna affinis* only in having more numerous and distinct radii.

CONCHIFERA MONOMYARIA.

Lima expansa. (Tab. III. fig. 34.)

Spec. Char.—Nearly orbicular with one oblique straight side, compressed, radiated; radii about forty, smooth, with concentric striæ between them; ear small, rectangular; hinge-line short; shell thin and tender.

Much more orbicular and compressed than any other *Lima* I know, but much too oblique for a *Pecten*. It is extremely rare; Mr. Edwards has one nearly perfect valve, and Mr. Dixon a fragment.

Pecten squamula. (Tab. III. fig. 29.)

A rare shell; it is in Mr. Edwards's Cabinet.

Pecten reconditus (Tab. III. fig. 27); and *P. plebeius*, figs. 28 & 32.

We are obliged to Mr. Nyst for having set us right about Brander's shell, which is more oval than the shell given under that name in the 'Mineral Conchology.' Whether figs. 28 & 32 be rightly referred to *P. plebeius* of Lamarck, I am uncertain. There are so many intermediate forms and the surface varies so much in roughness with the state of preservation, that it is extremely difficult to separate this group of *Pectens*, with twenty to twenty-five compound rays, into well-defined species. Fig. 32 owes its irregular form to fracture; it has a coarser surface than usual.

Pecten triginta-radiatus. (Tab. III. figs. 30 & 31.)

Spec. Char.—Margin orbicular, with a rectangular beak; compressed, radiated and minutely squamose; radii about thirty, simple, rounded, or with a slight furrow along the middle of each, covered with minute, close, perpendicular scales; furrows equal to the radii, and similarly squamose; ears large, radiated.

A broader species than *P. plebeius*, and, though similar, well distinguished by the number and simplicity of its rays; in some of the furrows between the rays single lesser rays occur, particularly in the specimen fig. 30. Fig. 31 is from Mr. Edwards's Collection.

Pecten quadraginta-radiatus. (Tab. III. fig. 33.)

Spec. Char.—Orbicular, with a rectangular beak, compressed, radiated, and squamose; radii simple, rounded, above forty; scales small, distant; ears large, radiated.

The very numerous rays distinguish this shell at first sight; they equal in size the spaces between them, which are convex in the middle. A rare species.

Spondylus rarispina.

Occurs in yellow sand with *Nummulites*, and is much worn; two specimens were found; one is in Mr. Bowerbank's Collection.

Ostrea elephantopus.

Spec. Char.—Hemispherical, subimbricated, smooth, heavy, obscurely eared; hinge-line broad and straight, the central pit slightly raised from the surface of the shell, broad and deep; margin of the flatter valve thick, its edge reflected; muscular impression orbicular, large, nearly central.

Diameter 6 or 7 inches, depth 3 or more inches.

This differs from *Ostrea gigantea* of Brander (Mineral Conchology, tab. 64) in the form of the hinge-pit, which is considerably elevated in that species, and in the depth of the hollow valve. It shows the same cellular tissue as *Ostrea cariosa* of the Bognor rock, which may possibly be the young of the same species, although such large specimens have not been found at that place.

There appear to be several species of Oyster resembling *O. gigantea* found at and near Bracklesham, but they seldom have both valves, and are otherwise imperfect, so that in this difficult genus it becomes impossible to define the species with any degree of certainty. Mr. Bowerbank possesses a fine collection of them.

Ostrea picta. (Tab. IV. fig. 1.)

Spec. Char.—Orbicular, uneven, not imbricated; attached valve very deep, the other nearly flat and thickened near the margin; hinge-area broad, flat, with a central pit; muscular impression large, orbicular; both valves striped with brown.

Colour is of so rare occurrence among Oysters, and especially among fossils, that we are glad to accept it for a specific mark: the present shell belongs to a section of the genus which contains species whose surfaces are not imbricated, but covered by a continuous plate of a fibrous structure; in this the structure is however obscure, in *O. tabulata* and *O. dorsata*, &c., it is very easily detected. Old shells seem to be imbricated, because the edges of the laminæ are worn away. The surface of the young shell, well shown in an individual which has been attached to a large *Nautilus*, is nearly smooth, but irregularly marked with distant, short, interrupted striæ; the hinge-area projects into the cavity of the shell.

Length 3 or 4 inches.

Ostrea longirostris. (Tab. IV. fig. 4.)

This is a remarkable specimen from the Cabinet of Mr. Hill the Curator of the Chichester Museum; a portion having been split from the inner surface, has disclosed two pearls imbedded in the portion to which the adductor muscle was attached. In the figure this slice has been turned over to show their position.

Ostrea radiosa, Desh.

Resembles *Ostrea pulchra* of 'Mineral Conchology,' t. 279, but is a longer-shaped shell, and has a larger hinge-area and longer muscular impression; the radiating undulations are also more numerous, more defined and more angular.

Ostrea elegans, Desh.

Is intermediate in several respects between the *O. radiosa* and *O. Flabellula*, but has more plaits than the latter. I much doubt the propriety of separating it as a species.

Ostrea dorsata, Desh.

This and the following belong to the same section of *Ostrea* as *O. picta*, distinguished by a thick, generally striated coat, which is so fibrous as to resemble the shell of *Pinna*: there are one or two recent species of the same section; they are of a dull purple colour, and very little imbricated.

Ostrea tenera. (Tab. IV. figs. 2 & 3.)

The Woolwich type of this species is generally smooth, like fig. 3; but I have reason to think that the fibrous striated coat is more easily decomposed than the other laminæ of the shell, and has therefore been generally destroyed; such appears to have been the case often with the Bracklesham individuals; however, some of the latter having the fibrous coat are almost free from striæ, and others want them over more or less of the surface, which has induced me to consider the striated ones as only varieties of the others.

MOLLUSCA GASTEROPODA.

Emarginula obtusa. (Tab. IX. fig. 31.)

Spec. Char.—Ovate, conical, depressed, radiated; principal radii 22–24, with one to three lesser radii between each, all granulated; marginal fissure shallow; apex central, pointed, deflected.

Length 3, height 1, width 1½.

The granulations upon the principal radii are coarse and transverse, being produced by the successive additions to the edge of the shell; the space filled up behind the fissure is crossed by strong lunate ridges and bordered by a thin plate, the reflected edge of the fissure.

In the Cabinet of Mr. F. E. Edwards.

Fissurella Edwardsii. (Tab. VII. fig. 9.)

Spec. Char.—Ovate, with rather straight sides, depressed, finely radiated, and reticulated; radii squamose; apex pointed; fissure oblong, its thickened internal margin truncated posteriorly; margin crenulated.

Length 4, height 1½, width 3.

Twenty or thirty of the radii are more prominent than the remainder, which are placed in sets of two or three between each of the larger ones; they are all crossed by scales produced by elevated lines of growth.

The figure is from a large specimen found by Mr. Edwards; and Mr. Bowerbank possesses a small one which shows the inside; and Mr. Dixon has two specimens in his Cabinet.

Infundibulum trochiforme. (Tab. XIV. fig. 27.)

Varieties of this species, or species closely connected with it, are found in most parts of the tertiary formation; but the characters are so irregular that it is almost impossible to define them.

Bulla expansa. (Tab. VII. fig. 18.)

Spec. Char.—Obliquely orbicular, rather square, compressed, striated; last whorl convex near the upper part; spire very short, rounded; aperture very wide, with a short canal above reflected on to the spire; no columella.

Only two specimens of this shell have been found. It probably belongs to the same section as *B. lignaria*, but with a much more expanded aperture; near the upper part the last whorl is suddenly very convex, which distinguishes it from *Sigaretus*, for which it might be taken.

Bulla Edwardsii. (Tab. VI. fig. 1.)

Spec. Char.—Oblong-ovate, striated; apex broad, umbilicate; spire concealed; aperture with the upper two-thirds narrow, the lower broad; striæ numerous, dotted; upper edge of the last whorl (the only visible one) narrow, rounded; columella wanting.

More closely convoluted and approaching to cylindrical than the recent *Bulla lignaria*, from which it also differs in the form of the deeply umbilicated apex, whose edge is rounded. Brongniart's *B. Fortisi* (Terr. du Vicent. 52. t. 2. f. 1) appears to be more elliptical, with the lower part of the aperture less open. The species found in the neighbourhood of Paris (*B. lignaria*, var. Deshayes, v. ii. 44. tab. 5. fig. 4–6) is hardly distinguishable, except that it is much smaller; the Cutch fossil (Trans. Geol. Soc., 2nd ser. v. 5, pt. ii. 328, pl. 26. fig. 1) is much more pointed in form, but has the same hollow apex with its rounded edge. It is therefore certain that there are several fossil species called by the same name; there are also at least two recent ones, as I believe that of the Indian seas to be different from the European one. The species found in the English Crag appears to be the same as the recent European one.

Bulla Defrancii.

I believe this to be identical with the shell found in the Paris basin, and called *B. lignaria* by Deshayes. The cylindrical form is characteristic of it. It is remarkable that it should also occur at Barton. Mr. Edwards's Cabinet.

Bulla extensa. (Tab. VII. fig. 6.)

Spec. Char.—Short fusiform, striated, umbilicate; apex of the spire sunk;

aperture narrow, pointed at both ends, its lip extended beyond the apex; striæ obscure in the middle of the whorl, deep at the base.

Length 2, width 1.

The umbilicate columella seems to distinguish this from almost all other fossil *Bullæ*. Mr. Edwards's Cabinet.

Fig. *a*, natural size; *b*, magnified.

Bulla lanceolata. (Tab. VII. fig. 7.)

Spec. Char.—Acutely conical with a produced base, smooth, except a few striæ near the pointed apex and six or seven near the base; aperture very narrow, its lip extended beyond the apex and slightly expanded and reflected at the base.

Length 2½, width 1.

Beautifully formed and polished: this is a remarkable little shell; it occurs in great numbers at Barton, but less frequently at Bracklesham.

Fig. *a*, natural size; *b*, magnified.

Bulla uniplicata. (Tab. VII. fig. 8.)

Spec. Char.—Cylindrical, smooth; apex deeply sunk; base striated; aperture narrow, its inner lip forming a double plait as it rises upon the columella.

Length 2½, width 1.

Much resembling *B. cylindrica*, but differing in the columella. It is in Mr. Edwards's Cabinet.

Fig. *a*, natural size; *b*, magnified.

Globulus labellatus. (Tab. VI. figs. 26 & 27.)

Fig. 27 represents a distorted variety. The thick left lip so much resembles that of a *Natica*, that the genus has been doubted.

Globulus conoideus. (Tab. VI. fig. 32.)

Spec. Char.—Spire conical, short, of four or five whorls which have a narrow depression on their upper edges; aperture nearly orbicular with a sinus formed by the spire, half as long as the shell; umbilicus large.

Strongly resembling *G. labellatus*, but shorter, and having the upper parts of the whorls a little flattened on their sides so as to make the spire conical.

Ampullina pachycheila. (Tab. VI. fig. 31.)

Spec. Char.—Globose, with a very small spire; aperture semicircular, pointed above, rounded with a reflected lip below, the left lip thick and pressed more or less into the umbilicus; shell thick.

Very rarely found of a regular form: the shell, although very thick, seems to have lost all its animal matter, and to have yielded very readily to pressure in the wet, sandy clay.

Natica Hantoniensis. (Tab. VI. fig. 20.)

A somewhat distorted variety of this shell is figured; the reference has accidentally been omitted in the List.

Natica turgida.

Spec. Char.—Oblong-ovate, with straightish sides, smooth; spire of three convex whorls, small, produced; last whorl elongated; aperture oval, elongated with a curved canal forming its upper angle; the left lip expanded over the preceding whorl, thickened and nearly closing the umbilicus, below which the edge is rounded and thick.

Length $\frac{1}{2}$ to $\frac{3}{4}$ of an inch.

This shell has a peculiar appearance in consequence of the great size and length of the last whorl; the left lip is large and regularly thickened, and in general nearly closes the umbilicus; but there is a variety greatly resembling in form the variety of *Globulus labellatus*, fig. 27, which has an open umbilicus, and at the lower part of the thickened lip a transverse furrow, of which slight traces only can be found in the variety with a closed umbilicus. Both varieties are in Mr. Edwards's Cabinet, where they were recognised too late for insertion in the plate.

Natica obovata. (Tab. VI. fig. 28.)

Spec. Char.—Obovate, with a small pointed spire, and the last whorl convex, umbilicate; aperture nearly round, its left lip spread almost over the umbilicus, thickened at the upper part.

An imperfect specimen, which I can refer to no other species.

The three genera *Globulus*, J. DeC. Sowerby, Index 'Min. Con.' (*Globularia*, Swainson), *Ampullina*, Deshayes, and *Natica*, Lamarck, are distinguished by the following marks; in the general form they are all nearly alike. The lower part of the left lip in *Globulus* is sharp and not reflected, and the umbilicus, whether open or covered, has no ridge rising in it. In *Ampullina* the lower part of the left lip is slightly reflected, and a sharp ridge ascends from it up the outer side of the umbilicus. In *Natica* the lower portion of the aperture is like that part in *Globulus,* but the left lip is thickened and forms a callus, from the base of which a ridge ascends the umbilicus on the side nearest the aperture. These characters are sufficient for fossils, but of course nothing can be said about the animals of the first two genera, as they are not known recent.

Delphinula Warnii. (Tab. VII. fig. 23.)

One of the most beautiful and at the same time most interesting shells of the Bracklesham beds, as indicating very precisely the corresponding French formation.

Solarium spectabile. (Tab. VI. fig. 2.)

Spec. Char.—Convex, striated; margin thin, sharp, deflected; whorls about six, slightly convex; their upper edges prominent, crenated; the spaces between the striæ unequal, alternately granular; umbilicus nearly equal in its diameter to half that of the shell, with a crenulated margin; aperture rhomboidal.

Height about half the diameter of the base.

Covered within the umbilicus, as well as over the other parts, with alternately linear and granulated ridges, which are largest towards the upper edges of the whorls and the margin of the umbilicus.

Solarium pulchrum. (Tab. VI. fig. 3^b.)

Spec. Char.—Very short, conical, striated; margin thin, sharp, projecting; whorls about five, convex above and below; the spaces between the striæ unequal, granulated; umbilicus nearly half the diameter of the base, with a square margin.

Height one-third the diameter.

Similar to the last, but more depressed and even, and without any hollow to distinguish the whorls.

Adeorbis planorbularis. (Tab. IX. fig. 20.)

A neat little shell found by Mr. Edwards.

Orbis patellatus. (Tab. IX. fig. 23.)

A curious shell and precisely corresponding with the French specimens. I quote Lea with a note of doubt, because, although his figure and description agree with this shell in almost everything, the size (0·15 of an inch) is so very different, that it is hardly possible they can be the same species: the American shell is almost microscopic; it is the type of the genus *Orbis*. Another of Mr. Edwards's discoveries. The specimen found in the Isle of Wight is in Mr. Morris's Cabinet.

Bifrontia.

We are indebted to Mr. Edwards's minute researches and delicate handling for all the species of this genus; they are remarkably typical of the French beds as distinguished from the clays of Barton and London, and indicate the relationship of the Bracklesham sands. They are all extremely tender shells.

Rotella minuta. (Tab. IX. fig. 19.)

Spec. Char.—Convex, smooth and shining; margin slightly angular; aperture semioval, oblique; base rather convex, the central callus small, defined.

This species of a genus rarely found fossil can only be compared with *Rotella nana* of Lea, 'Contrib. to Geol.' p. 214, t. 6. f. 225, which is a thicker and squarer shell, also rather less.

Mr. Edwards's Cabinet.

Turbo plicatus.

Mr. Edwards has this shell in his Cabinet.

Turritella bicincta. (Tab. VI. fig. 19.)

Spec. Char.—Turrited, elongated; covered with granose threads; whorls rather concave, their lower edges prominent, bicarinated; aperture . . . . .

This resembles *T. conoidea*, but is easily known by the two spiral ridges along the lower edges of the whorls.

Turritella conoidea. (Tab. V. figs. 6 & 10.)

This species is so variable that the synonyms cannot be satisfactorily given.

Turritella contracta. (Tab. VII. fig. 42.)

Spec. Char.—Turrited, elongated, nearly smooth, or obscurely granoso-striate; whorls concave, their lower edges very prominent, rounded, marked with two or three obscure ridges.

Very nearly resembling some varieties of *T. conoidea*, but its whorls are more concave and nearly smooth, and their upper edges are not rounded into the suture.

Turritella marginata. (Tab. VI. fig. 16.)

Spec. Char.—Conical, elongated, with convex whorls; ornamented with about nine sharp transverse ridges upon each whorl, a small portion of the upper part of which is plane.

Length little more than twice the width.

The convex whorls and smooth band around the upper part of each distinguish this shell.

Turritella nexilis. (Tab. VI. fig. 17.)

Spec. Char.—Conical, elongated, with flat whorls, of which the lower edge is rather prominent; covered with sharp transverse ridges, which are numerous and only slightly raised.

Length two and a half times the breadth.

A very neat shell. There are ten or twelve unequal ridges on each whorl. The small specimen is in Mr. Edwards's Cabinet.

The five latter species of *Turritellæ* in this List belong to one group of the genus, and the four preceding to another, in both of which the species are very difficult to define, because there are so many intermediate forms. *Turritella intermedia*, Desh., is also in Mr. Edwards's Cabinet of Bracklesham Bay fossils.

Cerithium incomptum. (Tab. VI. fig. 18.)

Spec. Char.—Turrited, with straight sides; the upper half of each whorl divided into large compressed tubercles, the lower half transversely sulcated with tuberculated ridges between the furrows; all the whorls alike.

A large shell between *Cer. giganteum* and *Cer. Cornu-copiæ*; it is a much rougher shell than the former, and unlike the latter, is uniformly sculptured throughout its length, and increases regularly, not more rapidly, as it grows older.

It is a curious fact, that a third large species of *Cerithium* should be found at a place which already possesses the two above-named large species, found at distant localities in France, and at no other place in England. I first noticed it in Mr. Bowerbank's Collection.

Cerithium hexagonum.

This sometimes occurs very large.

Cerithium cancellatum. (Tab. IX. fig. 22.)

Spec. Char.—Turrited, subulate; whorls convex, numerous, longitudinally costated; costæ arched, crossed by three sharp ridges on each whorl.

Five times as long as wide.

Somewhat like *Cerithium clavus*, Lam., but longer and with more convex whorls; it appears to be extremely rare.

Cerithium marginatum. (Tab. VI. figs. 4 & 5.)

Spec. Char.—Turrited, conical or subfusiform, longitudinally and transversely striated, hence imperfectly granulated; upper edges of the whorls prominent, bordered with obscure tubercles.

Width 2, length 5.

By seven or eight transverse striæ and numerous lines of growth, the surface is irregularly divided into rows of flattened tubercles, the upper of which is the largest and forms a kind of margin to the whorls. This species is rather obscurely marked in consequence of the specimens being in a bad state of preservation, and having their surfaces worn.

Cerithium semicoronatum, C. semigranulosum, C. muricoides, and *C. unisulcatum* are in Mr. Edwards's Cabinet.

Cerithium nudum, C. variabile, and *C. emarginatum,* have also been found at Bracklesham.

Pleurotoma amphiconus. (Tab. VIII. figs. 7 & 8.)

Spec. Char.—Doubly conical, smooth, with a few striæ round the base, and about three striæ near the upper part of each whorl; spire and aperture of equal length.

Width 2, length 5.

More common than *P. prisca*, from which it differs in the equality of the two cones of which it is formed.

Pleurotoma curvicosta. (Tab. VII. fig. 17.)

Spec. Char.—Fusiform, rather short, transversely striated, longitudinally ribbed or waved; ribs few, curved, thickened upwards; aperture elongated; beak short, straight.

Twice as long as wide.

A species of *Pleurotoma* which connects that genus with *Fusus*, with which indeed I have sometimes placed it.

Pleurotoma inarata. (Tab. VI. fig. 21.)

Spec. Char.—Fusiform, elongated, transversely striated; whorls convex with the upper edge extended and crenulated; striæ numerous, the spaces between them nearly smooth; aperture short-oval, with an elongated, very slightly curved canal.

Three times as long as wide: the canal equal to the spire.

This differs from *Pleurotoma rostrata*, which is not found at Bracklesham, chiefly in the absence of ribs or undulations.

Pleurotoma gentilis. (Tab. VI. fig. 25.)

Spec. Char.—Fusiform, elongated, acute, longitudinally ribbed and transversely striated; whorls convex in their lower parts, concave above; ribs numerous, thin, obscure in the hollow part of the whorls; aperture nearly round, with a short canal above and a long canal below; beak narrow, straight, longer than the round part of the aperture.

Above three times as long as wide; aperture, including the canal, nearly as long as the spire.

An elegant strongly marked shell; in Mr. Edwards's Cabinet.

Pleurotoma obscurata. (Tab. VII. fig. 19.)

Spec. Char.—Turrited, elongated, transversely striated, ribbed, or waved; whorls few, compressed above, with a row of granules around the edge; ribs rather prominent on the middle of the whorl; beak short, narrow, spreading into the oval aperture.

Length three times the width; the aperture and beak together equal the width of the shell.

The form of the beak affords a means of distinguishing this from the last.

Pleurotoma plebeia. (Tab. VI. fig. 23.)

Spec. Char.—Turrited, subcylindrical, obtuse, transversely striated; whorls concave above, with a row of bead-like tubercles along the middle; striæ decussated by lines of growth; aperture obovate, with a canal above; beak elongated, narrow, straight, shorter than the width of the shell.

Length three times the width.

Resembling *Pleurotoma comma*, but longer and blunter, and furnished with a narrower and longer beak and more striæ; a very common species.

Fasciolaria biplicata. (Tab. V. fig. 7.)

Spec. Char.—Fusiform with a short beak, acute, undato-costated, transversely striated; whorls convex, ten to twelve, with a compressed striated margin; costæ six or seven, broad, prominent in the middle of the whorl; aperture ovate, elongated; columella nearly straight, furnished with two plaits near the middle.

Width 2, length 5; aperture and canal longer than the width.

A remarkable, but by no means rare shell at Bracklesham Bay. Intermediate between *Fasciolaria* and *Fusus*, two nearly allied genera distinguished by the plaits on the columella of the former. Its nearest ally is *Fusus incertus* of Deshayes, which has a much longer beak.

Fusus Pyrus and *Fusus Bulbus.*

We have kept these two names separate, although we can hardly be persuaded that the shells indicated by them are not one species.

Fusus incultus. (Tab. VII. fig. 32.)

Spec. Char.—Fusiform, with a long narrow beak, transversely striated, and costated near the apex; striæ obsolete near the middle of the whorls, which are concave above and convex below; the last whorl large, ventricose; aperture ovate, with a short canal above and long canal running into the beak.

Three times as long as wide.

Whorls six or seven, rather short, and in this respect different from the young of *Fusus longævus*, to which in other points this shell bears a resemblance. It has a peculiar blunt and unfinished aspect by which it may be at once recognized.

Fusus errans. (Tab. VII. fig. 31.)

This shell varies in different localities; the specimens found at Primrose Hill have the last whorl less conical and more convex than either the Barton or Bracklesham individuals, and are also more coarsely striated. The variety (*tenuistriata*) with fine striæ is peculiar to Bracklesham.

It grows considerably larger than the specimen figured.

Fusus undosus. (Tab. VII. fig. 39.)

Spec. Char.—Subfusiform, with a short base, deeply striated transversely, longitudinally costated or undulated; spire small; whorls seven, convex; beak short, slightly curved; ribs gently raised, straight; striæ sharp, the spaces between them flat, unequal in breadth but all narrow; aperture almost round, with a short canal; outer lip striated within.

Length double the width.

An elegantly formed rounded shell, much like *Fusus regularis*, but smoother in its contour, and having a shorter and curved beak.

A good example of Montfort's genus *Trophon*, which has lately been adopted by Mr. S. V. Wood.

Fusus parvirostrum. (Tab. VII. fig. 30.)

Spec. Char.—Subfusiform-turrited, transversely striated, longitudinally ribbed; whorls numerous, keeled in the middle; ribs eight or nine, straight, prominent, and sharp in the middle; beak narrow, short and straight.

About three times as long as wide.

Very rare. A distinct and remarkable shell; the specimen is much crushed, which makes it appear wider than it really is. It is one of Mr. Edwards's treasures from the yellow sand beds.

Fusus læviusculus. (Tab. VII. fig. 34.)

Spec. Char.—Elongated, with nearly straight sides, transversely striated; whorls slightly concave towards their upper margins; striæ rather distant; aperture wide, with a small narrow canal above, and a short narrow beak; outer lip striated within.

Length 5, width 2; aperture and beak equal to the width.

Remarkable for the short aperture and proportionally long spire.

Strepsidura armata. (Tab. VII. fig. 11.)

Spec. Char.—Ovate, pointed, short; whorls striated above, each armed with about eight pointed tubercles, smooth below; aperture ovate, narrow above; base striated; beak curved.

Length, including the beak, about twice the width.

A shell with a smooth aspect; it can hardly be called ribbed, the tubercles are so little extended at the base down the whorl, which is in part free from striæ and somewhat flattened; it differs from *Strepsidura turgida* in the form of the aperture. We have not seen the beak perfect.

The genus *Strepsidura* was proposed by Swainson, and is well distinguished from *Fusus* by the curved beak as well as the short form.

Triton expansus. (Tab. V. fig. 15.)

Spec. Char.—Subfusiform, costated, crossed by numerous linear ridges, some of which are so thickened as they pass over the costæ and varices as to produce three or four tubercles, the uppermost of which are spiniform; aperture obovate; beak narrow, slightly recurved.

Length, including the beak, nearly twice the width.

Costæ three or four between each varix; the two upper tubercles of each row generally remain visible upon the spire, but not constantly; the uppermost is always the most prominent. The narrow beak is equal in length to the aperture.

Rostellaria lucida. (Tab. V. fig. 21.)

The Bracklesham shells are seldom so glossy as the Highgate ones, and are commonly equally striated all over, not smooth in the middle of the last whorl; but they vary much both in the striæ and in the costæ. The beak is described in 'Mineral Conchology' as "short?" for want of perfect specimens; we are now enabled to show that it is long, and also that there is no canal carried up the spire from the aperture.

Rostellaria arcuata.

There being some doubt whether the Linnæan *Strombus fissurella* be the fossil or recent species, I have thought it best to give a new name to the Paris basin fossil, which is not only different from the recent species, but also from the one found at Barton (*Rostellaria rimosa*, 'Min. Con.' t. 91), being a curved, not a straight shell.

The occurrence of this shell at Bracklesham is one of the indications of the resemblance of the Bracklesham beds, rather than the Barton ones, to the lower beds of the Calcaire Grossier of Paris.

Pseudoliva ovalis. (Tab. VII. fig. 13.)

Spec. Char.—Oval, short, with a small pointed spire, smooth; aperture large, ovate, with a short canal above; left lip very tumid; columella curved.

Resembling a very short *Oliva*, but may be recognized by the want of the smooth enamel-like band at the lower part. The marginal tooth on the right lip is short.

Voluta calva. (Tab. VII. fig. 28.)

Spec. Char.—Pyriform, smooth, obscurely ribbed; whorls concave above, their upper margins pressed to the spire; each rib terminated by a small spine at the edge of the concave space; spire short.

Length 5, width 3.

Remarkable among the coronated *Volutæ* for being smooth. The figured specimen is in Mr. Edwards's Collection. Mr. Dixon has lately obtained a similarly formed shell, quite smooth and also free from ribs, which I am much inclined to think is of the same species.

Voluta recticosta. (Tab. V. fig. 18.)

Spec. Char.—Oval, elongated, transversely and distantly striated, costated, crowned with two rows of erect spines; ribs numerous, thin, straight, each terminating in a spine; upper margins of the whorls concave between the two rows of spines.

Length twice the width.

Much resembling *Voluta ambigua* of Barton, but much less deeply striated, more ribbed and more acute in form; it is probably the same with *V. ambigua* of Lamarck and Deshayes, which is different from the Barton species.

Voluta uniplicata. (Tab. VII. figs. 45 & 46.)

Spec. Char.—Fusiform, subturrited, finely striated; volutions slightly convex, flattened in the middle, those on the spire costated, the last plain; columella nearly straight, with one plait near the base; aperture oblong-elongated, rather square above; pullus large.

Length 5, width 2.

A very distinct and not uncommon shell.

Cypræa Coombii. (Tab. VIII. fig. 6.)

Spec. Char.—Triangular, ventricose, posteriorly truncated, smooth; base flattened; the outer lip broad-edged, with a projection near the posterior end, nearly toothless; aperture very narrow, with the posterior canal curved upward on to the spire, the other extremity straight.

Length 6½, width 5.

The more triangular form and greater size have induced a belief that this may be a different species from *Cypræa tuberculosa* (*Ovula*) of Duclos, found at Rétheuil, &c. The large tubercles that are mentioned in the specific character of that species by Deshayes (v. ii. p. 717) are not constantly present, and they occur in some of the English specimens, therefore they can only be considered as accidental. First found at Bracklesham by Mr. Coombe, whose zeal in the search of fossils is commemorated in the name.

The want of teeth in the aperture has led to this being called "*Ovula*," but there are slight indications of teeth. It belongs to the same division as *Cypræa Mus*, and with it might form a good subgenus.

Cypræa Bowerbankii. (Tab. VIII. figs. 1 & 2.)

Spec. Char.—Egg-shaped, smooth; beak short, moderately wide; aperture narrow, curved, without a posterior canal; outer lip incurved, a little flattened towards the beak, with about thirty to thirty-five teeth, nine or ten of which are elongated on the flat part.

Length 3, width 2.

This large *Cypræa* is named after J. S. Bowerbank, Esq., F.R.S. &c.

Cypræa globosa. (Tab. VIII. fig. 3.)

Spec. Char.—Globose, smooth, with a small inversely conical, straight beak; aperture narrow, nearly straight, without a posterior canal; outer lip incurved with about thirty-five to forty small, equal teeth.

Nearly as wide as long, excluding the beak. A very distinct and rare shell.

Ancillaria fusiformis. (Tab. VIII. fig. 16.)

Spec. Char.—Fusiform; aperture narrow, less than half as long as the shell; basal notch small.

Length 5, width 2.

Well-distinguished by the short aperture, which but slightly exceeds the width.

Ancillaria obtusa. (Tab. VIII. fig. 15.)

Spec. Char.—Subcylindrical, obtuse; aperture broad, with the lip nearly parallel to the columella, above half as long as the shell.

Length 5, width 2.

The only specimen we have seen of this is much worn.

Conus pyriformis. (Tab. VIII. fig. 18.)

Spec. Char.—Inversely conical; the flat spire and pointed base are striated spirally, the rest of the surface is nearly smooth; aperture narrow.

The width nearly equals the length.

A very simply formed shell; there are a few obscure striæ on the upper part of the whorl, and about ten, rather distant, about the pointed base. *Conus brevis*, collected by Captain Grant in Cutch (Trans. Geol. Soc. 2nd ser. vol. v. p. 329, t. 26. f. 33), is a very similar shell.

MOLLUSCA CEPHALOPODA.

DIBRANCHIATA.

BELOSEPIADÆ.

The fossils which are arranged under this Order were noticed by Guettard in his 'Mémoires,' in 1783, among "Glossopètres ou dents de Requins fossiles," when after having called one a "Dent aîlée*," and another "Dent un peu courbe à base aîlée†," he asks, "Ces corps sont-ils bien réellement des dents?‡" and adds, "La seule façon de déterminer au juste leur nature est de trouver un poisson ou autre animal qui ait un corps semblable." This was sound reasoning; but it was left to Cuvier, after several erroneous indications by others, to point out the animal which did possess a body resembling them, and which he showed to be the Cuttle-fish or *Sepia*, in whose bone, or rather internal shell, a strong resemblance was immediately acknowledged; they however form links between the *Sepia* and *Belemnites*, whose animal having been since discovered in the fossil state, confirms the affinity.

Belosepia, Voltz.

This genus, proposed by Voltz in 1830§ as distinct from *Sepia*, and adopted by Blainville, but rejected by Deshayes and his followers, appears notwithstanding to be a good genus; unfortunately only a small portion of the shell is ever found, which prevents a complete comparison being made between it and the bone or shell of *Sepia*; enough however is known to show their affinity and also some good distinguishing marks. It may be convenient therefore to describe the shell or bone of the Cuttle-fish before defining the *Belosepia*. The shell of *Sepia* has for its basis a horny membrane, shaped like the elongated bowl of a spoon, and lined to near its edge with a thin layer of calcareous matter; the pointed end being directed towards the head of the animal is consequently the anterior, and the concave surface is ventral; near the posterior end and at a small distance from the bottom of the concave surface is an obtuse transverse ridge, beneath which the cavity becomes pointed, forming a kind of pit; from this pit proceeds a spongy convex mass that nearly fills the horny membrane; it is composed of thin, curved, parallel plates directed longitudinally, and separated from each other

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* Vol. v. p. 184, pl. 2. f. 10, 11 & 12: this is *Beloptera belemnitoidea*.

† *Ibid.* p. 186, pl. 2. f. 23, 29 & 30, are *Belosepiæ*.

‡ *Ibid.* p. 185.

§ Mémoires sur les Belemnites, p. 23.

by minute, perpendicular, tortuous laminæ; the posterior deeply-arched edges of the thin plates recede from the pit as they are piled up, forming a sloping surface which is covered with a thin membrane; the centre of the edge of the last plate is situated at one-third the length of the shell from the posterior extremity; the calcareous lining of the horny membrane has a radiated structure at the posterior part, which is also widely expanded and slightly reflected. The convex or dorsal surface of the horny membrane has a coat of fibrous carbonate of lime extended nearly to its margin; this coat is thickened and very rugged in the middle and about the apex or point over the small pit in the other surface; from this point a portion of it is produced in the form of a nearly cylindrical spine, beneath which it expands thinly over the membrane, and is radiated. To complete the structure, a series of membranes lining each other cap the posterior part of the dorsal surface enclosing the spine, but not pressing close to it nor to each other where they approach its base, which is consequently surrounded by a number of cavities*. The shell thus described is placed beneath the skin on the back of the animal, in the sac which also encloses the viscera; it is secreted by the surface of the cavity in which it lies. I have been thus particular in describing the shell of the *Sepia*, that I may the more easily point out how the fossils before us differ from it, and show that however imperfect these remains are, they indicate the existence of parts not known in *Sepia*, and of sufficient importance to mark a group generically distinct. The general form may be considered the same in both, but the fossils are much deeper and narrower: the anterior extremity of the fossil is unknown; the posterior portion is compressed laterally, and rendered smooth as if by the action of some large muscles such as do not exist in *Sepia*; hence a rounded, dorsal ridge is formed (the extremity of which is called a *callus* by Deshayes), which rises either perpendicularly or obliquely above the base of the spine. The expanded posterior extremity (called by Deshayes the *ventral lamina*) of the principal plate or membrane is thick and toothed; the spine (*rostrum* or *apophysis* of Deshayes) is large, thick, and complicated in its structure; these circumstances altogether show that great strength was required in these parts by the habits of the animal. On each side near thick prolongations of the base of the spine are several irregular depressions, beneath which the structure (as shown in Tab. IX. fig. 17 at *h*) is longitudinally fibrous; these are probably marks of the attachment of powerful muscles, and if so, the shell was not loose in the mantle as it is in *Sepia*: and we would venture to suggest that the lateral fins of the animal may have been placed very low down the sides of

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* Buckland's Bridgewater Treatise, tab. 44. f. 4 *a*.

the sac, and have had muscles to move them attached to the shell and working against its sides. On the ventral surface the cavity opposite the dorsal ridge or callus is deep and conical, and surrounding it are the remains of thin plates or *septa*, running obliquely to the slightly curved axis of the cavity, across which however they did not reach, but had their edges reflected against each other. There are no indications of thin tortuous laminæ between them, so that as far as we can at present tell, they are equally unlike the septa in *Belemnites* and the spongy mass in *Sepia*. The cavity is enclosed on the ventral side by a flat plate or *diaphragm*; the space between it and the reflected edges of the septa has been thought to represent a siphon. In general only the calcareous portions are preserved; and if the spine and posterior extremity were ever covered by a horny coat, it has entirely disappeared. In one specimen from Sheppy, for which we are indebted to Professor Owen's kindness, there are indications of the internal membrane between the calcareous coats, the animal matter being displaced by pyrites. This specimen is filled with indurated marl or cement stone, and is much longer than any other we have seen, but shows very slight marks of septa, which probably did not extend far from the apex, or may have been only narrow rudimentary rings*. The following short description may serve at present to define the genus :—

GEN. CHAR.—Animal probably a dibranchiate Cephalopod; shell internal, membranaceo-calcareous, elongated, very concave, its posterior extremity keeled, and rugose on the back forming a callus, compressed on the sides, and the ventral plate expanded, striated, thickened, and toothed at the terminal edge; a strong spine is placed between the extremity of the dorsal keel and the ventral plate; ventral cavity enclosed by a flat longitudinal plate or diaphragm, and containing many thin oblique septa; anterior portion thin, rounded, concave beneath.

The species are probably numerous, but they are extremely difficult to define, as age and other circumstances to which internal shells are particularly liable appear to cause much variation. They all occur in the same tertiary formation; the following, from Bracklesham, are supposed to be new.

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* Tab. IX. fig. 17, (*a*) the outer dorsal calcareous coat; (*b*, *b*, *b*) two or three imbricating layers of membrane alternating with calcareous laminæ; (*c*, *c*) the calcareous lining; (*d*) the surface of the stone waved in the direction of the lines of growth or margin of the shell; (*e*) a portion of the diaphragm; (*f*) the abraded surface of the beak or spine, showing a fibrous structure not visible in *Sepia*; (*g*) a portion of the diaphragm, also shown at (*g*) in figs. 12 & 16; (*h*) striæ indicating a fibrous structure under that part of the surface where I suppose a muscle to have been attached.

Belosepia Oweni. (Tab. IX. fig. 13.)

Spec. Char.—Callus perpendicular; spine short, thick, acute, depressed above, rounded on the sides and beneath; ventral cavity terminating near the lunate extremity of the ventral plate.

Length and breadth of the spine equal.

The ventral plate, as usual in the genus, is striated in rays from the end of the ventral cavity, is semicircular and but little extended; the point of the beak is slightly turned upwards and has no carina, or only a minute one. The very short spine distinguishes it from all the species described by Deshayes; the nearest is *B. Cuvieri*, but the figures quoted forbid its being referred to that species. Fig. *a.* represents the ordinary form; fig. *b.* shows a young individual with the spine more acuminated. It is dedicated to Professor Owen, who has laboured so successfully among the Cephalopods.

Belosepia brevispina. (Tab. IX. fig. 14.)

Spec. Char.—Callus perpendicular; spine very short, small, convex above, thick, acute; ventral plate lunate, thin.

Spine wider than long.

In this specimen the ventral plate is evidently much worn, and has thus lost its toothed edge. The small and extremely short beak is the distinguishing mark.

The other four species I distinguish by the following characters, and trust they are the species defined by Deshayes; probably the first two should be united. The spines of all four are sharply keeled along a great portion of the upper part.

Belosepia Cuvieri, Voltz*. (Tab. IX. fig. 11.)

Callus perpendicular; spine thick, bent upwards; ventral plate elongated.

Belosepia Blainvillii. (Tab. IX. figs. 10?, 16 & 17.)

Callus inclined backwards; spine bent upwards; ventral plate short.

Fig. 10 is an intermediate form, and smoother on the back than the true *B. Blainvillii.* The specimens figs. 16 & 17 are from Sheppey; they were presented by Professor Owen. Fig. 17 is referred to above; it is the most perfect yet discovered.

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* Mém. sur les Belemnites, p. 23, t. 2. f. 6. The figures referred to by Deshayes do not all accord with his description.

Belosepia longispina. (Tab. IX. fig. 12.)

Callus perpendicular; spine elongated, horizontal; ventral plate semioval, short.

Belosepia longirostris. (Tab. IX. fig. 15.)

Callus much inclined backwards; spine elongated, directed upwards; ventral plate short and broad.

Figs. *a*, *a*. are from two old specimens.

Fig. *b*. represents what I suppose to be a young one of the same species.

Beloptera, Deshayes.

This genus has a strong affinity to *Belosepia*, but the ventral cavity, instead of being partly open as in that and in *Sepia*, is perfectly closed and conical with transverse septa as in *Belemnites*. I have seen no indication of a siphuncle in it, except a minute curve or sinus in the edge of each septum. The oval wing-like processes, which help the resemblance to *Belosepia*, do not occur in both the known species, but rudiments of them may be traced in *B. Levesquii*. The species from Bracklesham is identical with that of the Paris basin. The anterior portion has never been found*.

CEPHALOPODA TETRABRANCHIATA.

Nautilus.

Examples of the genus *Nautilus* occur in the clay at Bracklesham, but they are in so soft a state that perfect specimens have not been procured. I have not thought proper to place *Nautilus ziczac* under the genus *Clymenia*, although it might well be separated from *Nautilus*. *Nautilus* has an external shell, and there is no reason to suppose that *N. ziczac* differs in this respect from the typical species; while *Clymenia* not only has a discoid shell, but in its structure more resembles internal shells, and probably bears to *Nautilus* a relation similar to that borne by *Scaphites* to *Ammonites*; and *Scaphites* is probably an internal shell, or at least partly so, for its form would not admit the animal to lodge in the terminal chamber. It would be speculating too deeply at present to arrange both *Scaphites* and *Clymenia* among the dibranchiate Cephalopods; but their resemblance to *Spirula* might almost lead to that conclusion.

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* In a visit to Paris in 1847, I compared our Bracklesham *Belosepiæ* with those in the cabinet of M. Deshayes, and I am much indebted to him for his valuable remarks, as well as for several good specimens of *Belosepia* and *Beloptera* from the Paris basin.—F. D.

Subkingdom VERTEBRATA.

Class PISCES.

There is no department of natural history more interesting and instructive than that of Ichthyology. When we consider that more than three-fifths of the earth's surface is covered with water, and that fishes of the greatest beauty and variety abound in countless numbers from the warmest to the coldest latitudes, it is not surprising that this study should have largely occupied the attention of the great Cuvier, and of late years have been so admirably continued and advanced by Professor Agassiz. But not only in the arrangement of recent fishes does the genius of Agassiz appear; he has also introduced a classification founded on the characters of the scales, which is of the utmost importance to the collector of fossil fishes, who is now enabled to abandon the vague term of Ichthyolite, and arrange his cabinet on scientific principles, giving to each specimen its appropriate place in the series of extinct species.

Professor Agassiz has determined nearly fifteen hundred species of fossil fishes in the various strata of the different geological periods; of these five or six hundred belong to this country, all of which are specifically and most of them generically distinct from the eight thousand recent species which he has examined. This is one of the most remarkable results of geology, aided by accurate zoological knowledge.

Fishes have been arranged by Baron Cuvier under two great divisions, called *Ossei* or bony, and *Chondropterygii* or cartilaginous*.

The remains of fishes in a fossil state most frequently found at Bracklesham, are principally of the cartilaginous order, and of the groups of Sharks and Rays. The Sharks (*Squalidæ*) include the genera *Galeocerdo*, *Otodus*, *Lamna* and *Carcharodon*, and the Rays (*Raiidæ*) *Pristis*, *Myliobates* and *Ætobates*. There are

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* Although there has not been discovered in Sussex so great a number and variety of fossil fishes as have been obtained from Sheppey, where the heads of fishes with the teeth in their natural position, and sometimes perfect specimens with scales and fins are found, of which the cabinets of the Earl of Enniskillen, Sir P. Egerton, and Mr. Bowerbank have furnished the means of determining upwards of sixty species, yet the localities of Bracklesham and Selsey may be considered unrivalled for the number of palatal remains of *Myliobates*, *Ætobates* and *Edaphodon*, which occur there in the best state of preservation.

also found a few examples of a much rarer family of cartilaginous fishes, called *Chimæroids*; the Bracklesham fossils of this family belong to the extinct genera *Edaphodon* and *Elasmodus*.

The fossil remains of the osseous order of fishes are few in number, and belong to the families *Siluridæ* and *Sphyrænidæ*, and to the genus *Platylæmus*.

The *Squalidæ* or Sharks have usually teeth conical and sharp-pointed, with a more or less compressed form, sometimes with trenchant or serrate edges and accessory basal denticles.

The *Raiidæ* or Rays found in that locality have teeth more compact than the *Squalidæ*, forming a kind of mosaic pavement in both upper and lower jaws.

Professor Owen observes in his 'Odontography,' page 47, speaking of the *Myliobates* which belong to the family *Raiidæ*, " that the jaws which support and work their dense and heavy teeth, are proportionally strong, and in *Ætobates* they nearly approach the density of true bone; in this subgenus the upper jaw is shorter and more curved than the lower, the anterior extremity of which projects beyond the upper jaw, and can be used like a spade in digging out shell-fish, &c.;" and page 48, " the teeth of the *Myliobates*, like those of the rest of the Plagiostomes, are successively formed at the posterior part of the tesselated series, in proportion as they are worn away in front." This worn and rugged character is well preserved in fossil specimens.

One or two specimens of an existing species of this curious genus, *Myliobates Aquila* (Eagle Ray), have been taken, according to Mr. Yarrell, on the English coast; they abound in the Mediterranean and Southern seas. The jaws and teeth of the *Zygobates*, one of this family, are often brought from China in the boxes containing crustacea and insects. Few fossils perhaps would have more perplexed a comparative anatomist than the palatal tooth of an extinct *Myliobates*, unless he had been acquainted with the recent genus.

The chimæroid genus *Edaphodon*, discovered and so named by the Very Rev. Dr. Buckland, had teeth adapted for crushing and bruising enclosed in the substance of the jaw, which are easily perceived by their peculiar structure. In the Edaphodon they are three in number, arranged in a horizontal position, their superior surfaces being more or less worn down and pitted, showing the remains of calcigerous tubes.

The *Pristis* or Saw-fish.—This curious fish has derived its name from a very singular and formidable weapon projecting from the anterior part of the head, provided with strong teeth as they are called, situated in a series of deep alveoli in each lateral margin; the true maxillary teeth being extremely small, and inadequate to destroy and secure its prey. But with this strong beak the Pristis is said to attack successfully even the larger cetacea. This genus was formerly placed with the *Squalidæ*, but Professor Agassiz considers the family of *Raiidæ* to have a stronger claim for its relationship.

Sphyrænodus, a genus formed by Agassiz.—The remains of one species, *S. priscus*, are occasionally found at Sheppey; at Bracklesham they may be considered very rare fossils. A magnified view showing the beautiful structure of the tooth of this genus is given in Professor Owen's 'Odontography,' pl. 54, under the name of *Dictyodus*.

Species of the recent genus *Sphyræna* exist in the Mediterranean, and are abundant in the Brazilian and American seas; they are considered more voracious than sharks, and particularly greedy of human flesh.

Siluridæ.—These fish are furnished with a strong dorsal defensive bone, and the first ray of the pectoral fin is composed also of a strong spine attached to the scapular arch or shoulder-bone; both these weapons are so articulated as to be erected or depressed according to the will of the animal. They frequent rivers, estuaries and lakes.

The dental remains of fish are much sought after by Palæontologists, being not only beautiful objects in themselves, but often the only indications of extinct species: they prove also the existence of a contemporaneous assemblage of plants and animals which must have supplied them with food.

Order CARTILAGINEI, *Cuv.* (PLACOIDEI, *Agassiz.*)

Suborder RAIIDÆ, *Müller.*

Genus *Myliobates.*

Myliobates.—The remains of the dental apparatus of these fish furnish some of the most interesting fossils of Bracklesham; they are commonly called 'palates,' and are found lying loose on the exposed surface of the London-clay formation, more especially after high and rough tides, and at the western part of the bay. Detached dental plates are very common, but good specimens with 6 or 7 rows are rare. I have during the last ten years collected a great variety of these curious crushing teeth, the specimens varying from half an inch in size to five inches; the enamel in most cases is worn away; when it remians, the specimen presents a beautiful black lustre. Professor Owen has observed that the dental plates in *Myliobates*, *Ætobates* and the allied genera are united by sutures, a beautiful adaptation to provide against the shocks and rough usage to which they must be exposed; it is the only instance of this mode of junction of contiguous teeth known in the animal kingdom. I have represented on Tab. X., XI. & XII., six well-marked species, and I have no doubt several others in my collection may be easily defined; the age and size of the fish must be borne in mind in making these comparisons, for we find the teeth of the recent *Myliobates* varying in the same species according to those circumstances. I saw in Cuvier's museum in the Jardin des Plantes, an extensive collection of recent specimens elucidating this range of variety; it is also exemplified by some of the specimens in our own College of Surgeons. In four specimens of *Zygobates* in my cabinet, no two are alike; some vary in the size and length of the principal dental plates, but more particularly in the shape and size of the accessory or lateral ones.

Myliobates Dixoni. (Tab. X. figs. 1, 2; Tab. XI. fig. 14; Tab. XII. fig. 3.)

Professor Agassiz has done me the honour to give my name to this species; he considers it very different from those figured in his work, and does not hesitate to distinguish it from all its congeners. The dental plates are very large, and the relative disproportion of their dimensions very remarkable, the average length of the principal plates being about a fifth of their width; the lateral plates are small, narrowish and elongated. In some specimens there is a strongly marked depression or groove near the edge; this is well seen in fig. 3, Tab. XII. The figured specimens are all from the upper jaw. The fine one, fig. 14, is from the cabinet of G. A. Coombe, Esq.

One singular example of part of the dental armour of the upper jaw of a species of *Myliobates*, nearly allied to, or identical with the *M. Dixoni*, has the small lateral plates developed on one side only, the large or principal plates thinning off to an edge on the opposite side; this is doubtless an abnormal or accidental variety.

Myliobates toliapicus. (Tab. X. figs. 3, 4, 5; Tab. XII. fig. 4.)

This species resembles the recent *M. aquila*; the difference in the fossil consists in the regularity of the diamond-shaped accessory plates, which in the recent fish are generally unequal. The specimen I have figured differs from the one bearing this specific name in Professor Agassiz's superb work, in having the surface of the teeth uniformly punctated, instead of striated or irregularly plicated, but in all other respects it is similar. I have one specimen from the Park-bed, allied to this species, with three rows of lateral teeth, the greatest number I have ever seen preserved.

The specimen figured, Tab. X. fig. 3, is from the lower jaw; and fig. 4 represents the under surface, showing the strong furrows so peculiar to the dental plates of this family. This mode of attachment is wonderfully adapted for giving strength to the teeth, whilst the substance to which they are attached favours the removal of the old and worn-away dental plates, which are succeeded by new ones from behind.

Myliobates irregularis. (Tab. XI. fig. 15.)

Of this species I am enabled to figure the most magnificent lower jaw that has as yet been discovered; the great irregularity of the dental plates, their shortness compared to their breadth, their solidity and depth, which in the centre of the specimen is one inch, are characters quite sufficient to determine it to be a new species. The black glossy character of the specimen is well shown by Mr. L. Aldous in the engraving. *From the Cabinet of G. A. Coombe, Esq.*

Myliobates striatus. (Tab. XII. fig. 2.)

The dental plates of this species are finely striated on the surface, and of considerable size. The original specimen named by Agassiz was from the Very Rev. Dr. Buckland's collection, and was found at Sheppey. The specimen engraved is from the lower jaw, and is half an inch thick in the centre.

Myliobates Edwardsi. (Tab. XI. fig. 16. Lower jaw.)

This specimen I found in one of my visits to Bracklesham with my friend Fred. Edwards, Esq., and have named it after him; it was considered a new species by Agassiz. In some of its characters it resembles *M. toliapicus,* but the gradual increase of the length or antero-posterior diameter of the dental plates from the back to the front or worn-down extremity of the series is very remarkable, combined with the elongated character of the second row of diamond-shaped lateral teeth. It is not quite half an inch thick in the centre. In young and smaller specimens of this tooth the gradual increase of the dental plates is also very constant.

Myliobates contractus. (Tab. XI. fig. 17. Lower jaw.)

The great antero-posterior, as compared with the transverse diameter of the dental plates, their uniformity, and the long narrow character of the first row of diamond-shaped lateral teeth, clearly distinguish this species.

It is half an inch in thickness at the middle.

A recent lower jaw of *Myliobates* is figured at Tab. XI. fig. 1, from the College of Surgeons, which well shows the resemblance of the recent to the fossil species. Professor Agassiz considered this a new and unpublished species.

Genus *Ætobates.*

Good specimens of this genus are of rarer occurrence at Bracklesham than those of *Myliobates.* Single dental plates are often met with ; they are picked up in the same situations and under the same circumstances as those of *Myliobates.*

Ætobates irregularis. (Tab. X. figs. 6, 7, 8 ; Tab. XII. figs. 2, 3, 4.)

The specimens figured in this work belong to the lower jaw ; those figured by M. Agassiz in his magnificent work are portions of the upper jaw of the same species. Mr. Bowerbank has a fine lower jaw of this species, with ten dental plates, and I have one with nine plates.

Fig. 2 of Tab. XI. has the enamel beautifully preserved ; it was found by Robert Drewitt, Esq., on a visit to Bracklesham with myself and Mr. Coombe.

Fig. 4 is a much-worn specimen, not a quarter of an inch in thickness ; it nearly resembles *Æt. subarcuatus* of Agassiz.

Ætobates convexus. (Tab. XI. fig. 5.)

This species is readily recognised by the great convexity and tapering extremities of the dental plates, which come almost to a point on each side.

Ætobates subconvexus. (Tab. XI. fig. 6.)

The dental plates of this species are more regular and not quite so convex as in the preceding; their extremities are also not so pointed: they are very different from those of *Æ. irregularis.*

Ætobates subarcuatus.

The characters of this specimen agree with Professor Agassiz's description of *Æt. subarcuatus*; I have a dental plate of this species 4 inches in width, which must have belonged to an enormous fish. It is very difficult to distinguish this species from *Æt. irregularis.*

Ætobates marginalis. (Tab. XII. fig. 1.)

On showing this specimen to Professor Agassiz, he considered that it was distinct from all the former species, and suggested that *marginalis* would be a good name for it. The characters of this species are so obvious and so different from any other, that it is at once recognised. The figure (Tab. XII. fig. 1) represents a portion of the upper jaw; the dental plates are much arched, very strong, and $\frac{3}{4}$ of an inch in thickness. The margins are apparently bordered by accessory teeth, but on the underside the dental furrows extend uninterruptedly to the margins—a character which at once distinguishes it from *Myliobates.* I have seen only two specimens; both are in my own collection.

Ætobates rectus. (Tab. XI. fig. 8.)

I have several detached dental plates of different sizes, so straight as to justify the above specific name, though in many respects they resemble *Æ. irregularis.*

Tab. XI. fig. 9.—Recent lower jaw of *Ætobates,* showing the natural position of the dental plates. *From the Museum of the College of Surgeons.*

Tab. XI. fig. 10.—The upper and lower jaws in their natural position from a small recent *Ætobates*; the upper jaw being nearly perpendicular to the lower, exemplifying their adaptation for triturating the smaller mollusks and crustacea. We find the same curved character of the upper jaw, and adaptation of the dental apparatus in the genus *Myliobates.*

From the Museum of the College of Surgeons.

Family Pristidæ.

Genus *Pristis*.

In Tab. XII. figs. 9 & 10, are given two views of the natural size of one of the rostral teeth of a Saw-fish, which differs by its curvature from all the known species recent or fossil, and for which the name *Pristis contortus* is proposed.

Family Edaphodontidæ, *Owen*.

Genus *Edaphodon*.

The beautiful jaws of this chimæroid fish are usually found in the substance of the London clay, after the surface has been well-bared by high tides and storms; the specimens are seldom rolled: when met with, it is advisable to pursue the search, for in more than one instance the premaxillary bones (formerly called *Passalodon*) have been also discovered*.

Suborder SQUALIDÆ, *Müller*.

Galeocerdo latidens. (Tab. XI. figs. 22, 23.)

The genus *Galeocerdo* has been formed by Agassiz from the genus *Galeus* of Cuvier. See page 230, vol. iii. of Agassiz's work on Fossil Fishes.

There can scarcely be any doubt but that the species above named is the same as that figured in the 'Poissons Fossiles,' pl. 26. fig. 22 & 23. The anterior margin is less arcuate than in most of the other species; the cone is sharp and pointed, the posterior notch forms a very sharp angle, below which the

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* A paper of great value to the palæontologist published in the 'Quarterly Journal' of the Geological Society for May 1847, by Sir Philip Grey Egerton, Bart., F.R.S., V.P.G.S., &c., on the Nomenclature of the Fossil Chimæroid Fishes.

Sir Philip Egerton has made a new arrangement of the dental armature of these curious fishes, and has clearly pointed out that the genus *Passalodon* must be abandoned, for the fossils constituting that genus are, in fact, the premaxillary apparatus of *Edaphodon*, and in like manner *Scaphodus* is the premaxillary of *Elasmodus*. Discoveries of this character are most valuable, and demonstrate the advantage of sound anatomical knowledge. The fossils of the genus *Edaphodon*, found in such good preservation at Bracklesham, have been in some measure the means of establishing these facts.

The genus *Elasmodus*, formed by Sir Philip Egerton, is remarkable for a laminated structure in both upper and lower jaws; this character suggested its generic name. "It has also, like *Edaphodon*, serrations are well-developed, but they are much finer on the anterior portion of the tooth ; this latter character distinguishes it from *G. Arcticus.*

The original specimen from which M. Agassiz's figure is taken is in the Museum at Paris, the locality unknown.

Lamna elegans. (Tab. X. figs. 28, 29, 30, 31.)

The beautiful teeth of this species are very common at Bracklesham, more so than at Sheppey ; the young teeth are finely striated, but the striæ are scarcely observable in the larger specimens. This species is common in the calcaire grossier, and has been also noticed in the crags*.

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three triturating tubercles, but the dentine of which they are composed is confluent, being rolled round like a scroll in the substance of the bone, one edge forming the margin of the tooth, the other buried in the centre."

I subjoin the Nomenclature proposed by Sir Philip Egerton of the *Edaphodontidæ*, as far as they relate to the Chalk and Eocene formations.

Subclass ELASMOBRANCHII, *Bonap.*

Order HOLOCEPHALI, *Müller.*

Family EDAPHODONTIDÆ, *Owen.*

EDAPHODON, *Buckland.*				
—— Bucklandi, *Agass.*.	Upper and lower maxillaries ...	E. latidens, *Buck., sp. inedit.*	Proc. Geol. Soc., vol. ii. p. 687 .... Agass., vol. iii. p. 351...	Bagshot sand and Bracklesham.
——eurygnathus, *Agass.*	Premaxillary ... Upper maxillary	Passalodon, *Buck.*	Proc. Geol. Soc., vol. ii. p. 687 .... Agass., vol. iii. p. 352...	
—— gigas, *Egert.*	Premaxillaries...	....	Proc. Geol. Soc., vol. iv. pt. 1. p. 211	Chalk, Houghton and Lewes.
—— helveticus, *Egert.*.	Lower maxillary	....	Proc. Geol. Soc., vol. iv. pt. 1. p. 154	Molasse, Switzerland.
——leptognathus, *Agass.*	Upper and lower maxillary	E. angustidens, *Buck., sp. inedit*............................	Proc. Geol. Soc., vol. ii. p. 687 .... Agass., vol. iii. p. 351...	Bagshot sand and Bracklesham.
—— Mantelli, *Buck.* ...	Lower maxillary	Chimæra Mantelli, *Buck.* ...	Proc. Geol. Soc., vol. ii. p. 206	Chalk, Lewes and Worthing.
—— Sedgwicki, *Agass.*	Lower maxillary	Chimæra Sedgwicki, *Agass*...	Agass., vol. iii. p. 349. Feuilleton 116.........	Greensand, Cambridge.
ELASMODUS, *Egerton.*				
—— Greenovi, *Agass.*..	Lower maxillary	Chimæra Greenovi, *Agass.*...	Agass., vol. iii. p. 350...	Unknown.
—— Hunteri, *Owen* ...	Lower maxillary	....	Odontography, p. 66 ...	Sheppey and Bracklesham.
—— ———, —— ..	Premaxillary ...	Scaphodus, *Buck., inedit.* ...	Odontography, p. 66 ...	Sheppey and Bracklesham.

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* In the cabinet of Dr. Robertson at Chatham, there is a portion of the jaw of this Shark with several teeth in it, found at Sheppey.

Carcharodon heterodon. (Tab. XI. fig. 19.)

The finely enamelled tooth of this species agrees so well with M. Agassiz's description as to leave no doubt as to its identity. The teeth are strongly serrated and curved in the lower jaw; in the upper jaw they are straight. I have figured a tooth from each jaw; the lateral or accessory lobes are more coarsely serrated than the body of the tooth. In Mr. Keele's cabinet at Southampton there are several teeth of this species which were found in that vicinity.

Otodus obliquus. (Tab. X. figs. 32, 33, 34, 35.)

These teeth are very common at Sheppey, where they occur of a much larger size than at Bracklesham; I have one large specimen from Bognor.

Otodus lanceolatus. (Tab. XI. figs. 20, 21.)

The tooth figured agrees in so many respects with M. Agassiz's description of this species, that I retain for it his name *lanceolatus*; it is however thinner and rather more lanciform in its character.

Vertebræ (Tab. X. figs. 24, 25, 26, & 27) of fishes. I have never seen more than three or four in one mass; when first found they are very soft and fragile and require great care for their preservation. The largest vertebra of a shark which I have seen is in Mr. Bowerbank's collection, and measures nearly 3 inches in diameter.

Order OSSEI, *Cuvier*, GANOIDEI, *Agassiz.*

Genus *Silurus.*

Tab. XI. fig. 11 exhibits part of the scapular arch with the strong dentated spine of the pectoral fin of a Siluroid fish, of a new species, and the first that has been discovered in a British formation. Fig. 12 is a view of the symmetrical dorsal spine of the same Silurus. Fig. 13 gives two views of the articular surface of the pectoral spine. This rare species is dedicated to Sir P. de M. Grey Egerton, Bart., whose unrivalled collection of fossil fishes, and whose intimate knowledge of that department of Palæontology, have served on many occasions to the advancement of Geology, and have proved of essential aid to the author in the present part of his work.

Family Pycnodontes.

Periodus Kœnigii, Agassiz. (Tab. X. fig. 13.)

The genus *Periodus* differs from *Pycnodus* in having the apex of the tooth surrounded by a large furrow; the figured specimen must have belonged to a large fish; it is similar in size to the original fossil from Sheppey, in the Collection of the Very Rev. Dr. Buckland, published in M. Agassiz's magnificent work.

Mr. Keele has a fine specimen of *Periodus* found near Southampton.

Order CYCLOIDEI, *Agassiz.*

Genus *Platylæmus**.

This genus is founded upon the dental plates figured in Tab. XII. figs. 11, 12 & 13. They are of two forms; the one, 12 & 13, symmetrical, the other (fig. 11) unsymmetrical and evidently one of a pair of plates, resembling the upper pharyngeal dental plates of a *Labrus* or *Scarus* in general form; whilst the symmetrical plate answers to the lower symmetrical pharyngeal plate in the same fishes. The fossil plates consist of a continuous dentary mass, with a smooth and nearly flat enamelled surface, finely punctate; the depressions indicating the extremities of the vascular canals of the numerous filamentary vertical denticles, of which the whole mass is composed. On the attached surface of the plate, three ridges converge from the three angles to a central pointed process. The specific name *Colei* is in honour of the Right Hon. the Earl of Enniskillen, who, in an excursion with the author to Bracklesham, obtained a fine specimen of this new species of fossil fish.

Sphyrænodus, Agassiz.

Sphyrænodus gracilis.—The specimen figured M. Agassiz pronounced a new species, having more slender teeth than *S. priscus.*

Family Xiphioides.

Genus *Cœlorhynchus.*

The fossils representing this genus are considered by M. Agassiz to be the nasal defensive bones of a fish of the *Xiphioid* family, and related to *Istiophorus*: they are common at Bracklesham, and are occasionally found at Sheppey.

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* Der. πλατὺς *latus*, λαιμὸς *gula*, broad-throat.

Description of the remains of the Fossil Reptiles from the Tertiary deposits of Bracklesham and Bognor, in the Museum of FREDERICK DIXON, Esq., *or figured in the present Work.* By PROFESSOR OWEN, F.R.S.

Class REPTILIA.

Order CROCODILIA, *Owen.*

THE existing species of the order *Crocodilia*[*] all belong to the section with *procœlian vertebræ*, or those having the fore-part of the vertebral body concave, the hind-part convex; and they constitute the types of three genera; which, besides being marked by certain characters of the tegumentary and perishable parts, are distinguished by others imprinted upon the enduring and fossilizable framework, viz. the bones and the teeth. Of these characters the most decisive and constant are afforded by the size, form and proportions of the teeth, and the relations of certain teeth of the under jaw to pits or grooves in the upper jaw. For example, "the reception of the fourth or canine tooth of each ramus of the lower jaw into a pit in the palate, where it is concealed by the upper jaw when the mouth is shut," is a character of the genus *Alligator*; "the reception of the corresponding teeth in notches, one on each side of the border of the upper jaw, where they are exposed to view when the mouth is shut," is a character of the genus *Crocodilus*. In both *Alligator* and *Crocodilus* the skull is depressed, the jaws thick and not very long, the borders of the jaws festooned, and the teeth of unequal size: the muzzle is broad and obtuse in most of the

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[*] 'Report on British Fossil Reptiles' in 'Report of British Association' for 1841, p. 65. In this Report I separated the *Crocodilia*, as an order, from the *Lacertilia*, *Dinosauria*, *Pterosauria*, and *Enaliosauria*, belonging to the great and diversified order *Sauria* of Brongniart and Cuvier. The existing forms of my order *Crocodilia* belong exclusively to the first section, or those "with concavo-convex, or procælian vertebræ," which section answers to the group defined and called '*Loricata*' by Merrem (Tentamen Systematis Amphibiorum, 8vo, 1820), and *Emydosauria* by MM. De Blainville and Gray. The order '*Crocodilia*,' as defined in my 'Report,' includes, however, some extinct species not admitted into the '*Loricata*' of Merrem, and excludes others which are ranked amongst the *Loricata* of Fitzinger, and the *Emydosauria* in the British Museum; I, therefore, found myself compelled to propose a distinct name (*Crocodilia*) for such differently constructed order.

Alligators, least so, perhaps, in *Alligator palpebrosus*, but is narrower and more tapering in most Crocodiles; and in some species, as e.g. *Croc. acutus* and *Croc. Schlegelii*, the jaws are lengthened as well as attenuated, and indicate a transition to the Gavials. In this genus (*Gavialis*) the jaws are very long and slender, their alveolar borders almost straight; the teeth are nearly equal in size and similar in form, and the first as well as the fourth teeth in each ramus of the lower jaw pass into notches in the border of the upper jaw when the mouth is shut. The symphysis of the lower jaw is of extreme length, its transverse section almost semicircular, and, as the corresponding part of the upper jaw presents a similar form, the elongated muzzle is characterised as 'cylindrical.'

Genus CROCODILUS, *Merrem.*

Species. *Crocodilus Spenceri.*

Remains of extinct species of true Crocodiles (*Crocodilus*, Merrem) have been discovered at Sheppey, Bognor and Hordle. Mr. Dixon possesses good examples of the *Crocodilus Spenceri* from the two former localities; and the Marchioness of Hastings has almost perfect specimens of the crania of the *Crocodilus Hastingsiæ*, from the Hordle Cliff. Dr. Mantell* has alluded to a fossil Alligator found in the Hordle Cliff, but I have not yet seen any specimen, description or figure manifesting the characters and determining the existence of the American genus of *Crocodilia* (*Alligator* or *Champsa*) in British eocene strata.

The specimen of *Crocodilus Spenceri*, from Bognor, in Mr. Dixon's museum, consists of a chain of eight vertebræ, including the sacral and characteristic biconvex first caudal, which are represented of their natural size in Tab. XV. fig. 1. A dorso-lateral bony scute (fig. 2) adheres to the same mass of clay close to the vertebræ, and doubtless belonged to the same individual. This fine specimen was discovered, and presented to Mr. Dixon, by the Rev. John Austin, M.A., rector of Pulbrough, Sussex. Fig. 3 is a rolled specimen of the anterior caudal vertebra of a large example of the *Crocodilus Spenceri*, from Sheppey.

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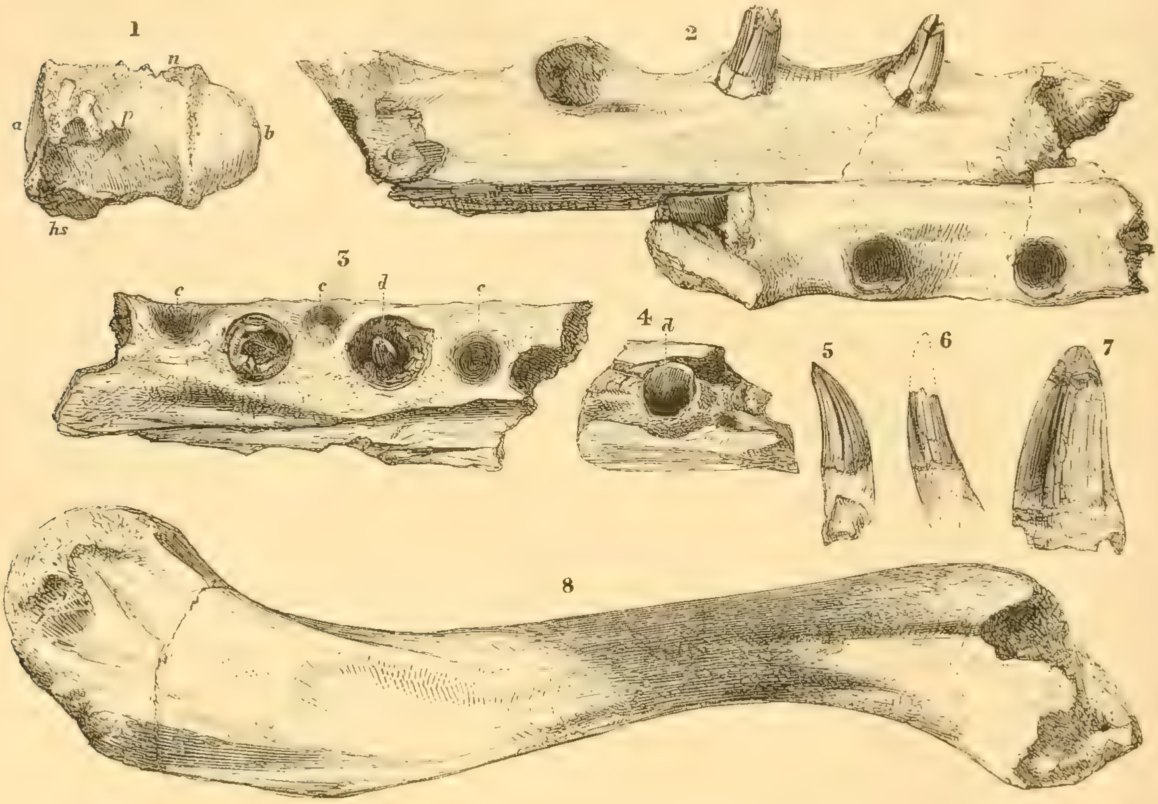
* "The only vestige of any other order of Reptiles observed in these strata is a tooth of the Crocodilian type, apparently of the *Alligator Hantoniensis*, a fossil species described by Mr. Searles Wood from a splendid specimen of the lower jaw and teeth, found in the freshwater beds at Hordwell Cliff on the Hampshire coast."—*Geological Excursions round the Isle of Wight*, 8vo, 1847, p. 115.

Genus Gavialis, *Oppel.*

Species. *Gavialis Dixoni.*

The characters of the genus *Gavialis* are much more strongly marked than are those which distinguish the Crocodiles from the Alligators, and the portions of the lower jaw of the Crocodilian figured in Tab. XII. figs. 22, 23 & 24, and in the subjoined woodcut, demonstrate, by the slender proportions of the mandibular rami (figs. 2 & 3), the extent of the symphysis, the uniform level of the alveolar series, and the nearly equal distance of the sockets of the comparatively small, slender and equal-sized teeth, the former existence in England, during the early tertiary periods, of a Crocodilian with the maxillary and dental characters of the genus *Gavialis*. These characters are, however, participated in by some of the extinct Crocodilians of the secondary strata, in which they coexist with a different



Teeth and bones of *Gavialis Dixoni.*

type of vertebra from that of the recent and known tertiary Crocodilian genera; it became necessary, therefore, to ascertain what form of vertebra might be so associated with the fossil Gavial-like jaws and teeth in the Bracklesham eocene deposits, as to justify the conclusion that such vertebræ had belonged to the same species as the jaws. Now, the only Crocodilian vertebræ that have yet been found at Bracklesham, so far as I can ascertain, present the procælian type of articular surfaces of the body, *a* & *b*, like that in Mr. Dixon's collection, fig. 1 of the above woodcut. This vertebra answers to the last cervical or first dorsal vertebra in the existing Crocodilians, and accords in its proportions with that in the Gangetic Gavial: the parapophysis, *p*, [lower transverse process articulating with the head of the rib] is relatively shorter antero-posteriorly. The broad rough neurapophysial sutural surfaces, *n*, meet upon the middle of the upper part of the centrum; the elsewhere intervening narrow neural tract sinks deeper into the centrum than in the modern Gavial, but is perforated, as in that species, by the two approximated vertical vascular fissures. The hypapophysis, *h s*, (process from the inferior surface of the centrum) has been broken off in the fossil, but it accords in its place and extent of origin with that in the anterior dorsal vertebra of the Gavial. Assuming the fossil procælian vertebræ from Bracklesham, and the above-described vertebra in particular, to have belonged to the same individual or species as the portions of fossil jaw, figs. 2 & 3, then these mandibular and dental fossils must be referred to the genus *Gavialis*, or to the long-, slender- and subcylindrical-snouted *Crocodilia* with procælian vertebræ. This genus is now represented by one or two species peculiar to the great rivers of India, more especially the Ganges; and the fossil differs from both the *Gavialis gangeticus*, Auct., and from the, perhaps nominal, *Gavialis tenuirostris*, Cuv., in the form and relative size of the teeth. The crown is less slender in the fossil than in the existing Gavials, and less compressed, its transverse section being nearly circular. There are two opposite principal ridges, but they are less marked than in the existing Gavials; and are placed more obliquely to the axis of the jaw, *i.e.* the internal ridge is more forward, and the external one more backward, when the tooth is in its place in the jaw. In the modern Gavial the opposite ridges, besides being more trenchant, are nearly in the same transverse line. The other longitudinal ridges on the enamel of the fossil teeth are more numerous, more prominent and better defined, than in the existing Gavials: the intermediate tracts of enamel present the same fine wrinkles in the fossil as in the existing Gavials' teeth.

On comparing the fragment of the fossil lower jaw with a specimen of a lower jaw of the *Gavialis gangeticus* of the same breadth across the symphysial part, at the intervals of the sockets, which breadth is 3 centimeters (1 inch 3 lines), I find that the longitudinal extent of 10 centimeters (near 4 inches) of a ramus of the fossil jaw includes five sockets; but in the Gangetic Gavial compared the same extent of jaw includes seven sockets, showing that the teeth are fewer as well as larger in the fossil Gavial in proportion to the breadth of the jaws.

The second portion of the jaw, fig. 3, is from the part where the rami diverge posteriorly from the symphysis, and near the posterior termination of the dentary series. Here the teeth become shorter in proportion to their thickness, and somewhat closer placed together: there is a shallow depression (*c*, *c*) in each interspace of the teeth, for the reception of the crowns of the opposite teeth when the mouth is shut. These depressions are longer, deeper and better defined in the fossil than in the recent Gavial of the same size.

The fragments of jaw and teeth of the fossil Gavial of Bracklesham show examples of young teeth penetrating the base of the old ones, according to the law of succession and shedding of the teeth which characterises the existing *Crocodilia*: fig. 3 shows the apex of one of the successional teeth at *d*; and fig. 4 *d* the hollow base of the same incompletely formed tooth seen from below.

Besides the fossil jaws, teeth and vertebræ of the extinct Gavial, an entire femur (fig. 8) of a Crocodilian has been discovered in the eocene deposits at Bracklesham, which, in its proportions, agrees with that bone in the Gavial of the Ganges. Cuvier, in his comparison of the bones of the Gavial with those of the Alligators and true Crocodiles, merely observes, "La forme des os du Gavial ressemble aussi prodigieusement à celle des os du Crocodile, seulement les apophyses épineuses des vertèbres sont plus carrées*."

With regard to the femur, this bone is more slender in proportion to its length in the Gangetic Gavial than in the *Crocodilus biporcatus* or the *Alligator lucius*, and the anterior convex bend of the shaft commences nearer the head of the bone; and in these characters the fossil femur from Bracklesham corresponds with the modern Gavial, and differs from the Crocodiles and Alligators, and also from the *Crocodilus Hastingsiæ*, of which species specimens of the fossil femur have been kindly submitted to me by the Marchioness of Hastings and Alexander Pytts Falconer, Esq. The fossil femur of the Gavial from Bracklesham (fig. 8) may therefore be referred, with the utmost probability, to the same

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* Ossemens Fossiles, 4to, tom. v. pt. 2. p. 108.

species as the portions of jaw, teeth, and vertebræ above described; and as these clearly demonstrate a species distinct from any known Gavial*, I propose to call the extinct species of the eocene deposits at Bracklesham, *Gavialis Dixoni*, after my esteemed friend, by whose scientific and zealous investigations so much valuable additional knowledge has been obtained respecting the fossils of that rich, but previously little-known locality.

The tooth from Mr. Coombe's cabinet, represented of the natural size in fig. 7 of the woodcut, p. 208, resembles in its proportions and obtuse extremity the teeth of the Crocodiles rather than those of the Gavials, and at first sight reminded me of those of the *Goniopholis* or amphicælian Crocodile of the Wealden period. On comparing it closely with similar-sized teeth of that species, the enamel-ridges were more numerous and decided in the *Goniopholis*; and the delicate reticular surface in the interspaces of the more widely-separated and feebler longitudinal ridges in the Bracklesham tooth was wanting in the *Goniopholis*. The minute superficial characters of the enamel of the large and strong Crocodilian tooth from Bracklesham closely agree with those of the *Gavialis Dixoni*. It is just possible that this may be a posterior tooth of a very large individual of that Gavial, as the teeth become at that part of the jaw shorter in proportion to their thickness in the modern Gavials. If it should not belong to that Gavial, it must be referred to a Crocodile distinct from those species of the secondary strata, or those existing Crocodiles which have teeth of a similar form; since they present a different superficial pattern of markings on the enamel.

Order OPHIDIA.

Genus PALÆOPHIS.

In the 'Transactions of the Geological Society of London,' 2nd Series, vol. vi. p. 209, pl. 22, I described and figured some fossil vertebræ of a Serpent from the eocene clay of Sheppey, corresponding in size with those of a *Boa constrictor*

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* The teeth of the fossil *Gavialis crassidens*, F. & C., from the Himalayan tertiary beds, are relatively larger than those of the Bracklesham Gavial. The fossil Crocodilian frontal bone from the Montmartre eocene, described by Cuvier in the 3rd volume of the 4to Ed. (1822) of the 'Ossemens Fossiles,' p. 336, and figured in pl. 76. figs. 7 & 8, shows by its form, as Cuvier has stated, that it belonged to a true Crocodile or Alligator, not to a Gavial.

The extinct Crocodilians called 'Gavials' by Cuvier in vol. v. pp. 127, 143, belong to different genera and to different sections of the order *Crocodilia*, those viz. characterized respectively by subbiconcave or by convexo-concave or opisthocælian vertebræ.

of about ten feet in length; but differing in their greater length as compared with their breadth, in the inferior position and uniform convexity of the diapophysis (tubercle supports which the rib), in the minor transverse extent of the zygapophyses (external and inferior articular processes) both at the front and back part of the vertebra, in the production of the posterior ridges extending from the neural spine to the posterior zygapophyses backwards into angular processes, and in other characters. For the distinct genus and species of Serpent thus indicated, the name of *Palæophis toliapicus* was proposed.

I have since received a vertebra of this species from Sheppey, of larger size than those figured in the above-cited memoir, and indicating a serpent of twelve or fourteen feet in length. The under surface of another vertebra of the ordinary size from Sheppey (fig. 15), but more perfect than the specimen figured in the original Memoir, was carinate along the middle, the keel being produced posteriorly into a low compressed tubercle, close to the articular ball, not separated therefrom by a smooth, flat tract, as in the existing Boas and Pythons.

In the 'Annals and Magazine of Natural History' for September 1841, I recorded the occurrence of smaller vertebræ of a *Palæophis,* indicating a species of about seven feet in length, found fossil in the eocene sand at Kyson in Suffolk, and at the same time the discovery by Mr. Dixon of fossil vertebræ "of a distinct species of *Palæophis* from the eocene clay at Bracklesham, corresponding in size with those of a Boa constrictor of upwards of twenty feet in length." (p. 2.) A mutilated specimen of one of these vertebræ is given in Tab. XII. fig. 14; but since this was figured Mr. Dixon has obtained more perfect examples of the great *Palæophis* of Bracklesham, from which I have selected the specimens represented in the woodcut, p. 213, figs. 1, 2 & 3, to illustrate its specific differences, independently of size, from the *Palæophis toliapicus*, figs. 14 & 15, p. 216, as well as from the existing Boa Constrictors and Pythons, which all show the type of vertebra represented in the figures 4, 5 & 6, p. 213, of the great *Python Sebæ.*

If the ophidian vertebræ from Bracklesham be compared with those from Sheppey, it will be seen, that although the anterior articular concavity (*c*, *c*) is of equal size in the same-sized specimens, and the prezygapophyses (*z e*) have the same restricted transverse development characteristic of the genus *Palæophis*, yet the breadth of the conjoined bases of the epizygapophyses (*z i*) is broader, and the depth of the interval between these and the prezygapophyses (*z e*) is greater in the Bracklesham species (*Palæophis Typhæus*). The vertebræ of the *Pal. Typhæus* (fig. 3) are shorter in proportion to their breadth and height than in the *Pal. toliapicus* (fig. 14), and the under surface of the vertebræ of both the *Pal. Ty-*

phæus and a second species of *Palæophis* (*Pal. porcatus*, fig. 10) from Bracklesham, instead of being carinate, as in *Pal. toliapicus* (fig. 15, p. 216), sends down two short subcompressed tubercles (hypapophyses), one from the fore-part, and a deeper one, like a short spine, from the back-part of the under surface: neither of these are continuous with or touch their corresponding terminal articular surfaces of the centrum.

Palæophis Typhæus.

Fig. 1.

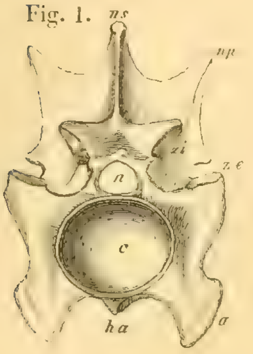


Fig. 2.

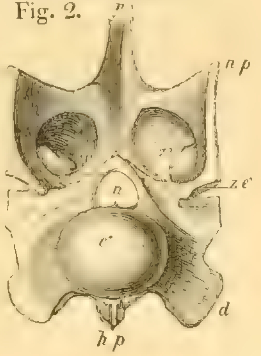


Fig. 3.

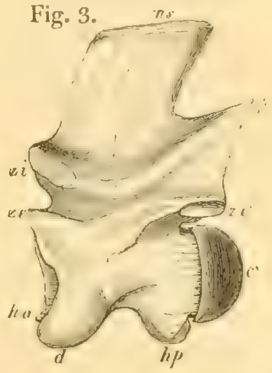


Fig. 4.

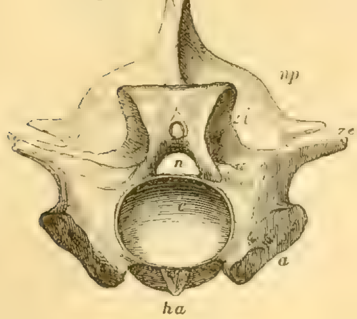


Fig. 5.

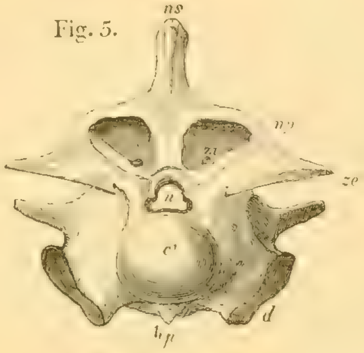
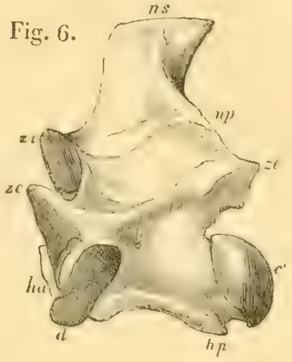


Fig. 6.



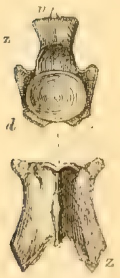
Python Sebæ.

Fig. 3 gives a side-view of one of the largest vertebræ of the *Palæophis Typhæus*, and fig. 6 a similar view of a corresponding vertebra of a specimen of the *Python Sebæ* upwards of twenty feet in length. The following differences are observable: the articular ball, *c'*, is set almost vertically upon the end of the body in *Palæophis*, whilst it is inclined obliquely upwards in the *Python* (fig. 6); the posterior hypapophysis, *h p*, is more produced in the *Palæophis*; the diapophysis, *d*, is also more produced, and its articular surface convex in both directions, not concave vertically at the lower half, as in *Python*. The posterior diverging ridges from the base of the neural spine send back the characteristic angular processes, *n p*, fig. 2, in the great *Palæophis* of Bracklesham, as in the species of Sheppey: the neural spine, *n s*, has a greater antero-posterior extent in *Palæophis*; it commences at the fore-part of the conjoined epizygapophyses, *z i*, and the diverging ridges, *n p*, fig. 3, are continued directly from the back part of its base; not from a little in advance of this, as in *Python*, *n p*, fig. 6. The neural spine in *Palæophis* is also longer than it is represented in the figure 3 (as I have ascertained by vertebræ subsequently discovered), and proportionally longer therefore than in *Python*. The anterior views of the corresponding vertebræ of *Palæophis* (fig. 1) and *Python* (fig. 4) show the characteristic differences in the transverse extent of the prezygapophyses, *z e*, and the shorter diapophyses, *d*, which are sessile in *Python*, but subpedunculate in *Palæophis*. The posterior views, figs. 2 & 5, show the still more striking difference in the form of the back-part of the platform or basis of the neural spine (*n s*), which is quadrate in *Palæophis*, but triangular in *Python* and all known existing serpents.

In the inferior transverse extent of the prezygapophyses, *z e*, and zygapophyses, *z e′*, of the *Palæophis*, we may discern a minor degree of deviation from the Lacertian type than in modern serpents; but in the genus of Lacertians (*Iguana*), which makes the nearest approach to the typical Ophidians by the presence of upper articular processes or epizygapophyses in addition to the normal ones at both ends of the neural arch, such accessory processes are distinguishable in the *Iguana* by their smaller relative size and their closer approximation to the inferior and normal zygapophyses: the diapophyses are also smaller and more elevated in the *Iguana* than in the *Palæophis*.

On comparing together eighteen palæophidian vertebræ of different sizes from Bracklesham, the smallest being of the dimensions represented in figs. 7 & 8, and thence gradually increasing to the size of the specimen figs. 1, 2 & 3, I find the following differences: in fig. 8, *e. g.* the articular cup and ball at the ends of the centrum are larger in proportion to the length of the centrum, as compared with the next-sized vertebra, fig. 7: the under surface of fig. 8 is convex transversely between the diapophyses, and sends down a short median ridge: in fig. 7 it is concave at the same part, and without the median ridge; but both vertebræ have the median process (hypapophysis) at the back-part of the under surface. In fig. 7 the fore-part of the epizygapophyses is concave, in fig. 8 it is flat; in fig. 7 the upper border is straight, in fig. 8 it forms an open angle: the space between the epizygapophyses and prezygapophyses is greater in fig. 7 than in fig. 8.

Fig. 7.



Palæophis Typhæus?

Fig. 8.

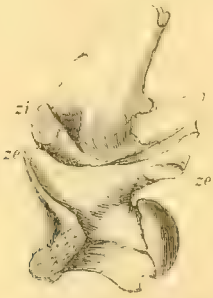
Palæophis porcatus?

Four vertebræ of progressively increasing size repeat the characters of the vertebra fig. 7; *i. e.* they have the fore-part of the under surface between the diapophyses excavated, and have only one hypapophysis, viz. that developed from the hind-part of the under surface; they have also the epizygapophyses nearly vertical, and raised high above the prezygapophyses. A vertebra of the same size as the largest of these four repeats the general characters of the small vertebra fig. 8: it has the anterior hypapophysis as well as the posterior one; larger terminal cup-and-ball surfaces in proportion to its size; smaller intervals between the epi- and pre-zygapophyses; less lofty posterior aliform productions of the neural arch, and the base of the neural spine extending nearly to the fore-part of that arch.

Both the above-contrasted vertebræ from Bracklesham agree in general size with those of a chain of six vertebræ from Sheppey, of which two are figured at fig. 14, but are shorter in proportion to the size of the articular ends: the length of the neural arch, at and including the inferior zygapophyses, is 2 centimeters in the Sheppey vertebræ and 1 centimeter 7 millemeters in the Bracklesham vertebræ, the articular cups and balls being of equal size in both vertebræ: the Sheppey vertebræ differ from both kinds of Bracklesham vertebræ in the continuous ridge or keel along the under part of the body (fig. 15): the neural arch is less suddenly compressed above, or inclines more gradually to the base of the spine.

Of the ten larger vertebræ from Bracklesham with both anterior and posterior hypapophyses, two (figs. 9 & 10) differ from the rest in having a strong external ridge extending from the anterior (*z e*) to the posterior (*z e'*) lower and external zygapophyses on each side of the neural arch. On comparing one of these vertebræ with another of the ordinary character and of the same size, the following further differences presented themselves: in the ridged vertebræ, which may be

Fig. 9.



Palæophis porcatus.

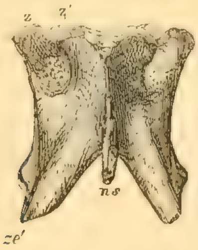
Fig. 10.

Palæophis porcatus.

referred for the convenience of description and comparison to a *Palæophis porcatus*, the articular ball is broader in proportion to its height; the prezygapophyses, *z e*, are more produced outwards and less produced forwards, so that they do not extend beyond the border of the articular cup, which is the case in the non-ridged vertebræ of *Palæophis Typhæus*; the epizygapophyses *z i* in the ridged vertebræ are connected by a broader and less excavated bar. The breadth of the base of the neurapophysis is greater in the ridged vertebra than in the unridged one, in proportion to its length. The articular surfaces of the zygapophyses are smaller in the ridged than in the unridged vertebræ.

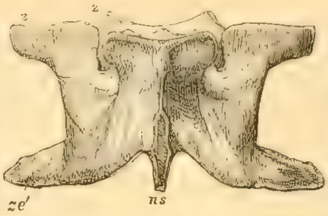
The ridged vertebræ from Bracklesham agree with the larger vertebræ from Sheppey in the shape of the epizygapophyses, but the Sheppey specimens have not the ridges. Figures 9 & 10 show the ridged character of the sides of the neural arch in *Palæophis porcatus*, and fig. 11 shows the consequent superior breadth of the base of that arch in relation to the length of the vertebra as compared with fig. 13, a corresponding vertebra of the *Palæophis Typhæus*. Fig. 12 in the same woodcut shows the striking difference in the proportions of the same part of the vertebra in the *Python Sebæ*.

Fig. 11.



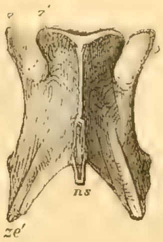
Palæophis porcatus.

Fig. 12.



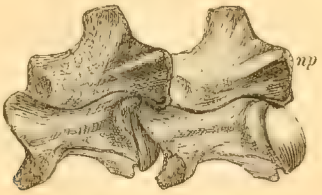
Python Sebæ.

Fig. 13.



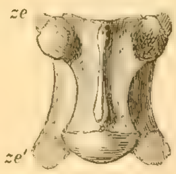
Palæophis Typhæus.

Fig. 14.



Palæophis toliapicus.

Fig. 15.



Palæophis toliapicus.

Figure 14 gives a side-view of two vertebræ of the *Palæophis toliapicus* of the ordinary size, and preserved in natural connection: fig. 15 shows the character of the under surface of the vertebræ of the same species.

Such are the observed differences which seemed worthy of mention in the series of Palæophidian vertebræ in the collection of Mr. Dixon. The nature of the differences may be interpreted in different ways: with regard to the small vertebræ, for example, those with a single spine from the posterior part of the under surface (fig. 7) may be small cervical vertebræ of the same species as that to which the large vertebræ with the two inferior spines belong; and the small vertebræ with two inferior spines (fig. 8) may have belonged to a smaller and younger individual of the same species, and have come from a more posterior part of the vertebral column of such individual. The anterior vertebræ of both Pythons and Boas, or example, are distinguished by a long hypapophysis (inferior spine) which subsides to a ridge in the succeeding vertebræ as far as the tail. In no specimen of Python or Boa, however, have I found the vertebræ presenting such differences of character as those indicated in the larger fossil Palæophidian vertebræ which I have described as 'ridged' and 'not ridged.' Leaving therefore the question of the nature of the differences in the smaller vertebræ open, and as possibly depending upon difference of age and of position in the vertebral series, I believe the characters of the ridged vertebra to be those of a distinct species of *Palæophis*, for which therefore I propose the name of *Pal. porcatus*. The generic character in each species is manifested in the pointed aliform productions of the back-part of the neurapophyses (*n p*), by the uniform convexity of the costal tubercles, and by the minor transverse production of the lower zygapophyses.

The *Palæophis toliapicus* is distinguished by its longer vertebræ in proportion to their breadth, and by the hypapophysial ridge, or the carinate character of the lower part of the centrum, in the vertebræ of the abdomen.

The *Palæophis Typhæus* is distinguished by its shorter vertebræ and by the anterior and posterior hypapophyses of the vertebræ of the abdomen; its neural arch is narrower, and its sides not longitudinally ridged.

The *Palæophis porcatus* is characterized by the longitudinal ridges connecting the anterior with the posterior zygapophyses, by its broader and squarer neural arch; but it has the two hypapophyses below like the other large species from Bracklesham.

Fig. 16.

Palæophis porcatus.

Figure 16 gives two views of two anchylosed vertebræ probably from near the end of the tail of the *Palæophis porcatus*: this unique specimen is from Bracklesham, and is in the collection of Mr. Dixon*.

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* Broken Ophidian vertebræ are often found at Bracklesham, but perfect ones are very rare; they are

Order CHELONIA.

Genus CHELONE.

Species. *Chelone trigoniceps*, Owen.

More than one of the old tertiary Turtles (*Chelone*) are remarkable for the longitudinal extent or depth of the symphysis of the lower jaw.

A species from the eocene clay at Harwich has this character so strongly developed, and the under surface of the symphysis so flattened, as to have suggested the 'nomen triviale' *planimentum** for it. The *Chelone longiceps*†, if we may judge by the length of the pointed upper jaw and bony palate, must have had a corresponding extent of the symphysis of the under jaw; and we may infer the same peculiarity from the straight alveolar borders of the maxillaries and their acute convergence towards the premaxillary bones in the allied species, *Chelone trigoniceps* (Tab. XIII. fig. 4), obtained from the eocene clay at Bracklesham, and now in the valuable collection of G. A. Coombe, Esq. Amongst the Chelonites which Mr. Dixon has obtained from the same formation and locality are portions of the fore-part of the lower jaw of four individuals of the genus *Chelone*, all exhibiting the characters of the pointed form and great depth of the symphysis.

One of these specimens (Tab. XIII. figs. 5 & 6) agrees so closely in size and shape with the fore-part of the upper jaw (*ib.* fig. 4)—fits, in fact, so exactly within the alveolar border, and so closely resembles that specimen in texture and colour, that, coming from the same formation and locality and being obtained by the same collectors, I strongly suspect it to belong to the same species of *Chelone*, if not to the same individual.

The known recent *Chelones* differ among themselves in the shape and extent

generally enveloped in sand: the plan I pursue is never to wash the specimens, but let them gradually dry, scraping the sand off by degrees with a small knife, and finally using a soft brush; when the sand has been entirely removed, a coating of diamond cement and water (equal parts) adds greatly to their preservation. I know of no greater pleasure that could be afforded to a palæontologist than the discovery of the head of one of these serpents. That enormous serpents lived and died in great numbers in England during the Eocene period is a fearful truth of geological evidence, and persons unacquainted with the more extraordinary creatures which are discovered in older formations, are ready to express their thanks, that these large snakes are no longer existing in our own country.—F. D.

* Trans. of British Association, 1841, Report on British Fossil Reptiles, p. 178.

† *Ibid.* p. 177.

of the bony symphysis of the lower jaw. Both the *Chelone imbricata* and the *Chelone caouana* have this part deeper and more pointed than the *Ch. mydas*, but neither species has the symphysis so depressed or so slightly convex below as it is in the Bracklesham *Chelonites*.

These fossils also differ amongst themselves in this respect. The symphysis which is here referred to the *Chelone trigoniceps* is the broadest and flattest: the figures 5 & 6, Tab. XIII. illustrate this character, and more especially the back view, fig. 7, showing the deep and broad genio-hyoid groove *g*: this is reduced to a transversely oblong foramen in *Chelone mydas*.

The second species indicated by the maxillary symphysis is that figured in Tab. XIII. figs. 1′ & 1″: its sides meet at a more acute angle, and it is narrower in proportion to its length; is more convex below and more concave above, with the alveolar borders a little more raised, and the middle line less raised than in *Chelone trigoniceps*. In this respect it is intermediate between the *Chelone imbricata*, where the upper surface of the symphysis is more concave, and the *Chelone caouana*, where it is flatter than in the *Chelone trigoniceps*. The fossil symphysis under notice has also a smooth transverse genio-hyoid groove at its back-part. It accords so closely in form with the end of the upper jaw of the *Chelone convexa* (fig. 1) from Sheppey, that I refer it provisionally to that species.

Two other specimens of the symphysis of the lower jaw (figs. 8 & 9), of rather larger size, appear to belong to the same species as that referred to the *Chel. longiceps* *, by the characters of the concavity of the upper surface, the convexity of the lower surface, and the degree of convergence of the sides or borders of the symphysis. The larger of the two shows the genio-hyoid groove, and the nearly vertical outer side of the jaw (fig. 10) opposite the back part of the symphysis, and this shows no impression of the smooth fossa receiving the insertion of the biting muscles; whereas in the *Chelone trigoniceps* (fig. 11) that fossa extends to the same transverse line or parallel with the back-part of the symphysis.

The very rare and interesting Chelonite in Mr. Coombe's museum, figured in Tab. XIII. fig. 4, was the first portion of the cranium of a reptile of this order that I had seen from the eocene deposits at Bracklesham. It includes the bones forming the roof of the mouth and portions of the bony nostrils and orbits, and the tympanic pedicles.

The extremity of the upper jaw is broken off, but the straight converging alveolar borders clearly indicate the muzzle to have been pointed, as in the

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* Report on British Fossil Reptiles, p. 177.

Chelone longiceps of Sheppey; and the muzzle being shorter, the form of the skull has more nearly approached that of a right-angled triangle. The whole cranium is broader and shorter, and the tympanic pedicles wider apart. The middle line of the palate developes a somewhat stronger ridge: the orbits were relatively larger and advanced nearer to the muzzle than in *Chelone longiceps*: the malar bones are more protuberant behind the orbits, and their external surface inclines inwards as it descends from behind and below the orbit to form the lower border of the zygoma, which it does not do in the *Chelone longiceps.*

The upper surface of the fossil shows the palatines rising to join the vomer at the middle line, and the two small subcircular vacuities (occupied by membrane in the recent skull) between the palatines and prefrontals and maxillaries; the anterior border of the temporal fossa formed by the malar and pterygoid is entire on one side, and shows that that vacuity was as broad as it is long. The olfactory excavations in the maxillaries are deep. The articular surface of the tympanic pedicles closely accords with those of recent Chelonians.

The very regular triangular form of the skull indicated by this fragment has induced me to propose the name of *Chelone trigoniceps* for the species.

Chelone convexa, Owen[*].

The cranium of the Chelonite from the London clay of Sheppey, which was kindly presented by the Earl of Enniskillen to Mr. Dixon, figured in Tab. XIII. figs. 1, 2 & 3, differs from the *Chelone breviceps*[†] in the more pointed form of the muzzle, and the less rugose character of the outer surface of the bones; and from the *Chelone longiceps*[‡] in the less produced and less acute muzzle, and the more rugose surface of the bones. In its general proportions and triangular form it approaches nearer to the *Chelone trigoniceps*, but differs from this species in the contour of the lower border of the orbits, in the configuration of the surface of the bony palate, and in the minor expansion of the malar regions. The palate is traversed longitudinally by a deep median groove, between which and the shallower grooves on the inner sides of the alveolar borders are two well-marked longitudinal convexities.

The frontal bones enter into the formation of the upper borders of the orbits, which are nearly circular in form, as in *Chelone longiceps*; not subrhomboidal with the angles rounded off, as in *Chelone breviceps.*

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[*] Proceedings of the Geological Society of London, December 1, 1841, p. 575.

[†] Report on Brit. Foss. Reptiles, p. 178.

[‡] *Ibid.* p. 177.

The finely-wrinkled character of the superficies of the bones in the cranium here described, smooth in comparison with that in *Ch. breviceps*, so closely agrees with that of the bones of the carapace and plastron of the *Chelone convexa*, described in my 'Report on British Fossil Reptiles*,' that I shall provisionally refer the cranium to that species.

Portions of a fossil carapace of a *Chelone* from Bracklesham, some of which are figured in Tab. XII. figs. 16 & 17, indicate a large individual of probably one of the two extinct species of the genus above-defined from the characters of their skull. Figure 18 shows two views of the mutilated head of a humerus: figure 19 gives two views of an ulna. Fig. 17 is an expanded neural spine of a dorsal vertebra, forming one of the median pieces of the carapace; and fig. 16 is a portion of an expanded rib, forming one of the lateral pieces of the carapace; all of a true *Chelone*.

Genus TRIONYX.

The fragments of the carapace and plastron of a large *Trionyx* from Bracklesham are also of a kind too imperfect to give at present more certain information than the genus of Chelonian reptiles to which they have belonged. Fig. 15, Tab. XII. shows part of the eighth expanded rib from the right side of the carapace.

Figs. 12, 14 & 16, Tab. XIII., are views of a sacral vertebra of a *Trionyx*, from Bracklesham; figs. 13, 15 & 17 are corresponding views of the homologous vertebra of a recent *Trionyx* of the same size.

Amongst the remains of the genus *Trionyx* discovered at Bracklesham, ought to be specified a considerable portion of the right hyposternal, showing the characteristic notch for the xiphisternal bone, the smooth inner surface and the rugous, worm-eaten character of the external surface. The thickness of this bony plate is from 3 to 5 lines, and indicates a species as large as the full-grown specimens of *Trionyx ægyptiacus*. A portion of the hyosternal bone of the same plastron was found with it. Remains of the *Trionyx* are more or less common at Hordle, Sheppey and the Isle of Wight; but they have not yet been noticed, so far as I am aware, in the eocene deposits at Bognor.

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* Report on Brit. Foss. Reptiles, p. 178.

DESCRIPTIONS

OF

THE FOSSILS

FROM

THE EOCENE DEPOSITS OF BOGNOR.

ANNELIDA.

Serpula flagelliformis.

This is rare both at Bognor and at Bracklesham.

CIRRIPEDA. § 2. *Pedunculated.*

Xiphidium.

Gen. Char.—Stem covered by shelly scales; body compressed, composed of thirteen valves; one subulate dorsal valve, increasing downwards from the apex, and six pairs of lateral valves, of which one pair is terminal and two pairs medial, all increasing from their apices downwards, and three smaller pairs around the base enlarging laterally.

A genus distinguished from *Scalpellum* by the form and mode of increase of the dorsal valve, which in some species resembles so much the same valve in *Pollicipes*, that, so long as I had only seen separate valves of the body, I was induced to refer the species to that genus. In the arrangement of the other valves, their number, and in their mode of increase, it is wholly different from *Pollicipes*, and much more like *Scalpellum*, in which, however, the dorsal valve has a projecting point or elbow in its centre, from which it enlarges both upwards and downwards.

This genus occurs in London clay, chalk, gault, and perhaps in lias, for *Pollicipes planulatus*, Min. Con. 647. f. 2, may possibly belong to it. The true *Pollicipes* I have only seen fossil in lias, and *Scalpellum* in crag.

Xiphidium quadratum. (Tab. XIV. figs. 3^b & 4.)

Spec. Char.—Dorsal valve with flat sides, its section quadrangular; scales on the stem narrow, pointed.

The finest specimens of this Cirripod are large masses of sandy stone, containing great numbers mixed with *Vermetus Bognoriensis.* The stems however are decomposed, and the scales which I presume covered them are scattered in all directions. At Hampstead and Highgate, single valves only have been found by Mr. Wetherell.

CRUSTACEA.

Astacus Bellii. (Tab. XV. figs. 3 & 4.)

Spec. Char.—Thorax smooth and punctate; claws and moveable finger having a strong obtuse carina, and furnished with a double series of spines; abdomen smooth, punctate, and slightly sculptured. The double row of spines may be accidental, as they are sometimes observed on recent Lobsters.

I have called this species after my friend Thomas Bell, Esq., F.R.S., F.G.S., the author of the excellent work on British Crustacea. Fossil Crustaceans are very rare at Bognor and Bracklesham, though common in the London clay at Sheppey and Highgate. A work is much wanted on British Fossil Crustacea, and I hope Mr. Bell will turn his attention to the subject when he has finished the recent species.

Cancer Leachii, Konig. (Tab. XV. fig. 5.)

This specimen is in sulphuret of iron, and was found by G. A. Coombe, Esq. It is now in the cabinet of T. Bell, Esq.

I have one more specimen of this species in my own collection; these being the only two examples I have been able to procure from Bognor. At Alum Bay in the Isle of Wight, this species occurs in very fine preservation, from the Eocene formation of that locality.

CONCHIFERA DIMYARIA.

Pholas Pechellii. (Tab. XIV. fig. 10.)

Spec. Char.—Shell subclavate, concentrically striated; anterior portion but slightly sinuated, small, separated by a deep, narrow, oblique furrow, which is directed backwards; beaks anterior, not prominent; length half the width.

A species almost destitute of imbricating teeth upon the lines of growth, and thus approaching to *Teredo*. It occurs very rarely, in fossil wood at Bognor. It is named after my esteemed friend Captain Pechell, M.P., whose father resided many years at Bognor.

Teredo.

I have removed this genus from among the *Tubicolaria*, because the structure of the valves and boring habits of the animal are those of *Pholas*, and the tube is only a deposit of secreted matter after the passage for the animal has been perfected, and not present at all times. *Teredina* is only the fossil form of *Teredo*, the difference being the effect of a mineral deposit in the membranous tube of the animal. (See Min. Con. vol. i. p. 231.)

Cultellus affinis. (Tab. XIV. fig. 6.)

This shell occurs so large and handsome at Barton as to seem a distinct species.

Panopæa Puella. (Tab. XIV. fig. 14.)

Spec. Char.—Shell elliptical, slightly compressed, concentrically waved; beaks almost central, prominent; both extremities rounded.

The beaks are mostly placed at about two-fifths of the diameter of the shell from the anterior extremity; in *P. intermedia* they vary in position, but are generally placed at one-third the diameter; on the other hand, in the *P. corrugata* they are nearer to the extremity, especially in the larger individuals. It may be doubtful, therefore, whether *P. Puella* may not be an infant state of *P. intermedia*; its being somewhat flatter would rather favour that opinion. Mr. Dixon has, however, in his museum a mass with several hundred specimens not varying in size.

Panopæa corrugata. (Tab. II. fig. 12.)

This shell has only lately been found at Aldwick near Bognor, in a bed of clay on the shore and adjacent rocks. It is more perfect at Bracklesham, and is described among the shells from that locality.

Pholadomya Dixoni.

I have ventured to quote Nyst, although I have not seen an authentically-named specimen.

Pholadomya virgulosa. (Tab. XIV. fig. 31.)

A very characteristic shell of this part of the London clay.

Cyprina planata. (Tab. XIV. fig. 11.)

The individuals found at Bognor are all smaller than those of Nuneham.

Cyprina? nana. (Tab. XIV. fig. 8.)

Spec. Char.—Shell broadly oval, transverse, regularly convex, polished; beaks prominent, anterior; lunette not sunk, inconspicuous; hinge-slope prominent, curved; lines of growth numerous, fine, sharp.

A more regularly oval shell than *C. planata,* which it otherwise much resembles; it is also much smaller. Not having seen the hinge, I am doubtful of the genus.

In large groups.

Cardita Brongniartii. (Tab. XIV. fig. 33.)

A handsome shell only known at Bognor; it was first noticed by Dr. Mantell, but is not uncommon.

Cardita quadrata. (Tab. XIV. fig. 12.)

Spec. Char.—Shell transverse, imperfectly rectangular, rather convex, ribbed; ribs numerous (above twenty), furnished with obtuse scales; beaks small, near the anterior extremity; lunette nearly flat; length two-thirds the width.

The small ribs and general form mark this as distinct from any other *Cardita* I know. It occurs assembled in great numbers in blocks of sandy stone.

I have resumed the generic name *Cardita,* as it appears to have the priority over *Venericardia.*

Pectunculus brevirostris. (Tab. XIV. fig. 32.)

As the surface of this shell in the Bognor rock is always in a different state from the French specimens of *P. pulvinatus*, I cannot with confidence refer it to that species, which besides appears to be less convex.

Modiola simplex. (Tab. XIV. fig. 16.)

Spec. Char.—Shell lanceolate, compressed, smooth; anterior extremity very small, rounded; beak near the anterior extremity; lobe indistinct; hinge-line and the opposite edge straight, converging towards the anterior extremity; posterior extremity semicircular.

Occurs in masses of Septarium. It is like *Modiola depressa* of Min. Con. t. 8, but is more pointed.

Pinna margaritacea.

This appears to have sharper ribs than *P. affinis*, but probably they are the same species differently preserved.

In Septaria.

CONCHIFERA MONOMYARIA.

Ostrea cariosa.

The structure of the shell of this species, noticed by Deshayes, is common to others, even to the recent *O. edule.* It is the constant cellular structure of the mass between the external fibrous laminæ and the pearly lining of the shell, and is manifest in old shells when partially decayed: it much resembles the cellular tissue in the bark of trees, or fat between the muscles of animals.

Ostrea tabulata.

Spec. Char.—Shell orbicular, depressed, smooth; upper valve slightly concave, even, its plates few, with distant, scarcely raised edges; lower valve obscurely marked by radiating undulations, its plates few, in groups, with remote, deeply imbricating edges; beaks small, pointed; muscular impression ovate, curved, of a moderate size.

This was evidently a rapid-growing shell; its nearly smooth external laminæ extend far between each period of growth and show their fibrous structure distinctly, especially upon the surface. An abundant shell.

Ostrea elephantopus.

This Oyster does not properly belong to Bognor, as it is only found at some distance from the rocks, and is probably recent on the opposite side of the Channel.

MOLLUSCA GASTEROPODA.

Infundibulum trochiforme. (Tab. XIV. fig. 27.)

Larger specimens occur at both Bognor and Barton. I cannot rest satisfied at present that *I. tuberculatum* (Min. Con. f. 97) is the same species as *I. trochiforme.*

The two species, *Globulus patulus* and *G. sigaretinus*, have been accidentally left in this genus: they should be referred to *Ampullina.*

Natica? microstoma. (Tab. XIV. fig. 24.)

Spec. Char.—Shell subglobose, pointed, smooth; spire large, prominent, the whorls convex, squarish; umbilicus narrow, deep; aperture semicircular, only two-thirds the length of the shell.

The specimen is not perfect enough to afford a complete description; the small size of the last whorl distinguishes it. Rare.

Acteon simulatus?

The specimens which I refer to this name are imperfect casts, but in them the spire seems to be longer than in the Barton shells, and the shells are also smaller.

Solarium bistriatum. (Tab. XIV. fig. 20.)

This is one of the most beautiful and most perfect of the analogues of the *Calcaire grossier* we know. It is withal a rare shell and only lately discovered.

Littorina sulcata. (Tab. XIV. fig. 23.)

Specimen small and imperfect, but it agrees well with young shells from Barton.

Turritella scalarioides. (Tab. XV. fig. 10.)

Spec. Char.—Turrited, corded; whorls six or seven, convex, with ten thin ridges or threads around each, of which the middle ones are largest; base defined by a sharp ridge ornamented with many fine threads or striæ; lines of growth sharp; aperture nearly round.

Twice as long as wide.

First discovered by Mr. Wetherell at Highgate, where it is rare.

Fusus undosus. (Tab. VII. fig. 39.)

This species is fully described as a Bracklesham shell. It appears to vary in the elevation of the costæ, which are often, especially on the last-formed whorl, only slight waves; some specimens which show no other difference have them very strong.

Pseudoliva semicostata. (Tab. XIV. fig. 26.)

The French shell is smaller and apparently more regularly ribbed, but there can be little doubt of the species being the same, although I have not been able to compare specimens.

MOLLUSCA CEPHALOPODA.

TETRABRANCHIATA.

Nautilus.

Four species of this genus, found at Bracklesham and Bognor, may be distinguished by the following marks:—

Nautilus imperialis.

Orbicular, slightly flattened ; umbilicus open ; septa twice curved, their sides broad ; front rounded ; siphuncle nearly central.

Nautilus Sowerbii.

Lenticular ; umbilicus open ; septa twice and very much curved, their sides narrow ; front angular ; siphuncle near the inner edge of the septum.

Nautilus centralis.

Globose ; umbilicus open ; septa once curved, the side lobes broad ; siphuncle central.

Nautilus regalis.

Oblate spheroidal ; umbilicus filled up ; septa once curved ; front obtuse or flattened ; siphuncle nearly central.

Nautilus urbanus, found in London and at Sheppey, is like *N. regalis,* but flatter, and has the siphuncle near the inner edge of the septum : it probably belongs to a higher bed than the Bracklesham or Bognor beds.

PISCES.

Otodus obliquus. (Tab. XV. fig. 11.)

This species, determined by M. Agassiz, is very common at Sheppey.

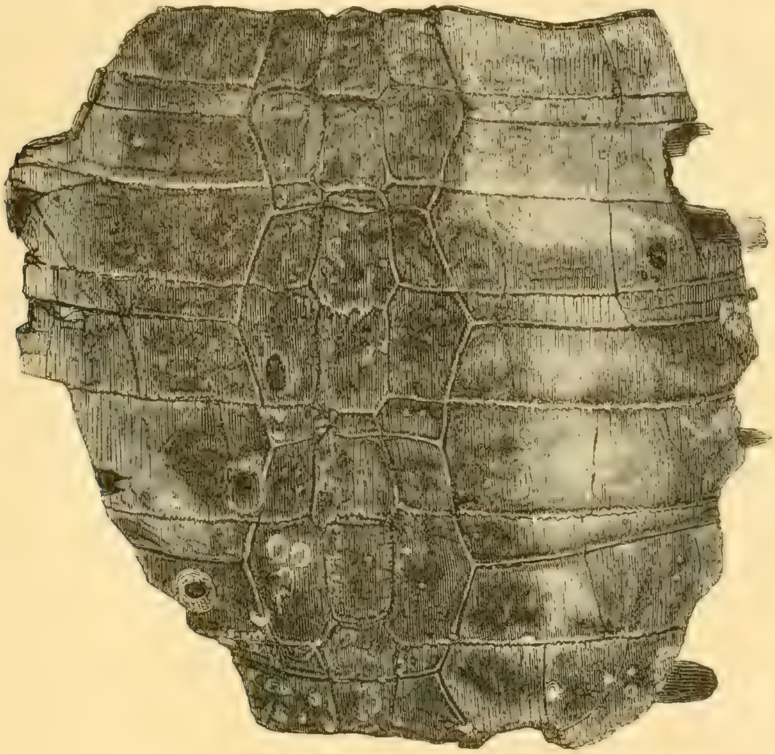
Teeth and vertebræ of fishes, so common at Bracklesham, are very seldom met with at Bognor.

Note of the remains of a Turtle in the Museum of F. Dixon, Esq. By Professor Owen, F.R.S.

REPTILIA.

Chelone declivis, Owen.

Subjoined is a woodcut of a portion of the carapace of the *Chelone declivis*, from the London clay of Bognor; it is the only specimen that has hitherto



Chelone declivis, half the natural size.

been discovered in that locality. The extinct Turtle represented by this specimen, and indicated by the above term, bears the same relation to the *Chelone convexa*, as the *Chelone longiceps** does to the *Chelone latiscutata*†; that is, it has the

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* Proceedings of the Geological Society of London, December 1, 1841, p. 575. † *Ibid.* p. 574.

same general characters of the fossilized parts of the carapace, but differs in the narrower proportions of the vertebral scutes, and the more open angle at which their two lateral borders meet: the vertebral angles of the costal scutes being correspondingly less acute. The specimen consists of the seven anterior neural plates, and the corresponding seven pairs of costal plates.

The neural plates correspond in form with those of the *Chelone convexa*: the first is crossed at its middle part by the impression dividing the first from the second vertebral scute: the second neural plate is an oblong four-sided one, with both ends of equal breadth. The third neural plate resumes the hexagonal figure with the broadest end and two shortest sides at the fore part; and is crossed in its lower half by the impression dividing the second from the third vertebral scute. The fifth neural plate is crossed by the next transverse impression nearer its lower border. The sixth and seventh scutes retain the same form and proportions as in the *Chelone convexa*, and have not their antero-lateral borders increased in length, as in the *Chelone longiceps*. The declination of the ribs from the neural plates gives the same degree of convexity to the carapace as in the *Chelone convexa*, and the impressions of the scutes have the same depth and breadth. The only difference indicative of specific distinction lies in the form of the scutes: and the question is, whether, in the progress of growth which makes the longitudinal extent of two of the vertebral scutes nearly equal to three, so great a change could be effected in their shape as is shown in the specimen of *Chelone convexa*, in which it will be seen that the second vertebral scute, though more than one-third longer in *Chel. declivis*, is of the same breadth as that in the smaller specimen of the *Chel. convexa*, and that the fourth vertebral scute preserves the same length without diminishing in breadth as it does in the *Chelone convexa*.

Notes on Fossil Palm-Stems, and Wood from the shore of Sussex.

Amongst the pebbles of the beach on the Sussex coast are occasionally discovered portions of fossil wood. I am well-aware that from rolled specimens no satisfactory evidence can be produced as to the geological period when the various trees and plants were in existence; yet as several of them indicate remarkable characters, which have not hitherto been noticed in this country, and are well observed by having thin slices placed under the microscope, I am anxious to add a short account of the more curious examples, and I have great satisfaction in stating that Robert Brown, Esq., F.R.S., has been so kind as to give me his valuable assistance in drawing up the following remarks.

To persons unacquainted with the distribution of fossil trees and plants in the great divisions of geology, it may be as well to observe, that in the earlier and transition period, the vascular cryptogamous plants, such as Calamites, Ferns, Lycopodiaceæ, &c., are mostly discovered, the remains of these plants principally furnishing coal; in the Secondary formation Cycadeæ and Coniferæ are abundant; and in the Tertiary, Dicotyledonous woods (Coniferæ included) are particularly found, many of them agreeing with families of the present day[*].

Palm structure rarely occurs in the earlier geological periods; in the secondary only a few specimens have been traced, but in the tertiary they are more abundant; and as many as eight or ten species have been noticed by Ad. Brongniart in his list of the fossils of the tertiary series.

Seven localities have been pointed out by Cuvier and Brongniart in the tertiary strata of France, Switzerland and the Tyrol, in which fossil palm-leaves have been found differing from any known species.

Fossil stems of Palms beautifully silicified are brought from Antigua; they also occur in the East Indies, in Hungary, and in the calcaire grossier of the Paris basin. Prostrate trunks of Palms of large size have been found above the gypsum beds in the vicinity of Paris, and as they are associated with freshwater shells and not drifted, they grew probably not far from the spot where these remains are discovered[†]. During my visit to Paris in 1847, Ad. Brongniart

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[*] The family of Coniferæ have been discovered in nearly all the geological periods.

Dr. Unger, in his 'Synopsis Plantarum Fossilium,' published at Leipsic, 1845, mentions 141 species, which are distributed as follows:—

The transition formation	2
Old red sandstone	12
Lower new red sandstone	2
Magnesian limestone	1
Upper new sandstone	8
Keupersandstein	7
Lias	7
Oolite	7
Chalk	6
Eocene	13
Miocene	73
Pliocene	3

[†] According to Mr. Bowerbank, palmaceous fruits are abundant at Sheppey, while coniferous fruits are comparatively scarce. At Bognor and Bracklesham, the fossilized wood is mostly dicotyledonous.

most obligingly showed me the very extensive Fossil Palm Collection at the Jardin des Plantes, in which there are one or two specimens found at Montmartre.

Dr. Unger enumerates several species of the Palm family which are distributed through various formations.

In the old red sandstone formation (four)—
Flabellaria borassifolia, *Sternberg.*
Zeugophyllites calamoides, *Brongniart.*
Palæospathe Sternbergii, *Unger.*
———— aroidea, *Unger.*

In the middle and lower oolite (four)—
Carpolites conica, *Lindley and Hutton.*
———— Bucklandi, *Lindley and Hutton.*
———— areolata, *Lindley and Hutton.*
———— ———, *Lindley and Hutton.*

In the chalk (one)—
Flabellaria chamæropifolia, *Göppert.*

In the Eocene (four)—
Flabellaria Parisiensis, *Brongniart.*
Palmacites echinatus, *Brongniart.*
Burtinia Faujasii, *Endlicher.*
———— cocoides, *Endlicher.*

In the Miocene (twenty-six)—
Flabellaria Latania, *Rossmässler.*
———— rhapifolia, *Sternberg.*
———— oxyrachis, *Unger.*
———— verrucosa, *Unger.*
———— crassipes? *Unger.*
———— Martii, *Unger.*
———— major, *Unger.*
———— hæringiana, *Unger.*
———— maxima, *Unger.*
———— Lamanonis, *Brongniart.*
Phœnicites pumila, *Brongniart.*
———— spectabilis, *Unger.*
———— salicifolia, *Unger.*
Phœnicites angustifolia, *Unger.*
Fasciculites didymosolen, *Cotta.*
———— Cottæ, *Unger.*
———— anomalus, *Unger.*
———— lacunosus? *Unger.*
———— palmacites, *Cotta.*
———— perfossus, *Unger.*
———— Partschii, *Unger.*
———— Fladungi, *Unger.*
———— Sardus, *Unger.*
Baccites cacaoides, *Zenker.*
———— rugosus, *Zenker.*
Endogenites rugosus, *Brongniart.*

In the Pliocene (four)—

Flabellaria Antiguensis.
Palmacites crassipes.
Fasciculites Antiguensis.
——— Withami.

Forty-three species; being about one-third of the number in proportion to the family of Coniferæ.

Nearly a thousand species of recent Palms are supposed to exist; they are found in all quarters of the globe; the greatest variety occur in Æquinoctial South America, where they flourish most luxuriantly, some of them reaching 70 feet or upwards in height. In Asia they are not quite so numerous. The Date-palm (*Phœnix dactylifera*) is a native of Africa, a most abundant and useful species, though less beautiful than many other kinds. This Palm grows also in Asia, and is cultivated in many parts of the south of Europe, but only brings its fruit to perfection near Valencia, where it was originally planted on account of its fronds being used at the celebration of Palm Sunday. The Date-palm is the species mentioned in the Bible, and was emblematic of Judæa; as we see on the coins of Vespasian and Titus with Judæa Capta, &c.; it also occurs on the reverse of a coin of Nerva, and on the beautiful coins of Panormus in Sicily, &c. The Palm has been regarded by almost all nations as the emblem of victory. Palmyra is said to have derived its name from the numerous palms which grew near it. The *Phœnix dactylifera* is a most essential article of food for the inhabitants of Egypt, Arabia and Persia. In Europe there is but one indigenous Palm (the *Chamærops humilis*), of small size, being seldom more than 7 or 8 feet in height*. The Palm tribe diminish in size and beauty from the equator towards the temperate zones, the climate best suited being from 75° to 85° of Fahrenheit, England being about 50°; and they flourish best on the banks of rivers and estuaries, or near the seashore.

The Cocoa-nut Palm (*Cocos nucifera*), so common on the continent of South America, its adjacent islands, and the Polynesian groups, is also a most valuable species, supplying in various ways the wants of man†. The Date and Cocoa-nut Palms have pinnated leaves like many of the fossil species.

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* In the Jardin des Plantes at Paris, I saw in 1847 two Palms of this species nearly 16 feet in height, which are considered the finest European specimens.

† The *Cocos nucifera* has a cylindrical stem, being 3 or 4 feet in diameter at the root, and tapering to 5 or 6 inches at the top. It has no branches, but shoots up one bold stem 60 or 70 feet, bearing at

Description of Tab. XVI.

Fig. 1. Section of a specimen of fossil Palm-wood of large size, found a little to the east of Worthing; it does not appear to have been much rolled; its character is like some of the Bognor wood, very dark, and containing sulphuret of iron.

a. Magnified section.

The structure of this Palm resembles that of the cocoa-nut species, having but one form of fasciculi or bundles of vessels; it is in good preservation, and shows very clearly at letter *b* the stem, and letter *c* the root.

Fig. 2. Section of a Palm of a more common species, much rolled and not so large as fig. 1: found between Worthing and Little Hampton.

a. Magnified horizontal section.

This Palm exhibits, in addition to the fasciculi of the preceding specimen, smaller bundles entirely fibrous or consisting of elongated cells. This fossil is much decomposed, but does not contain sulphuret of iron.

b. Longitudinal section in which spiral vessels are indistinctly shown, and a more distinct view of one of the great tubes or dotted ducts.

c. Magnified view of crystallized bodies pervading fig. 2. I have observed similar bodies in other specimens found on the coast.

Fig. 3 & fig. 3 *a*. Section of a much-rolled specimen found near Shoreham.

a. Magnified section.

This Palm seems to be a modification of fig. 2; but its structure is not well seen, owing to its being much decomposed; it shows however the fibrous structure of the small fasciculi more distinctly. Figs. 1, 2 and 3 are modifications of Palms found in great perfection in the fossil specimens from Antigua.

Fig. 4. Section of the root of a Palm not much rolled, found opposite Worthing; a great portion of it is converted into sulphuret of iron.

a. Magnified section, differing in some respects from the preceding specimens, and also from those commonly brought from Antigua or the East Indies.

I have a very large specimen of fossil Palm-wood found at Bracklesham Bay quite black; it shows however by its rounded appearance that it must have been

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the top a crown of long fringed leaves, like a graceful plume waving to the wind. Its timber is used for domestic purposes; its leaves converted into baskets, bonnets, &c.; the fibres of the husk that covers the fruit, into ropes, mats and all kinds of cordage, and the shells into drinking and other cups, bottles, &c. The liquor contained in the fruit is a delicious drink, the fruit itself is eaten, and a most valuable oil is prepared from it.

long disturbed and rolled ; other specimens of wood, of decidedly palm structure, I have found between Bognor and Shoreham.

It is impossible to fix the precise geological formation to which these trees may have belonged. The dark specimens containing so much sulphuret of iron, resemble, by their external appearance, the dicotyledonous wood found at Bognor, Bracklesham and Sheppey, and may be derived from the Eocene formation, flourishing with the Crocodiles and Serpents of that period ; others are agatized in a similar manner to the more recent formations of Antigua, though differing in external character.

Fig. 5. Section of a coniferous wood found near Worthing, much rolled and very hard.

a. Magnified view, which shows the arrangement of vessels as in common deal.

b. Section taken parallel to the medullary ray from the centre to the circumference, pointing out the uniformity of vessels and the arrangement of discs, in which it materially differs from the Araucarian arrangement more usually found in fossil Coniferæ.

c. Vertical section cut at right angles to the medullary ray, in which the vessels appear to be without discs, the sections of the medullary rays being shown at *d*.

Fig. 6. Section of common dicotyledonous wood much agatized in the centre : this character of fossil wood is very common at Bognor, and rolled specimens are occasionally picked up along the coast.

a. Magnified transverse section, showing the structure to consist chiefly of elongated cells, with scattered larger tubes, resembling the dotted ducts of palm structure.

All these woods are occasionally agatized, and look very well when cut and polished.

The dark parts are portions of land of very recent marine and freshwater alluvial formation.

In the line of coast from west to east, the following places are of interest to geological inquirers.

The references are to the pages of the text in which descriptions of the different localities are to be found, and the letters to particular fossil beds.

Bracklesham Bay, pp. 10, 21, 25–27.

This bay has been formed by the encroachments of the sea on the land. Between 1292 and 1341 arable lands in the parish of West Wittering, of which the tithe was valued at *3l. 6s. 8d.*, were drowned by the sea or destroyed by sea-sand. [See Sussex Archæological Collections, i. 60.] In neighbouring parishes, the tithe of arable land was rated at *4d.* an acre, we may therefore assume that the loss during the above limited period was 200 acres;—a small portion, however, of the probable loss during the last ten or twelve centuries.

A. Barn beds, p. 27; B. Cerithium beds, p. 26; C. Cypræa, p. 26; D. Belosepia and Beloptera, p. 26; E. Clibs, Mixen rocks and pole, p. 25; F. Park beds, p. 24; Houngate rocks, p. 26.

Thorney Marshes are evidently of marine origin, and with Pagham Harbour must have been a shallow estuary separating Selsey from the mainland, and making it, what its name expresses, an island. The presence of sea shells, of existing species, proves this. But if geological evidence were wanting, we have full historical proof in the evidence of the Venerable Bede, who tells us, that "King Ethelwalch gave the most reverend prelate, Wilfrid, land of eighty-seven families, to main-"tain his company who were in banishment, which place is called Selsey, that is, the island of the Sea-Calf. That place "is encompassed by the sea on all sides, except the west, where is an entrance about the cast of a sling in width; "which sort of place is by the Latins called a peninsula, by the Greeks, a chersonesus." [Bede's Ecclesiastical History, b. iv. c. 13.] Thus we are led to believe that when Selsey first became known to the English nation, it was an island; that in Bede's time the process of silting up the estuary must have commenced. The completion of this process would seem to have been before the Conquest, judging from the notices of the district in Doomsday. [See Horsfield's History of Sussex, ii. 35. It should be observed that this work is cited in the text as Baxter's History of Sussex. Mr. Baxter was the publisher only.] As the action of the tides on this coast seems uniformly to carry sand and shingle from west to east, we may infer that the gradual wasting, which has taken place on the shore of Bracklesham Bay, served to supply a large portion of the material of which these marshes are formed; the remainder would be brought by the little rivulets which empty themselves into them.

Selsey, pp. 7–10; F. Park bed, p. 24; Pagham Harbour, pp. 8, 27–28.

By a typographical error in the text, the loss of land, at the time this creek is supposed to have had its origin, is made to be 1700 instead of 2700 acres. [See Sussex Archæological Collections, i. 59.] As the extent of the harbour appears never to have exceeded 1000 acres, it is probable that the greater portion of this loss was of land lying outside its present mouth.

Barn rocks and Bognor rocks, pp. 30–31; Felpham—submerged forest-trees, p. 31; Middleton Ledge, p. 33; Little Hampton and Valley of the Arun, p. 34; Worthing, p. 37.

DESCRIPTIONS OF THE FOSSILS OF THE CHALK FORMATION.

Notes on the Corals. By William Lonsdale, F.G.S.

The fossils represented in Table XVIII. figures 1 to 10 have been frequently mentioned by palæontologists. Lhwyd probably alludes to them under the designations or descriptions, "columellus turbinatus albus cretaceorum," and "columellus turbinatus minor subalbidus[1];" but Mr. Conybeare[2] and Dr. Mantell[3] apparently first identified the coral with *Caryophyllia* of Lamarck[4], the former authority noticing also the resemblance to *Caryophyllia cyathus*; and that generic assignment with Dr. Mantell's specific name *centralis,* has been adopted by subsequent British authorities. Herr Roemer[5], however, and Herr Geinitz[6], as well as Von Hagenow, have preferred the genus *Turbinolia*: *Caryophyllia cyathus* has also been transferred by Ehrenberg[7] to *Cyathina*. In attempting to approximate therefore towards the right systematic position of the cretaceous zoophyte, it will be necessary to inquire what are the primary structures of the Anthozoa comprising Lamarck's *Caryophylliæ,* also of the corals to which the name has been lately restricted; and how far the fossil under consideration can be referred to any of those polyparia, or to *Turbinolia* or to *Cyathina*.

I. *Caryophyllia* as proposed by Lamarck[8] included fifteen species arranged under two divisions: "§ Tiges simples, soit solitaires, soit fasciculées;" and, "§§ Tiges divisées ou rameuses;" but this arrangement, though dependent upon

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[1] Lithoph. Brit. Ichnographia, 1st ed. 1699, p. 8. nos. 136, 137. Lhwyd's specimens were obtained in Kent.

[2] Outlines of Geol. of England and Wales, p. 74, 1822.

[3] Fossils of the South Downs or Geol. of Sussex, p. 159. t. 16. f. 2, 4, 1822.

[4] Anim. s. Verteb., ed. 1836, t. ii. p. 346. no. 1.

[5] Verst. Norddeutschen Kreidegebirges, p. 26, 1840.

[6] Charakteristik Petref. des sächsisch-böhmischen Kreidegeb. Drittes Heft, p. 92, 1842.

[7] Beiträge, &c., p. 76, or Berlin Transactions for 1832.

[8] Edit. 1816.

physiology, was based on purely external forms, no allusion being made to the properties which produce a single or a fasciculated mode of growth, or to those which give rise to a branched development; it will consequently be advisable to consider Lamarck's species with reference to the manner of reproduction in an individual specimen. They may be grouped as regards this important character under three heads:—

1st. Single stems which do not produce lateral buds or shoots, and propagate by ejected ova or germs, as—i. *Cary. cyathus*, No. 1 of Lamarck.

2ndly. Species which, in addition to ejected ova or germs, develope lateral buds, as—i. *C. calycularis*, ii. *C. fasciculata*, iii. *C. astreata*, iv. *C. musicalis*, v. *C. flexuosa*, vi. *C. cæspitosa*, vii. *C. anthophyllum*, viii. *C. cornigera*, ix. *C. ramea*: being Nos. 2, 4, 5, 6, 7, 8, 9, 10 & 11 of Lamarck.

3rdly. Species which branch by terminal subdivisions, as—i. *C. fastigiata*, ii. *C. angulosa*, iii. *C. sinuosa*, and iv. *C. carduus*; or Lamarck's Nos. 12, 13, 14 & 15.

One species, *C. trunculus* (No. 3 of Lamarck), is omitted in this distribution, as it does not appear to have been figured, and its mode of producing additional cavities is not mentioned. Of the other fourteen species, the first of the above groups contains only *one*; the second, *nine*; and the third, *four* species. Were the genus therefore restricted according to the primary character on which they are founded, *Caryophyllia* should, it is conceived, be applied to the second group, on account of its numerical importance. It admits however of well-marked divisions based on the character of the mantle.

a. Species the exterior of which is wholly enveloped by the mantle, as—i. *C. ramea*, and ii. *C. calycularis*.

b. Species in which only the upper extremity of the branch is covered, as—i. *C. flexuosa*, ii. *C. cæspitosa*, iii. *C. anthophyllum*? and iv. *C. cornigera*.

c. Species provided with a mantle which forms an intermediate structure, as—i. *C. fasciculata*, ii. *C. astreata*, and iii. *C. musicalis*.

For the first subdivision (*a.*) as respects *C. ramea*, M. De Blainville[1] proposed the genus *Dendrophyllia*, and it is believed he was fully justified in doing so: *C. calycularis* is assigned to the above position in consequence of a recent coral presented to me by Sir C. Lyell, and obtained off Prince's Island, west coast of Africa, by Lieut. Holland, R.N , agreeing in all its characters and dimensions with Esper's figure[2], the first quoted by Lamarck. Dr. Milne Edwards states[3]

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[1] Man. d'Actinologie, p. 354.

[2] Pflanzenthiere, Madrepora, tab. 16.

[3] Anim. sans Verteb., ed. 1836, t. ii. p. 348.

that *C. calycularis* apparently includes two species, neither of which belongs to the genus; Ehrenberg[1] considers his *Cladocora calycularis* as the equivalent of Lamarck's *Caryophyllia*; but he alludes to Boccone's *Astroitis*; and Mr. Dana[2] adopting that genus, includes in it the recent coral in question, quoting Esper's figure, with however an allusion to the great size of the terminal cups. From this statement it is evident that Lamarck's species is not a *Caryophyllia*, according to the most recent authorities.

For the second subdivision (*b.*) Ehrenberg has proposed the genus *Cladocora* (*op. cit.* p. 85 *et seq.*); and, for the corals composing the third, he has retained in a restricted sense Schweigger's term *Anthophyllum* (p. 89). These determinations are believed to deserve acceptance, and they provide for the whole of Lamarck's species arranged in the second of the foregoing groups.

The third group distinguished by a fissiparous process would claim therefore, on the grounds of numerical importance, a right to the name of *Caryophyllia*; and Ehrenberg[3] on physiological characters has restricted the term to the species possessed of that property. *Lobophyllia* has been proposed by M. De Blainville[4] for an equivalent assemblage of corals; but Mr. J. E. Gray[5] of the British Museum, in a recent paper on the arrangement of stony *Anthozoa*, retains Lamarck's generic designation, making *Lobophyllia* a synonym, and thus recognizing, it is presumed, the correctness of Ehrenberg's limitation. Mr. Dana[6], on the contrary, has revived Oken's name, *Mussa*, for such of Lamarck's *Caryophyllia* as subdivide; applying the latter term to Ehrenberg's *Cladocora*; but Oken's genus[7] was proposed, it is believed, in 1815–1816, whilst Lamarck's dates back to about 1801. Mr. Stokes and Mr. Broderip[8] have proposed to restrict *Caryophyllia* to those corals which have the leading characters of *Caryophyllia Smithii* of the coast of England, or *Cary. cyathus* of the Mediterranean; and M. Milne Edwards[9] proposes to confine the genus to conical polyparia, fixed at the base, and simple or scarcely aggregated.

Amidst this diversity of opinions it is difficult to adopt a determination which will meet with general consent; and Lamarck's definition, " simple ou rameux,"

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[1] Beiträge, &c. p. 86.

[2] Exploring Expedition, Zoophytes, p. 406.

[3] Beiträge, &c., p. 91.

[4] Man. d'Actinol. p. 355.

[5] Ann. and Mag. Nat. Hist., Feb. 1847, vol. xix. p. 128.

[6] Expl. Exped. Zoophytes, pp. 173, 378, *et seq.*

[7] Lehrbuch der Naturgeschichte, 1815–1816. The compiler of the above memoranda cannot refer to the work.

[8] Zoological Journal, t. iii. p. 486.

[9] 2nd ed. Lamarck, t. ii. p. 346.

affords no assistance. If the simple species were adopted, the genus would contain only one of those originally described by Lamarck, and that authority would appear in subsequent works on zoophytes to have but little claim upon attention; whereas if the group characterised by a fissiparous process be selected in conformity with the systems of Herr Ehrenberg and Mr. Gray, Lamarck's share in the genus would be prominent; and *Caryophyllia* would moreover rest on a very decided as well as all-important physiological character.

The foregoing remarks have been intruded upon the reader to explain, why simple, fixed corals are not considered the representatives of *Caryophyllia*; and it is only with such polyparia that the chalk fossil admits of comparison.

The *Cyathina* of Ehrenberg[1], founded on *Caryophyllia cyathus*, is characterised by simple lamellæ, and the terminal star having a circle of small plates or projecting points between the outer lamelliferous zone, and the central contorted structure: it consists also, as previously stated, of simple stems permanently fixed; and the exterior is not covered by the polype, except immediately adjacent to the upper margin; and there only when the animal is extruded. One of Ehrenberg's essential characters is the central structure of the terminal cavity, particularly the circle or crown of projecting points (consult remarks *op. cit.* p. 77); but he says, "apud Madreporas tales coronæ frequentes sunt, rariores apud Astræas et Favias inveniuntur" (*loc. cit.*). Mr. Dana[2] refers directly to *Ast. pentagona* as having such a circle; and the structure exists in *Cladocora cæspitosa* (*Caryophyllia id.*, Lamarck). A similar character is also visible in a variety of *Oculina pallens* of Ehrenberg (*Oc. hirtella* of Lamarck, as represented by Esper, *op. cit.* tab. 14). The structure appears to vary considerably in different species, and even in specimens usually assigned to *Cyathina* (*Cary.*) *cyathus*, presenting sometimes rounded plates (Esper, tab. 24), sometimes sharp spines (Sol. & Ellis, tab. 28, f. 7)[3]. Such a circle moreover, from the statements of Ehrenberg and Mr. Dana, and from the instances mentioned above, cannot be regarded by itself as a generic distinction, however valuable it may be in separating *Cyathina* from other simple, turbinated, and permanently fixed corals: it should also be remembered that the plate may vary with conditions of growth, being nothing more than a lobe of the lamellæ in front of which it stands. As respects the chalk fossil, out of

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[1] Beiträge, p. 76. Hermann describes the coral under the designation *Madrepora calendula*, and he states that it had not previously been noticed in detail, though Mercati had figured it in the Metalotheca Vaticana (1719). Naturforscher xviii. Stuck. s. 115. tab. 5. f. *a*, *b*. 1782.

[2] Explor. Exp. Zooph. p. 370. Consult Esper, Pflanzenthiere, Madrep. tab. 39. f. 1 & 2.

[3] Consult Hermann, *op. cit.*, tab. 5. f. *a*, *b*. His description is also believed to be the fullest yet published: also Mr. Dana, p. 370–371.

thirty-two examples, many of which had well-preserved terminations, only one exhibited traces of the character, and it afforded other peculiarities. So far therefore as this component part is concerned, the fossils generally which are assigned to *Cary. centralis*, cannot be regarded as *Cyathinæ.*

The internal composition of *Cya. cyathus* is unknown to the compiler of these memoranda; but in a coral believed to be a distinct species of similar dimensions, transverse plates between the lamellæ were wanting; and though a union of two of the latter was noticed in one instance, yet such a junction could not be regarded as an equivalent structure. They were also absent in the largest, longest specimens of *Cy. Smithii.* On the contrary, they formed a prominent structure in the chalk fossil (Tab. XVIII. fig. 3) wherever the interior was exposed. With respect to the proportion of the exterior covered by the animal, the extinct coral apparently differed also from the recent. Of thirty-two specimens examined, seventeen were encrusted by marine bodies; and five of the seventeen exhibited clear evidence of affixed zoophytes having been coated by coral secretions, and the added matter was not limited to a particular part, but was spread evenly and continuously thinning off upwards. It is therefore evident that the animal had the power of contracting and extending, and possibly at somewhat distant intervals of time. The absence of encrusting bodies cannot however be received as a proof of an investment by the polype, depending clearly on extraneous circumstances; nor can their presence, except in cases similar to that just mentioned, as it is often difficult to determine, especially in organic remains, whether the incrustation took place during life or subsequently; and the only conclusions which can be drawn regarding the cretaceous fossil are,—1st, that the exterior was not wholly and permanently covered by animal matter; and 2ndly, that the extension was not so uniformly restricted as in *Cyathina.* The recent genus evidently could not thicken the outer surface after the first perfecting of the wall; and in the fossil coral the coating varied in amount, or was in some cases not perceptible. About twenty specimens had plainly additions, while ten gave no indication of increase; and both the thickened and unthickened were regular as well as irregular in growth, and differed not in composition. If the coral which is considered a new species of *Cyathina* exhibits truly the characters of the genus, a decided filling up of the lower portion occurs. The total height of the specimen was 1½ inch, the depth of the terminal cup 7 lines, and the centre preserved its reticulated composition 3 lines lower; but throughout the remaining 8 lines, that structure was solidly filled up, as well as the intervals between the lamellæ to a great extent. *Cy. Smithii* afforded no proof of a central consolidation, but traces of partial interlamellæ obliteration were observed. Not an indication of such a process was visible in specimens of the fossil 2 inches in height. One other character requires consideration. Ehrenberg states, that in *Cyathina* prolification is rare, monstrous (*op. cit.* p. 37). Three specimens of the chalk coral bore one incipient lateral cavity each; two of the cases occurring close to the upper margin, the other about 4 lines below it, the total height of the mature specimen being an inch. The largest, situated close to the margin, slightly exceeded a line in diameter; and the case, at a distance from an upper edge, exhibited but a slight excess of development, its height being only $\frac{3}{4}$ths of a line. It is not necessary at present to notice the peculiarities of these young cavities, but attention will be again solicited to them.

From the preceding imperfect remarks it would appear, that the chalk zoophyte usually referred to *Caryophyllia centralis* differs from *Cyathina* in the absence, with one exception, of the circle of lobes within the terminal cavity—in the existence of numerous transverse plates between the lamellæ—in a much greater outward covering by the animal—and in many cases of an external thickening, with a want of any internal filling up of the lower part. If Ehrenberg's character of a crown of plates in conjunction with an isolated mode of growth may be considered a satisfactory generic distinction, the prevailing absence of it in the chalk fossil would be sufficient to justify a separation from *Cyathina*; and if there be added to it the other differences, though some of them may be regarded as only differences in degree, the whole taken together form an aggregate of dissimilarities which is believed to require another generic assignment.

2. *Turbinolia.*—Respecting the continental determinations before mentioned, it is sufficient to state, that whether free or not in the earliest period of development, the chalk fossil soon became permanently fixed; whereas a free condition when mature is one of Lamarck's essential characters. That authority nevertheless included in his genus corals of very different detailed construction, as *T. turbinata* and *T. cyathoides*[1], when compared with *T. crispa* and *T. sulcata*. Many other fossils have been subsequently added to those originally described, but apparently without a full consideration of the characters of the solid portions, or of the probable nature of the animal and its habits. The cretaceous fossil differs most materially from the species just mentioned, whether the two first or the two last be the objects of comparison. How far it may agree with other extinct zoophytes assigned to the genus, is a question which does not admit at

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[1] Consult Fougt's original figures, Amœn. Acad. Tomus i. tab. 4. f. 2, 3, 7; and f. 1, edit. 1749, referred to by Lamarck.

present of discussion; but should such agreements be detected, still they would not make the fossils immediately under examination *Turbinoliæ*, as those species would not structurally accord with *T. crispa* and *T. sulcata*, which are invariably admitted to be generic types.

For single, fixed corals wanting the central structure of *Cyathina*, Ehrenberg proposed the term *Monomyces* with the following characters:—lamellæ simple; mantle non-retractile, enveloping the exterior to the root; stems fixed, solitary or with simple germs on the side, not branched:—the genus being considered equivalent to fixed *Fungiæ* and single *Caryophylliæ* (*op. cit.* p. 77). Three species are noticed. The first, *Mon. patella* or *Fungia patellaris* of Lamarck, is a free coral as exhibited by Ellis and Solander[1], and is stated by them to be "acaulis." Lamarck says, "elle a quelquefois un pedicule court en dessous[2]:" two of Esper's figures[3], referred to by that authority, exhibit something like a foot-stalk, but the apparent structure is alluded to in the description as a portion of some unknown coral[4]; two other figures however (6 & 7) display a bold, cylindrical body protruding from the centre of the under side; it is, nevertheless, not affirmed to be a part of the specimen. Whatever may be the nature of that zoophyte, all pediculated *Fungiæ* are most probably, if small, young examples of a mature free state[5], or if large, abnormal developments. The second species, *Mon. Anthophyllum*, is believed to be unfigured; the description also is not full, and Mr. Dana refers it to *Euphyllia* (*op. cit.* p. 160. *Flabellum* of Lesson). The third species assigned doubtfully to the genus is the *Fungus eburneus* of Shaw[6], but it would appear from his delineation to be closely allied to *Mon. Anthophyllum*. The chalk fossil having been considered by some authorities a single *Caryophyllia*, and exhibiting evidently mature conditions of growth, would seemingly belong to Ehrenberg's genus; but one of the leading characters of *Monomyces* is a perfectly enclosing non-retractile mantle, whereas the extinct coral was enveloped to only a certain extent, and not always to the same amount. Moreover no account is given of the internal composition; and provided Mr. Dana's conclusion is correct, transverse plates between the lamellæ do not exist, being absent in *Flabellum pavonium*, and it is presumed in analogous *Euphylliæ*. *Monomyces* consequently

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[1] Natural History of Zoophytes, or Lamouroux, Exp. Méthodiq. tab. 28. figs. 1–4, p. 52.

[2] Anim. s. Verteb., 2nd edit. t. ii. p. 372. no. 4.

[3] Pflanzenthiere, Madrep. tab. 62. f. 1, 2.

[4] *Op. cit.* Fortsetzungen, Erster Theil, pp. 76, 77.

[5] Consult Mr. Stutchbury's Memoir, Trans. Linnean Soc. vol. xvi. p. 493 *et seq.* pl. 32.

[6] Travels in Barbary, &c., 3rd edit. vol. ii. plate at p. 369. fig. 18. descrip. p. 371. no. 18.

cannot be regarded as a fully established genus; and so far as it is known, it differs from the subject of this notice. Believing therefore that the chalk fossil is not referable to any known genus, the term *Monocarya* is suggested for it, not on account of verbal precision, but in allusion to the previous determination, and in contradistinction to *Monomyces*, should any zoophytes be found, recent or fossil, possessing the peculiarity of permanently fixed *Fungiæ* (Μύκης).

Monocarya, n. g.

Single, fixed, rarely gemmiferous on the side; more or less enveloped by the animal, more or less thickened externally; lamellæ numerous, simple, unequal; many intermediate transverse plates; centre reticulated; no internal filling up.

Monocarya centralis (*Caryophyllia centralis*, Mantell). (Tab. XVIII. figs. 1 to 10.)

Cylindrical or conical, often bent; base a more or less extended layer; exterior ribbed, papillated; ribs variable in outline and dimensions, altering during development; occasionally concealed by external thickening; terminal cavity shallow or deep; lamellæ unequal in breadth, uniformly thin, waved, jagged, tuberculated on the sides, when perfect and fully produced, the broadest project above the margin with a rounded outline; intervals between lamellæ distinct at the circumference of the cavity; transverse plates thin, slightly curved, irregularly distributed, none visible in terminal cup; centre more or less ample, formed of reticulated laminæ.

Columellus turbinatus, Lhwyd? Lithophyl. Brit. Iconographia, 1st edit. p. 8. nos. 136, 137, 1699.

Corallite or Madreporite, Parkinson, Org. Rem. vol. ii. p. 32. pl. 4. f. 15, 16.

Madrepora centralis, Mantell, Fossils of the South Downs, 1822.

Caryophyllia, Conybeare and W. Phillips, Outlines of Geol. of England, p. 74, 1822.

Caryophyllia centralis, Fleming, Brit. Anim. p. 509. no. 6, 1827–1828; Mantell, Geol. Trans. 2nd series, vol. ii. p. 204, 1828–1829; Geology South-East of England, 1833; Wonders of Geology, 3rd edit. vol. i. p. 307. fig. 3, 1839; J. Phillips, Geol. of Yorkshire, part 1. pl. 1. fig. 13, 1829; R. C. Taylor, Mag. Nat. Hist. vol. iii. p. 271. fig. *f*, 1830; De Blainville, Man. d'Actinol. p. 346, 1830–1834; Milne-Edwards, 2nd edit. Lamarck, t. ii. p. 358, 1836; Morris, Cat. Brit. Foss. p. 32, 1843; Ansted, Geology, Introductory, Descriptive, and Practical, vol. i. p. 475. fig. *c*.

Turbinolia centralis, Roemer, Verstein. Norddeuts. Kreidegeb. p. 26, 1840; Geinitz, Charakt. Schichten u. Petref. säch.-böhm. Kreidegeb. p. 92, 1839–1842; and Gäa von Sachsen, p. 131, 1843.

The specimens submitted to examination presented considerable irregularities of growth (Tab. XVIII. figs. 3, 4, 9), consequent probably on having been attached to moveable bodies. One of those described by Mr. Parkinson adhered to "a plate of an Echinus" (*op. cit. sup.* p. 32). A tendency to an extension in one, possibly a vertical, direction prevailed evidently from the earliest period, as in the specimen delineated in fig. 3, a marked curvature existed close to the base, and two other equally decided cases occurred in the collection; Dr. Mantell also gives a very prominent example of changed inclination. (Geol. S. Downs, t. 16. f. 4.) This determination to a certain line of growth deserves, it is conceived, attention, as *Cyathina Smithi* will extend outwards from the perpendicular face of a rock, without any effort to attain a vertical position. The conical outline was chiefly limited to the earliest formed portions of the coral (figs. 1, 2, and lower part of other figures), slight variations taking place after the cylindrical contour was attained; and Mr. Conybeare considers the elongated variety as "perhaps only a different stage of growth" (*op. cit.* p. 74) of the conical. One specimen (fig. 5) was cylindrical nearly throughout. The differences in diameter (figs. 4, 6) apparently depended more on relative vigour of development at an early period of existence, than on subsequently augmented powers (compare fig. 2 with figs. 3, 4 & 6). The characters of the ribs also varied: near the base, when not overlaid by outer secretions, or not abraded, they were in very many specimens alternately large and small; but occasionally three of subordinate size occurred, the middlemost however being more prominent than the other two. As the coral extended upwards, the ribs became almost uniformly broad, and in one case (fig. 4) nearly flat; but the greatest variations were adjacent to changes in direction of growth, distinct ridges being often obscure in those parts (figs. 3, 4); and if a succession of deviations occurred, the ribs were slender and more or less interrupted (fig. 3). The papillæ likewise differed in distinctness and number, and they were occasionally not detectable even where the outer surface had not been overlaid. In some specimens the structure existed in the lower part, but was chiefly wanting in the upper; while in that represented by fig. 7, it was inconspicuous throughout; and in one case the exterior had a jagged appearance, due to the papillæ being irregularly aggregated. Examples of much greater deviations in outer composition, arising, it was conceived, from injuries received by the polypes, occurred in Mr. Dixon's fine suite (figs. 9, 10). Outer additions, as before stated, were not unfrequently wanting (figs. 1, 2, 3, 4) ; and such specimens were either beset by extraneous substances (fig. 2), or not (figs. 1, 3) ; but in the case (fig. 2) it is probable that the animal died some time before the coral was buried up by sediment, as the shell occupied a large extent of surface, and reached nearly to the margin of the terminal cavity. Several examples (figs. 6, 5, 8) had an uniform layer spread over almost the whole surface, concealing more or less the ribs. In the first the addition was (fig. 6) coated by other bodies ; while in the second (fig. 5) it encrusted Bryozoa, and in the third an undetermined parasite. The characters of the terminal cup varied considerably: the cavity, as shown in figure 2, is deep, the lamellæ are narrow, and the reticulated centre occupies a large area ; while in figures 3 *a*, 4 *a*, 7 *a* & 8 *a*, either the depth of the cavity is less, or the lamellæ occupy greater space, or the central structure is much contracted ; but if the specimens thus represented or the delineations be studied together and in connexion with figure 3, the deviations will be found, it is believed, to depend on different stages and degrees of development, or on the state of preservation ; the relative diameters being duly considered as affecting the dimensions of the reticulated centre : moreover, if the comparison be extended to a suite of very many specimens, other variations will appear, but no distinctions to justify specific separations. The internal composition of the coral was beautifully shown in the fractured example, figure 3, especially the uniform, downward character of the lamellæ, their structure being the same near the base as in the terminal cavity, without a trace of filling up ; the number as well as distribution of the transverse plates was likewise clearly exhibited, also the unaltered nature of the central reticulation. Figure 4 displays a still lower exposed interior, and differs not from figure 3, except that the axial portion is larger and more fully shown. Two of the lateral germs before mentioned are delieated of their natural dimensions in figs. 2 & 7. The slightly greater instance (fig. 7) is situated nearly mid-way between the extremities of the coral. The diameter of the cavity was rather less than a line, and that of the base about twice that measurement ; the height barely exceeding half a line. The exterior presented sharp ribs, with others intermediate but scarcely discernible ; and the base consisted of an expanded layer similar to that of mature specimens of *Monocarya centralis.* The interior of the cavity was deep, but exhibited only blunt projections or rudiments of lamellæ ; and it gave not the least indication of a central reticulation. The other example (fig. 2) was situated close to the margin ; it had no external ribs or distinct expansion at the base, but the interior had rather more prominent lamellæ than in the former instance. This young cavity was so intimately connected with the structure of the mature coral, that no doubt could be entertained of its having been produced by the polype which inhabited the latter. No evidence was obtained whether a marginal development was effected progressively as the side of the parent was perfected, or whether it was a pallial production: doubts may also be entertained respecting the origin of the example, figure 7, as it might have been formed in the mantle, or have sprung from an ejected ovum accidentally settled on an exposed side. Whatever the source may have been, it is plain that such young cavities were of infrequent occurrence, and should be regarded as exceptional rather than essential productions.

Three other corals are represented in Tab. XVIII. (figs. 11, 12, 13), as they exhibited characters somewhat dissimilar from those mentioned in the preceding paragraphs. One of them (fig. 11) differed from the specimens previously noticed in the lamellæ being knife-shaped, regular in outline, and almost in contact at the periphery of the coral (fig. 11 *a*); and not thin throughout, waved, and separated at the circumference of the cavity by clear intervals. It presented also, as before mentioned, traces of rounded lobes in front of the broadest lamellæ. Externally, the ribs were visible only in the upper half of the surface, the lower being smooth, and partially coated by Bryozoa: the internal structure could not be ascertained. Mr. Dixon's collection contained two other clear examples of similar lamellæ; but the specimens (fig. 12) were much more slender than that just noticed, bearing about the same proportions to it that figure 6 bears to figure 2. Their internal composition was also not ascertained; but their exterior was smooth nearly to the upper margin, and bore evident proofs of considerable outer additions; attached zoophytes and apparently annelides were likewise overlaid by the polype secretions. The three corals thus far characterized were believed to belong to *Monocarya*, and should the internal structures warrant a specific separation, they might perhaps be distinguished by the term *Monoc. cultrata*. The other fossil (fig. 13), obligingly lent by Mr. Tennant, F.G.S., agreed in the outline of the lamellæ with ordinary specimens of *M. centralis*; but the sides of the plates were nearly smooth, and there was an almost total want of a central reticulation. This structure has been already stated to vary considerably, but chiefly in proportion to the diameter of the specimen. Mr. Tennant's coral exceeded in this respect the largest examples of *M. centralis* which were examined; yet it had a less definite centre than the lower portion of figure 3. From a single specimen in probably an early stage of growth, no opinion can be offered respecting either genus or species, and a right determination of the coral must consequently be left to future research.

Tab. XVIII. figs. 14 to 28.

The coral next to be noticed agrees in some respects with certain species of *Oculina*; and the comparative observations will be chiefly confined to that genus. It consists of small amorphous masses, the largest (fig. 14) of the seven specimens examined being only $1\frac{3}{4}$ inch in height and $1\frac{1}{2}$ in breadth. From a base (fig. 15, +) which presented no expanded layer, but was moulded apparently on an irregular perishable surface, sprang one or more primary stems, that progressively enlarged upwards; and from their sides issued subordinate shoots, the whole being united by external additions. The main branches as well as the offshoots were traversed throughout by hollows or stellated cavities, often of large dimensions, but no doubt could be entertained that the former had once been occupied by lamellæ, traces of their existence being clearly detectable, as will be shown in a subsequent paragraph. A comparison of figures 14 & 16, which express fully these characters with Esper's[1] delineation of *Oculina virginea* of Lamarck, &c. would lead to the supposition that the fossil and recent corals were generically allied; and Mr. Gray has recently stated, that the older branches of *Oculina virginea* often become tubular[2]. The large hollows in Esper's delineation, however, arose apparently from the removal of extraneous bodies, the specimen from which it was taken being stated to be "einer rindenförmigen Mass[3];" and an analogous mode of growth with the encrusted substance is shown in figure 3 of his tab. 12. In the genus *Oculina* moreover nothing approaching to a persistent, main, stellated cavity exists; such a structure constituting an essential difference between it and the *Dendrophyllia* of M. De Blainville. The nature of the abdominal cavities and the mode of producing young hollows in the two zoophytes offer other distinctions. Among existing *Oculinæ* the cavities have great uniformity of character and dimensions in the same specimen, the changes due to growth being generally small; and the interior exhibits no signs of irregularity or peculiarity in progressive development. The greatest variations in size occur in *Oc. proli-*

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[1] Esper, Pflanzenthiere, *Madrep. oculata*, tab. 13.

[2] Annals Nat. Hist., Feb. 1847, vol. xix. p. 123.

[3] *Op. cit.* Erster Theil, p. 108.

fera[1], a Norwegian coral, respecting which additional information is much desired. On the contrary, the cavities in the chalk fossil (figs. 14 & 16) differed considerably in capacity, the largest being nearly 5 lines in diameter, and the smaller scarcely one; every intermediate measurement also occurring, and proving that upward development was attended very generally by great increase of transverse area. Occasionally however the horn-like branches had, to the extent of their production, nearly cylindrical cavities. The terminations of the stellated hollows, and the interior of those deprived of the lamellæ exhibited likewise marked inequalities. The smaller often presented an inner radiated area, surrounded more or less completely by a not uniform zone, which had again its outer boundary. The zone was sometimes structureless (figs. 19 & 22, mag.); but in other instances it was wholly lamellated (f. 26) or the inner star had perished (f. 23), leaving a cylindrical hollow, environed by a circle of narrow, radiating plates. Several of the larger cavities, though empty in the upper part, retained in the lower similar structures, or exhibited on the sides inequalities which indicated their former existence (figs. 15 & 16). It is believed that nothing analogous to what has just been noticed exists in true *Oculinæ*.

Ehrenberg[2] states that in that genus, "gemmæ non ex appendicibus pallii seu stolonibus prodeunt, sed ex ipso tubulo intumescente:" Mr. Dana[3] says, "Each bud is for a time at the apex, but it gradually becomes lateral, and then gives off another bud from its upper side;" and Mr. Gray[4], that in *Oc. axillaris* they are emitted from each edge of the cell; while in *Oc. prolifera* one or two buds are produced from one side of the animal, and in *Oc. virginea* as well as *Oc. hirtella* "the cell at the tip is the one last developed." These statements prove that in *Oculina* each polype, including in the term all animal structures in addition to those of the abdominal cavities, produces but one or two buds, at or towards the upper portion of the parent; and though in incrusting specimens, such as those figured by Esper (*loc. cit. ante*), there is an appearance of pallial developments, yet the cavities were most probably formed during the upward growth of the animal around the incrusted body, and not in the mantle which subsequently invested the coral's outer surface. The chalk fossil exhibited two processes in every specimen examined[5]. By one of them the addition was effected at the upper

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[1] Consult Ellis and Solander's Zoophytes, or Lamouroux's Exp. Méthod, tab. 32. f. 2; also Esper, *op. cit.* Madrep. tab. 11.

[2] Beiträge, p. 78, note.

[3] Explor. Exped. Zoophytes, pp. 67, 391.

[4] *Op. cit.* p. 126.

[5] Other genera of Anthozoa, as the *Siderastræa* of De Blainville, have also two similar processes;

margin of the parent; and by the other, in the mantle, and often at a considerable distance below the extremity. In the first mode (figs. 14, +, 18, +, 21) the cavity was progressively advanced as the wall of the previous structure extended upwards; and the young additions were not limited to one or two, nor to a particular side of the parent hollow, or to a single period of its growth; more than two having been noticed, irregularly situated, and either on the margin or, when perfected, below it. This progressive plan of formation distinguishes the fossil from *Oc. pallens* of Ehrenberg (*Oc. hirtella*, Lamarck, Esper, Madrep. tab. 14), and possibly other species, in which the young cavity is produced in the substance of the animal matter investing the top of the branch, and simultaneously around the whole of the incipient area; while in the chalk zoophyte the process agrees with that observable in *Dendrophyllia ramea* (De Bl.); but with this difference, that in the recent coral there is not a perfect, early disconnection between the interior of the older cavity and that of the offset, whereas in the extinct a solid, continuous wall cuts off immediately all direct communication. Occasionally, where the lamellæ had perished, an irregular hole appeared at the base of the side shoot, but it was plainly due to fracture or decay. The second process was seated in the investing mantle, and, as before stated, often considerably below the extremity of the stem or branches; and these young abdominal receptacles were distinguished from the others, by their less size and indistinctness, as well as by the development, however imperfect, being contemporaneously effected around the area. The earliest observed stage of this second process (fig. 24, mag.) presented a small conical mound, about a line in breadth, of variable form, and with an irregular opening, in which traces of lamellæ were visible. Some of them seemed to have a partial, and others a perfect solid covering; but as an absorbing power among Anthozoa is believed to be unknown, and as cavities which had attained maturity with some upward growth were also occasionally coated over, it was inferred, that the polype structures of those incipient fabrics, as well as of the more advanced, had perished prematurely, and that the mounds had been overlaid by a layer of coral matter secreted from the mantle. Similar coverings may be noticed in cavities of *Oculinæ* from which the abdominal structures have been removed by accidental destruction. An advanced step in these pallial

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the additions along the hemispherical margin of the coral, consisting first of limited arcs, afterwards of semicircles and ultimately of circles, according as the general polype substance grew; and the young hollows within the area of a specimen are simultaneously formed around their whole circuit, being produced in the midst of animal structures.

productions appears to have been the formation of a lamellated zone around the mound (figs. 28, 27 mag.), one of those peculiar increments before mentioned. This early step was not accompanied by an upward extension, the outer structure being based on the general surface of the coral. After a time the two areas probably blended by growth into one, the diameter of somewhat elongated simple cavities being about equal to that of the mound and zone united (fig. 17 magnified in same proportion as fig. 26). In further advancements no differences, it is presumed, occurred in the growth of pallial and marginal developments, or between them and the upward extension of the primary cavities, but that all progressed by the same general law, and by successive stages of lateral expansion, more or less visible in the hollows from which the lamellæ had perished.

The lamellæ afford a further distinction; they agree with those of true *Oculinæ* by exceeding twelve in number[1], but they do not pass solidly into the structure surrounding the cavity; while in the recent genus they range in all species, it is believed, into that portion of the coral. The interior of the largest cavities (fig. 14), which had lost their lamellæ, exhibited no fractured, perpendicular edges, but faint ridges and furrows, roughened only by the peculiar texture of the coral, and therefore proved, it is conceived, that the removal of the lamellæ was owing to a want of solid union with the wall, and not to disruption. Sometimes, particularly in young pallial developments, a perfect junction existed between the lamellæ and the then existing boundary, and even in more advanced states there was an apparent junction. The structure forming the circle to which the lamellæ were united, is believed however to have been developed by portions of the polype differently constituted from those which produced the general body of the coral, including the permanent boundary of the cavities. Thus, the partially preserved, mature hollows (fig. 20) had a slight interval between the lamellæ edges and the surrounding solid substance of the coral, indicating the removal of a thin perishable layer; and where the decay was less (fig. 25), the position of the interval was occupied by a structure intimately blended with the lamellæ, and filling also to a limited extent the space between them: in some cases likewise single plates occurred in contact with the permanent boundary, or were united to it by minute points, decomposition having taken place more rapidly between the lamellæ, than between the edges of the latter and the undecaying periphery. The inner perishable composition was evidently produced by structures immediately

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[1] Consult De Blainville's genus *Dentipora*, Man. d'Actinologie, p. 382, and M. Milne-Edwards's remarks on *Oc. virginea*, 2nd edit. Lamarck, t. ii. p. 455, for species with less than twelve.

connected with the viscera, and which secreted a large proportion of animal matter among the calcareous particles; whereas the solid enduring body of the coral was developed from others belonging to the mantle, and which deposited a preponderating amount of mineral ingredients. The irregularities within the abdominal cavities both large and small appeared, so far as was observed, to arise from the imbedded position of the hollows. The greatest inequalities existed in those specimens (fig. 16) which had immersed cavities, as if a struggle had been maintained at periods of increase, between the visceral and pallial portions of the polype; and it should not be forgotten that one of the properties of the latter structure is to close over areas unoccupied by it; on the contrary, in specimens (fig. 14) characterized by cavities which possessed during growth a great degree of free surface, subsequently thickened, the interior was remarkably uniform in outline, and traversed only by faint vertical lines, or impressions derived from lamellæ edges.

In a summary of differences between *Oculina* and the chalk fossil, it would appear, (1) that in the latter, dominant cavities ranged upwards from the base to the full extent of the coral, no limits to their growth being evident, whereas in *Oculina* no similar hollows exist: (2) that the cavities produced at the upper extremity of the corals spring in *Oculinæ* from the investing portion of the polype, and contemporaneously around their area; while in the chalk fossil the formation was effected progressively as the margin of the parent hollow was advanced: (3) that according to the authorities quoted in a preceding paragraph, only one or two germs spring in the recent genus from the upper end of each mature cavity; but the extinct zoophyte produced successively three and four, and possibly a greater number: (4) that in *Oculinæ*, pallial developments at a distance from the superior extremity of a branch are very rare, being exceptional rather than essential formations; whereas in the cretaceous Anthozoon they are common and constitute a leading feature: lastly, the lamellæ in the recent coral have a prevailing permanency, but in the fossil an extreme liability to decay. This aggregate of differences forbids, it is conceived, the chalk zoophyte being assigned to *Oculina*; and as the structures on which it depends do not, so far as the describer is aware, co-exist in any established genus, it is suggested that the word *Diblasus* might be adopted as a distinguishing term, founded on the twofold mode of budding, while in *Oculina* only one prevails, (δὶς *bis*, βλαστὸς *germen*).

Diblasus, g. n.

Fixed, invested externally by the mantle, outer surface irregularly thickened; abdominal cavities, variable in characters; lamellæ numerous; additional cavities produced on the margin of those previously formed, and in the mantle at irregular distances from it.

Diblasus Grevensis, sp. n. (Tab. XVIII. figs. 14 to 28.)

Amorphous, lobed, abdominal cavities immersed or projecting, conical or cylindrical; lamellæ unequal, near together, spinous on the sides, no distinct central structure, but a union of broadest lamellæ; surface partially ribbed, external additions unequal.

So far as the describer is aware, though this fossil is stated to be very abundant at Gravesend, no account of it has been published, nor is he aware of its having been figured. In the third volume of 'Guettard's Memoirs[1],' a Kentish coral is represented, and some resemblance may be detected between that delineation and the zoophyte under consideration; but M. Guettard's fossil is stated to be articulated; "En effet on distingue encore quelques-uns des nœuds qui forment les articulations du corail articulé" (*loc. cit.*); and M. De Blainville has designated it by the term *Isis breviarticulata*[2]. Had the cavities preserved fully their lamellæ, a resemblance would possibly have existed with M. Goldfuss's[3] *Lithodendron gibbosum*, found in green, sandy marl of the chalk formation near Bochum, but the English fossil exhibits none of the characters of Schweigger's genus[4], equivalent to *Oculina* and *Caryophyllia*, in part, of Lamarck; or of the peculiarities which distinguish *Lithodendron*, as limited by British palæontologists[5]. M. Ehrenberg[6] conceives that *Lithod. gibbosum* may belong to his *Stephanocora*, characterized partly by the cavities having a central area similar to that of *Cyathina*,—a structure however not detected in the best-preserved portions of the chalk fossil.

The seven specimens submitted to examination, four belonging to Mr. Dixon's cabinet, and three obligingly lent by Mr. Tennant, did not afford many data for detailed remarks. The mode of growth was best shown in that represented by

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[1] Mémoires sur différentes parties des Sciences et Arts, t. iii. pl. 58. f. 5. p. 520.

[2] Man. d'Actinologie, p. 503.

[3] Petrefacten, p. 106. tab. 37. f. 9.

[4] Beobachtungen, Syst., tab. 6.

[5] Mr. J. Phillips's Geology of Yorkshire, part 2. p. 202: also Sir R. I. Murchison's Geology of Russia, vol. i. Appendix A. p. 597.

[6] Beiträge, &c. p. 77.

figure 14, exhibiting three well-defined primary cavities with numerous lateral shoots, the whole being united, to a certain extent, by external additions. In other specimens, as figure 16, the plan of development was less apparent; but the example delineated had two distinct surfaces of attachment, at right angles to each other, and the manner of growth was probably affected by them. Figure 15, + displays fully the general appearance of the part by which the coral was fixed, the interior being in all cases cavernous, as if it had been moulded on a perishable body, resembling that of the root of a large fucus; and the edges were very thin though fractured. The striæ on the exterior were of limited occurrence (figs. 15, 16), and in some cases (fig. 14) they were almost invisible; but where best shown, they presented either broad, slightly raised ribs with fine intermediate furrows, or narrow ribs with broad furrows. The amount of thickening was very unequal, and the addition terminated sometimes abruptly, as if the mantle had been lacerated (fig. 14, ‡): in a specimen lent by Mr. Tennant, it exceeded in one place three lines. Incrusting Bryozoa and other marine animals occasionally appeared, but to a limited extent, indicating no lengthened exposure of the specimen on which they existed. To the previous imperfect remarks on the abdominal cavities very little can be added. The great dimensions they, in some cases, attained, and the diversity of size which characterized every specimen, are well shown in figure 14; but the lowest extremity of the largest had as limited an area as that of the small horn-like projections. The best-preserved margins of the primary cavities were very thin, proving, so far as the specimen was concerned, the full extent of its upward growth. Respecting the characters of a perfect terminal hollow no opinion could be formed, except that in the earlier stages of development, the depth appeared to have been very small. The lamellæ greatly exceeded twelve (fig. 19), and they occupied the major portion of the area, being very near each other: sometimes they were alternately broad and narrow; but no regular sequence was maintained; their thickness also varied, and some of them were slightly bent or waved in the range towards the centre; their sides were spinous, as well as edges, so far as the latter could be ascertained; and occasionally a lateral junction of the plates was perceptible. The centre appeared to be a simple union of the broadest lamellæ.

Tab. XVIII. figs. 29 to 33.

Very few extinct, articulated corals have been noticed by naturalists. Scilla[1], Walch[2], Parkinson[3], and other palæontologists have described more or less fully, as well as figured, the well-known fossil to which Goldfuss[4] has applied the term *Isis Melitensis*, but for which Schlotheim[5] apparently proposed and perhaps at an earlier date the designation *Isis pileatus*. Goldfuss[6] enumerates also another tertiary species *Is. reteporacea*, considered however by M. Milne-Edwards[7] to be a very doubtful determination; M. De Blainville[8] has likewise assigned the appellation *Is. breviarticulata* to a Kentish zoophyte, stated by Guettard[9] to be truly "un coralloide articulé;" and the latter authority[10] figures another body "à trois branches, qui sont comme articulées à leur origine." Lastly Sir C. Lyell[11], in his memoir on the cretaceous and tertiary strata of Seeland and Moen, has delineated a "coral allied to *Isis* from the limestone of Faxoe." Of these extinct Anthozoa *Is. Melitensis* alone can be brought into direct comparison with the English chalk fossil, the others being insufficiently described and figured so far as the compiler of this notice is aware, specimens being also unattainable; and in conducting the inquiry, it will be requisite in consequence of M. Goldfuss's determination, to mention briefly the leading characters of recent species of *Isis*.

That genus, as limited by Lamarck[12], Lamouroux[13], and later authorities, consists of an axis composed of calcareous segments united by horny intervals or "internodes" of less diameter; the whole being invested by a friable, perishable crust, easily detached from the axis, and the visceral cavities are wholly confined

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[1] De Corporibus Marinis, &c., ed. 1759, p. 63. tab. 21. f. 1; first published in Italian in 1670, La vana speculazione, &c.: consult also Scheuchzer's copies of Scilla's figures, Herb. Diluv., edit. 1723, p. 79. no. 194. tab. 14. f. 1.

[2] Naturgeschichte der Verst. Knorrischen Sammlung, &c., Dritter Theil, p. 194. Supp. tab. 6 *f.* figs. 6, 7; 1771.

[3] Org. Rem., vol. iii. p. 72. pl. 8. f. 2. 4. 7, 1820–24. Parkinson alludes also to a Calne oolitic fossil as referable to *Isis*, p. 73.

[4] Petrefacten, &c., p. 20. tab. 7. figs. 17, 1826–1833.

[5] Systematisches Verzeichniss, &c., p. 19, 1832, published after Schlotheim's death. The catalogue includes three other species of *Isis*; but it is impossible to determine the nature of the bodies so designated without further assistance.

[6] *Op. cit.* p. 99. pl. 36. f. 4.

[7] Lamarck, 2nd edit. tome ii. 477. Observations 1836.

[8] Man. d'Actinol., p. 503, 1830–34.

[9] Mémoires, &c., tome iii. p. 520. pl. 58. f. 5, 1770.

[10] *Op. cit.* p. 493. pl. 41. f. 4.

[11] Geol. Trans. London, 2nd series, vol. v. p. 249. fig. 5, 1838.

[12] *Op. cit.* tome ii. p. 473.

[13] Exposition Méthodique, p. 39.

to it, even in the very youngest parts of the coral; the number of tentacula is eight; the branches or lateral segments issue, with rare exceptions, from the calcareous portions of the main stems; and as the coral advances in age, the intervals are overlaid by a layer, similar in composition to the substance of the segments, the lower part of an old specimen, presenting a continuous or uniform character[1].

Scilla's figure of *Isis Melitensis* was drawn from detached portions found near each other and put together (*op. cit.* p. 63). The coral however agrees with *Isis Hippuris* and other recent species in the general form and furrowed exterior, when perfect, of the segments; but it differed in their terminations having convex or concave articular surfaces with a central foramen; and the ligament, whatever may have been its nature, had apparently far less thickness than in *Is. Hippuris*; whereas in the recent coral there are no articular surfaces, the ample horny intervals affording great facilities for motion. So far as the fossil is described or figured in the works consulted, or specimens would permit a conclusion to be drawn, the segments were not penetrated by abdominal cavities; but the inference is valueless, very young portions not having been examined or apparently delineated.

The fine specimen of the chalk fossil represented by figure 29, Tab. XVIII., consisted of many, long, slender segments, ribbed or furrowed on the outside, and generally displaced; but in a few cases they were in their right position or nearly so (fig. 30), and some of the lateral shoots were undisturbed and in close contact with the main stems (figs. 30 & 31), the whole of the evidence leading to the conclusion, that the intervals, if the term may be used, were exceedingly slight. The lateral segments necessarily sprung from calcareous portions; but occasionally two issued from one termination, giving rise to a bifurcated mode of growth. The articular surfaces were slightly convex and concave (fig. 31), and concentrically furrowed with a central boss or depression. Some portions of the furrowed exterior (fig. 30) afforded no signs of structural hollows, but others gave faint indications of them; and in following the same branch upwards, a gradual increase of distinctness became apparent, the upper portion exhibiting regular cavities with less than twelve crenulations in the boundary: other parts of the specimen presented similar characters. From this amount of evidence it is

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[1] For illustrations of the structures noticed in the text, consult Ellis and Solander's Zoophytes, or Lamouroux, Exp. Méthod., tab. 3. figs. 1–4; tab. 9. figs. 3, 4; also Esper's Pflanzenthiere, *Isis*, tab. 1, 2, 3, and 3 A.

plain that, for a certain period, the segments of the axis were occupied by abdominal structures, and that the hollows were gradually obliterated. No vestige of a crust could be detected, though no doubt of an investing animal substance could be entertained. One indication of an overlaid interval was noticed.

On comparing the composition of the chalk fossil with that of *Isis Hippuris*, points of resemblance will be found in the general form and furrowed surface of the segments; in the side offshoots issuing from calcareous portions of the axis, also in two occasionally proceeding from one termination; and it is believed that the intervals in both zoophytes were equally overlaid by calcareous additions. The differences consist in the fossil having more decided articular surfaces, with much less of interval; and in the all-important distinction of the segments being penetrated by abdominal cavities; while it is universally admitted that in *Isis* they are confined to the investing layer.

As respects *Isis Melitensis*, an agreement exists in the articular surfaces and in the construction of the segments; but that coral is far too imperfectly known to the compiler of these memoranda for an opinion to be hazarded of its full characters, though he doubts if the generic determination should be received.

From the difference in the position of the abdominal cavities, it is conceived the chalk fossil cannot be regarded as a species of *Isis*, or of any other genus of articulated Anthozoa, known to the describer. He therefore suggests, that it might be distinguished by the name *Axogaster* (ἄξων *axis*, γαστὴρ *venter*), in consequence of the digestive cavities penetrating the axis.

Axogaster, g. n.

Fixed, base a branched, creeping root; axis calcareous divided into segments with small intervals; articular surfaces of the segments convex or concave; abdominal cavities inserted in the segments, progressively obliterated; crenulations in sides of the cavities less than twelve: nature of encrusting layer unknown, lateral segments produced on the side of the calcareous portions of the axis.

Axogaster cretacea, sp. n. (Tab. XVIII. figs. 29 to 33.)

Segments slender, generally long, unequal in outline, often bent, traversed longitudinally by waved ribs or furrows; articular surfaces grooved concentrically with a central boss or pit; intervals between segments very small, occasionally represented by an indented line; lower end of lateral segments implanted in side of main segment; abdominal cavities irregularly distributed, round or oval, not deep, sides steep, with about nine indentations; general surface modified by age and thickened, the additions concealing the intervals.

Figure 29 fully represents, in the natural size, the general characters of the coral; and the fine specimen from which it was taken afforded perhaps sufficient evidence of every important condition of growth. The portion given on an enlarged scale (fig. 30) exhibits equally well the nature of the furrows or ribs, the characters of the abdominal cavities, and the relative position of the articular surfaces. The specimen delineated in figure 33 was believed to be a root of *Axogaster cretacea*; and the transverse division at the lower extremity of figure 30 presents a somewhat similar appearance, but it is believed to be only a contorted ramification, the surface being rounded on the under side, and not compressed as in the root (fig. 33). The downward increase in size was gradual, where the growth had not been greatly affected (the portion, figure 30, which measured 1½ inch in length, was at the upper end one line broad, and at the lower two), but occasionally globular protuberances occurred with minor irregularities. The extremity of a growing segment was slender and conical, but it displayed a furrowed surface to the very apex and abdominal cavities a little below it. No true branches or divergences in the segments, similar to those in *Isis Hippuris*, were noticed; the closely applied lateral shoots (fig. 30) being clearly side segments, as they were separated from the parent stem by a circular line, with a want of perfect coincidence in the range of the furrows; while a divergence in the recent coral has no partition interval, and the ribs and furrows are uninterruptedly continued. The grooved pits occasionally visible in the side of the stems (fig. 32), and structurally identical with articular surfaces, afford further evidence of the assigned nature of these lateral shoots. The segments varied in length from one to ten lines, the greater extension not being due to overlaid additions concealing intervals. The surface in young and mature states was strongly ribbed, with intermediate furrows of rather less width; and the ribs were rounded and waved in their longitudinal range bending around the visceral cavities. At the junction of the closely applied lateral nodes, a want of perfect conformity in direction was apparent on the side of the offset; but more or less of continuous range was visible on the upper and under surfaces. Proceeding downwards from young to older portions, the ribs became gradually less prominent, and the furrows shallower; while in aged segments the surface displayed only irregular striæ. The articular extremities varied in the degree of convexity and concavity; but the fully shown displayed a central boss (fig. 30 *a*) or a corresponding depression. The circular ridges were crenulated, the indentations agreeing with the grooves on the surface; and the ridges themselves represented apparently successive surfaces; but very thin slices taken vertically and transversely gave scarcely a trace of a concentric composition, nor did weathered stems, the most decayed exhibiting only a rough central hollow. In *Isis Melitensis*, on the contrary, enveloping layers can be detached mechanically, the exposed portions being fully ribbed; and a cross-fractured segment presented many severed surfaces and concentric lines indicative of several more. Young and mature articular extremities had the whole area beset with these circles; whereas an aged segment displayed a thick, outer layer, which had been moulded seemingly upon the edge of another of similar nature; and being evidently ill-adapted for lateral motion, it exhibited possibly a precursory step towards a perfect consolidation.

The visceral cavities were unequally and irregularly distributed in parts unaltered by age; and they were very readily distinguished from the articular pits on the side of a segment, by their elliptical form, shallowness, perpendicular sides and want of concentric ridges. The conical extremity of an incomplete segment (fig. 31) gave a deep, well-formed cavity with indentations around the edge, not more than half a line from the apex, proving the early production and rapid advancement towards completion of the structure. The prevailing shape was an oval, the direction of the major axis generally conforming to that of the segment; the length was half and the transverse measurement about $\frac{3}{8}$ths of a line; and the dimensions at the bottom were nearly the same, making the sides almost perpendicular. The floor was slightly concave or irregularly flat. The indentations around the periphery were seldom so exhibited that the exact number could be counted; but they seemed to vary from eight to ten, differing very little, if really at all, from *Isis*, which has eight tentacula. During the obliterating process, the cavities became gradually shallower, and the boundaries less defined, all traces of their previous existence being finally lost (fig. 30).

Respecting the nature of the enveloping matter no evidence was afforded; and not the slightest stain, indicative of its having existed, occurred in the chalk, whereas the form and even the texture of Amorphozoa are very often preserved in that manner. From this it may possibly be fair to infer, that it was of an evanescent nature, not very dissimilar from that of the crust of *Antipathes*, or perhaps wholly animal.

The supposed root represented by figs. 33 & 33 *a* apparently belonged to a young specimen. The articular pit situated near the centre was concentrically furrowed within; and close to its edge, three successive layers had been exposed by an accidental fracture. The main branches tapered and subdivided as they receded from the pit, giving off also small, lateral shoots. Their upper surface was round and more or less ribbed, not boldly as in the mature condition of the segments, but irregularly and faintly as in older stems. The under side, so far as it could be safely ascertained, was unequally flattened, as if it had been attached to a rough body.

Tab. XVIII. figures 34, 34 *a*.

It remains to notice a fossil represented of the natural size by figure 34. The surface was strongly and obliquely ribbed, resembling so far that of *Axogaster cretacea*; but it had no circular lines or other indications of segments, nor a vestige of a visceral cavity. At the edge of the broader extremity, several thin concentric layers were exposed, moulded more or less regularly upon each other, and in conformity with the exterior ribs. The transversely fractured extremity (fig. 34 *a*) exhibited also very many thin, undulating, opaque lines, representatives apparently of other similar laminæ; but they were separated by translucent interspaces, and crossed by irregular plates, which did not extend to the very centre. These characters justify, it is conceived, the inference that the fossil was originally an incrusted coral, and from its composition it is believed to have consisted of layers in which calcareous and animal matter alternately prevailed. The total want of subdivisional lines would intimate only to the extent of the specimen itself, a non-segmentary composition; and nothing absolute can be said respecting the absence of the abdominal cavities, except that the ribs were much bolder than in those portions of *Axogaster cretacea* in which the hollows had been obliterated by age. It must be further stated, that no laminated, internal constitution similar to the one just mentioned was detected in the coral described in the preceding notice. That peculiarity is moreover believed to separate the fossil from all described incrusted corals, whether articulated or not; but the real characters must remain to be developed by the discovery of further specimens.

Tab. XVIII. figures 35, +, 36 & 37.

The fossil next to be considered possesses many marked distinctions. It is attached throughout its whole extent, and consists of circular, shallow, abdominal cavities with about eight indentations in the side, and connected by a diverging as well as anastomosing band composed of irregular solid fibres. In its general mode of growth and viewed by the unassisted eye it resembles some species of *Aulopora*[1]; but the digestive organs, instead of being lodged as in that genus, in elongated tubes, which occupy the structural intervals between the circular openings, were confined to the round depressions of limited depth, the intermediate bands being solid, and having no visible communication with the cavities. In one respect, however, there was possibly an important agreement between the polype of the chalk fossil and that of *Aulopora*. From the eight indentations in the abdominal hollows little doubt can be entertained, that the former belonged to the class *Anthozoa*; and M. Milne-Edwards[2] has stated his belief, that *Aulopora* was more nearly allied to *Cornularia* than to any other zoophyte, and that it is in consequence referable to the same class[3]. In the visceral cavities and fibrous or ribbed intervals, resemblances exist with *Axogaster cretacea*; but the investing animal matter ranging between those receptacles could not apparently have possessed similar functions to that which surrounded *Axogaster*, the bands bearing no signs of additions or changes after maturity; and so far as the specimen extended, no indications of obliteration were noticed in the cavities themselves. The attached mode of growth would necessarily preclude an articular composition.

Not being aware of any established genus with characters similar to those mentioned above, the describer suggests that the extinct coral might be distinguished by the term *Epiphaxum* from ἐπιφὺς *adnascens* and ἄξων *axis*, in allusion to the attached mode of growth.

Epiphaxum, g. n.

Axis attached throughout, formed of solid fibres; visceral cavities seated in the axis and provided with eight indentations or blunt lamellæ; investing layer unknown.

Epiphaxum auloporoides, sp. n. (Tab. XVIII. figs. 35, 36 & 37.)

Axis elongated, slightly convex, divergent and anastomosed, component fibres

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[1] Consult Goldfuss, Petref. pl. 29. f. 1 *a*, 1 *b*.

[2] Annales des Sciences Nat., 2nde série, Zool., tome ix., or Recherches sur les Polypes, Mém. sur les Crisies, &c. p. 15: also remarks on *Aulopora*, 2nd edit. 1836, Lamarck, t. ii. p. 323.

[3] Consult M. Milne-Edwards's notice of the animal of *Cornularia rugosa*, Lamk. t. ii. p. 128.

irregular in extent; intermediate furrows of variable breadth; abdominal cavities circular, slightly raised; margin formed of lateral union of fibres.

The only specimen examined (fig. 35†) was affixed to a *Micraster* (*Spatangus*, Auct.) about 1½ inch in length and breadth; and the zoophyte extended over fully a third of the surface. The coral agreed in colour and opacity with the *Micraster*, though no distinct signs of rhomboidal cleavage were detected; an *Alecto*, however, which was associated with it, had a duller aspect, and apparently a more solid texture; nevertheless it would be as correct to consider the Echinoderm an internal cast, as to assume that the fibrous band represented only the interior form of a perished body.

The mode of growth was very irregular (fig. 37), and seemed to have been chiefly influenced by the form of the *Micraster*; but the diverging branches of the axis always issued from the side of an abdominal cavity, except in the case of a bifurcation. In the only good example (fig. 36) which was noticed of such a subdivision, the fibres separated longitudinally into two fasciculi, and then ranged onwards for about half an inch, when the two bands terminated at a visceral hollow. The manner of forming terminal additions was not very well shown, as it was difficult to distinguish between an immature development and an abraded portion. The most satisfactory case (fig. 36) consisted of two rudimentary cavities with a faint connecting band, the whole exhibiting only traces of structure; but the plan conformed strictly to that of other *Anthozoa* and of *Bryozoa*, visceral receptacles and associated structures being commenced and more or less advanced, far in front of a perfected portion, where alone exists the digestive apparatus, which affords the animal and mineral materials.

The visceral hollows in general projected markedly above the axis, the fibres of the latter bending upwards and constituting the boundary wall. They were nearly circular and of great uniformity of size, but the inner diameter was scarcely half a line; and the whole breadth was usually less than that of the adjacent portion of the axis (figs. 36, 37). The depth was sometimes very small even in mature examples, and it rarely exceeded the diameter. The sides were highly inclined; the base was slightly concave or rugose; and the margin, formed by the lateral union of the fibres, exhibited in the best preserved cases a serrated outline. The lamellæ equivalents were well shown, eight having been distinctly counted in many cases; and occasionally a wedge-shaped projection or lamella was detected. The distance between the regularly formed cavities varied from nearly three lines to about one; but two cases were observed of an imperfect cavity placed obliquely by the side of another fully produced; and a similarly inclined rudimentary structure (fig. 37†) occurred about midway in a band, the boundary circle resting partly on the fibres, and partly on the Echinoderm itself. So far as could be ascertained, young cavities formed in advance of the perfected, were not based upon the axis, but being secreted contemporaneously with it, were equally situated on the subjacent general surface. Many of the older hollows, however, had the bottom clearly raised above that level; and a certain amount of upward growth was therefore inferred, with successive internal additions, to adapt the depth to the dimensions of the abdominal organs. If this be correct, the obliquely placed imperfect cavities would indicate subsequent developments, being wholly or partly based on the axis, but whether they should be regarded as normal or abnormal interpolations, no opinion is offered. Their existence nevertheless proves, it is conceived, that the axis was invested by the polype.

The breadth of mature bands varied from one to half a line, a slight contraction also frequently occurring midway between two visceral centres. The length, as already stated, was sometimes three lines, though occasionally limited to one; and the greatest intervals existed apparently where the divergences were fewest. Fibres often extended uninterruptedly from one abdominal hollow to another, and even further, passing around the side of those structures; but they were frequently shorter, especially near the cavities; and as they became less numerous the outer fibres inclined inwards, to maintain a due compactness. The greatest number counted was ten, and the least five, allowing for local defects or injuries. So far as was ascertained they were united at the base; the intermediate furrows however were deep and well-defined, while no changes dependent upon age were detected, nor any signs of a laminated texture.

With respect to the systematic position of *Epiphaxum*, the eight indentations, and the proofs of an investing living crust suggest, that it ought to be associated with those eight tentaculated Anthozoa, which constitute the "*Polypiers Corticifères*" of Lamarck (*Phytocorallia Octactinia* of Ehrenberg). Among the known zoophytes of that division, the abdominal cavities are however confined to the cortex, even when it is evanescent, on a specimen being removed from the water. Other eight tentaculated Anthozoa which have the visceral receptacles within the fabric or axis, according to Dr. Grant[1], of the coral, as the *Halcyonina* and *Tubiporina*, differ so essentially in structure from *Epiphaxum*, that it is impossible to regard the fossil genus as a member of either of those families. On the con-

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[1] On the Structure and Nature of Flustræ, Edinb. New Phil. Journ., no. 5. p. 116. 1827.

trary the agreement in the nature of the abdominal cavities is greatest with those groups which have twelve or more lamellæ; and it is believed that the true position of the chalk fossil will be found to be intermediate between them and the ordinary corticiferous genera, and to supply a break in existing zoophytes.

Spinopora Dixoni. (Tab. XVIII. figs. 38, 39.)

Expanded, encrusting or branched; branches slender, tortuous, and irregularly divergent; spinous tubercles small, unequally distributed; wart-like protuberances variable in number and distinctness, with or without radiating ramifications; apertures to abdominal cavities poriform, minute, very numerous, often arranged in a circle around the spinous tubercles; cavities crossed internally by transverse plates; net-work forming the coral, microscopically porous.

M. De Blainville[1] proposed the term *Spinopora* for two cretaceous corals to which M. De France had assigned in manuscript the name *Pagrus.* No descriptions or even figures of the two original species appear to have been published; but M. De Blainville, who had examined the labelled specimens, added a third species by removing to the genus a Maestricht fossil previously named *Ceriopora mitra* by Prof. Goldfuss[2]. The essential characters ascribed to *Spinopora* are —"un polypier calcaire, circonscrit, diversiforme, appliqué, adhérent par une face ordinairement concave et à cercles concentriques en dessous, réticulé et hérissé de tubercules épineux, entre lesquels sont des cellules poriformes en dessus." (*Op. cit.* p. 415.) It was however in consequence of the external structures shown in the figures of *Spin. mitra* that the English chalk fossil was referred to the genus; and though they exhibit no traces of ramifications radiating from the wartose protuberances, yet as that structure was almost wanting in one of Mr. Dixon's specimens (Tab. XVIII. figs. 39, 39 *a*), the presence or absence of it is not regarded as an essential generic element. Among the corals described by M. Michelin[3] is one which resembles in some respects the English fossil, and is considered by him to be identical with the *Chrysaora spinosa* of Lamouroux[4]. In the observations on the coral it is not stated whether the determination rested upon an actual comparison with M. Lamouroux's specimens; but the figures in the 'Iconographie Zoophytologique' differ almost totally from

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[1] Man. d'Actinol. p. 415.

[2] Petref. p. 39. tab. 30. f. 13 *a, b*; also, Man. d'Actinol. pl. 70. f. 3, not a good copy.

[3] Icon. Zoophyt. p. 237. *Chrysaora spinosa*, pl. 55. f. 8.

[4] Exposition Méthodique, p. 83. pl. 81. f. 6, 7.

those in the 'Exposition Méthodique,' wanting altogether prominent, solid ridges, and being beset with numerous small tubercles, not a trace of which is delineated by Lamouroux, nor is the structure noticed in his account of the fossil, the specific name being apparently derived from stunted branches, which bear, in the natural size figure, the semblance of large spinous projections. M. Michelin, moreover, in his remarks upon the coral represented by him, no doubt with great accuracy, says, "Ce polypier et le suivant ne nous paraissent pas avoir une grande analogie entre eux;" and he adds, "Nous nous réservons, lorsqu'un plus grand nombre d'échantillons de l'espèce en discussion sera connu, d'adopter plutôt pour elle le genre *Neuropora,* créé par M. Bronn;" *Neuroptera spinosa* being among his own synonyms for *Chrysaora spinosa.* A comparison of M. Michelin's figures with the delineation of Mr. Dixon's coral (figs. 39, 39 *a*) will establish an identity in two particulars,—1st, in the general character of the tubular apertures; and 2ndly, in each having small spinous projections; if also in the former ramifying ribs occur as in the *Chrysaora spinosa* of Lamouroux, another analogy would exist, and the absence of wart-like protuberances would be the only visible distinction. The two latter structures are however not considered generic characters, being of irregular or uncertain occurrence, and therefore not essential components. Mr. Dana[1] regards "tubercles" likewise as hardly a character of generic importance, in his observations on *Spinopora.* Under these circumstances the choice of a term or genus was somewhat arbitrary; but it was believed, that *Neuropora* should not be adopted on account of the want of prevalence in the ramifying ridges, and the changes to which they appeared liable[2]. Lamouroux's *Chrysaora* seemed also to be objectionable from a want of sufficient agreement in the chalk fossil with the original description; and although *Spinopora* may not have been established on an altogether satisfactory basis, the internal structure being unknown, yet when its ascertained characters were considered in the aggregate with or without ramifications, the polype which formed the coral was believed to have possessed an assemblage of structures sufficient to warrant the adoption of the genus.

Respecting the position of *Spinopora* in a general classification, it may be stated, that M. De Blainville[3] associated the genus with others composed of corals for the greater part now admitted to have been formed by Ascidian Polypes; and the same opinion appears to have been entertained by M. Milne-Edwards[4], as he

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[1] Exploring Expedition, Zoophytes, p. 572.

[2] Consult Goldfuss, tab. 11. f. 5, 7.

[3] Man. d'Actinol. p. 401.

[4] Edit. 1836 of Lamarck, t. ii. p. 263–265.

placed the genus between *Cellepora* and *Eschara*. Mr. Dana[1], on the contrary, alludes to *Spinopora* in his Appendix to *Madreporacea*, stating however that the connection with the tribe is uncertain. From the occurrence of transverse laminæ in the abdominal tubes of the English fossil, the true general position is nevertheless believed to be in the class Anthozoa, and the nearest more definite approximation to be with such *Milleporæ* of Lamarck as have been grouped by M. De Blainville under the term *Palmipora* (*op. cit.* p. 391). Those corals are associated by MM. De Blainville (*op. cit.* pp. 382, 391), Milne-Edwards (Lamk. t. ii. p. 307), and Dana (Zoophy. p. 544, &c.), in the same great assemblage as *Madrepora*; but it is impossible to conjecture what number of tentacula the fossil polype possessed, not a trace of lamellæ or of what are commonly regarded equivalent structures having been detected. Notwithstanding the best provisional allocation appears to be near *Palmipora* or a similar restriction of Lamarck's *Millepora*.

Three specimens of the coral were examined. One (fig. 38, nat. size) consisted of a broad, slightly convex mass with the base of a branch projecting from it; the others were ramose, the larger (fig. 39, nat. size) having partly incrusted a cylindrical body; and the smaller was composed of a detached group of slender branches, the extreme height and breadth of the specimen being about an inch, and the greatest width of the branches 1½ line.

In the expanded specimen (fig. 38) the increase of the coral, independent of augmentations within the area of previously formed portions, was effected by extensions around the whole margin of the disk; and in the ramose examples by additions to the upper extremity of the branch.

The apertures to the abdominal cavities or tubes were not raised above the general surface and scarcely perceptible to the unassisted eye, but they were very numerous, and principally close together, forming the meshes of a fine network. In this respect there was a marked difference from *Palmiporæ*. Immediately adjacent to the small spinous processes, they had (fig. 39 *b*) a circular arrangement resembling the petals of a flower; a similar distribution is visible in Goldfuss's figure 13 *b* (tab. 30) of *Spin. mitra*, and apparently alluded to in his description of the species (p. 39); elsewhere the pores had no definite position. Their outline varied, but with a tendency to a round contour; and their boundary was for the greater part ill-defined; though occasionally an opaque line surrounded the tube both on the surface, and in the centre of transversely fractured branches.

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[1] Zoophytes, pp. 570, 572.

The depth of the terminal division of the tube, or the receptacle for the digestive organs was small, a point of agreement with *Palmiporæ.* Internally the tubes had a simple outline, ranging vertically in the expanded specimen ; but obliquely in the centre, and horizontally in the outer portion of branched examples. The transverse laminæ, in the best preserved cases (fig. 39 *c*), were near each other, and thick, giving the tubes a cellular appearance ; but nothing was observed in any part of the coral to justify a suspicion that it was referable to the family Celleporidæ, or was formed by an ascidian polype. As before stated, lamellæ were totally wanting. M. De Blainville says the apertures of *Palmiporæ* are "obsolètement radio-cannelée" (*op. cit.* p. 391) ; and to the extent observed, the openings of *Pal. complanata* as well as of *Pal. alcicornis* presented very slight traces of any structure which could be regarded as a representative of lamellæ, agreeing in this respect with the English chalk fossil. Ehrenberg did not observe tentacula in a living specimen of *Millepora* (*Palmip.*) *complanata* (Beiträge, p. 125). The composition of the general fabric, confining the term to the network, was prevailingly slender, and penetrated in every direction by numerous very minute pores ; and the texture of the spinous processes, of the large warts, and the venous ramifications was strictly analogous. The spines were irregularly distributed, and often indistinct from abrasion or smallness ; and their position was occasionally indicated rather by the arrangement of the tubular apertures than by prominence of character. The warts and the ramifications proceeding from them (fig. 38 *a*) were generally, but to a variable extent, penetrated by abdominal cavities. Some of the warts were almost wholly occupied by them, though the amount of protuberance was not thereby markedly affected ; while, on the contrary, the existence of the branched structure seemed to depend on their absence, as not an instance was observed of raised divergences except the apertures were few in number. The internal range of the last three component parts was not clearly ascertained. One wart traversed by a few tubes was progressively worn down, but no variations were observed at the different stages of the operation ; and a portion of a branch abraded as nearly vertical as possible, gave a totally indistinct composition, the tubular cavities vanishing also. This obscurity was believed to arise from mineralization, and not from effacement by animal secretions, fractured portions of both expanded and branched specimens affording open tubes throughout the whole intersections.

No cases were noticed of structurally closed apertures.

BRYOZOA.

Alecto ramea, De Blainville ?. (Tab. XVIII., figs. 35‡, 40, 41.)

Ramifications irregularly divergent, nearly uniform in breadth ; visceral tubes bordered by a narrow tubulous band ; outline of cavity generally distinct ; apertures slightly inclined upwards, oval, uniserial, situated along the middle of the ramification.

De Blainville, Man. d'Actinologie, p. 464. pl. 78. fig. 6 ? *A. ramosa* (?) Milne-Edwards, Ann. Sc. Nat. 2nde série, Zool. tome ix. pl. 16. fig. 1 ? or Recherches sur les Polypes, Mém. sur les Crisies, &c. pp. 15, 46. Chalk of Meudon, Milne-Edwards ; Gravesend, Morris, Cat. British Fossils, p. 30[1].

It is difficult to form an opinion respecting the corals which M. De Blainville has named, but not described and indifferently figured ; nevertheless M. Milne-Edwards has referred to *Al. ramea* (Rech. p. 15.) a fossil carefully delineated by himself, and concerning which he has published some precise particulars. He states that the cells are " en général garnies latéralement d'une petite bordure lamelleuse assez distincte, laquelle s'étale quelquefois beaucoup et peut réunir en une seule masse des branches voisines." A somewhat similar lateral structure exists in the specimen represented by fig. 40 mag., Tab. XVIII., illustrative of these memoranda ; but the band, instead of constituting a horizontal plate, had an inclined surface ; and, when viewed with a sufficient power, as a Codrington lens, was clearly tubular. No similar composition is alluded to by M. Edwards, nevertheless it has been thought right to adopt provisionally the designation *ramea* ; but should an actual difference be found in the side structure, the English fossil might be distinguished by the specific name *tubulata*.

The specimen represented in part by figure 40 was attached to a Micraster (fig. 35‡), and did not strictly agree in mode of growth with M. DeBlainville's figure or that of Prof. Milne-Edwards, being much less compactly ramose ; but it remains to be ascertained how far the nature of a base, and differences in the surrounding medium, may affect in this genus a plan of development or any other character. The position and range as well as the arched distal extremity of the cavities were well-marked by lines of a different colour from the tube itself ; but in the older portion of the specimen they were less distinct than in the younger, in

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[1] Roemer has applied the term *Aulopora ramosa* (von Hagenow) to a fossil stated to occur in the chalk of *Sussex*, Rügen, Peine, and Sarstedt. Verst. Norddeutschen Kreidegebirges, p. 18. tab. 5. fig. 15, 1840.

consequence apparently of external additions. The best-preserved apertures were slightly inclined upwards and had a raised margin. The tubular nature of the lateral structure was shown (fig. 40) partly by an opaque-white, narrow, irregular band, bounded outwardly by a translucent line similar to those forming the sides of the abdominal cavities; and partly by abraded branches presenting on each side a narrow furrow more or less filled with chalk, when first exposed; and it is believed that the similarity in the surface colour of both the central tube and the band was owing to infiltered matter: at the extremity of a branch occurred also two minute openings, which accorded in position with the tubuli of the band.

The coral represented by figures 41 and 41 *a* to *c*, agreed more nearly than the preceding in its mode of growth with M. De Blainville's delineation of *Al. ramea*. If examined without a knowledge of the specimen above noticed, some of its characters might escape detection, and specific differences be assumed; the whole of the ramifications exhibiting under an ordinary pocket lens a semi-cylindrical outline and uniform composition. An attentive inspection, however, proved the existence of a central tube with lateral inclined bands of an opaque white colour, and separated from the medial cavity by very fine translucent lines; while fractured portions (figs. 41 *b*, *c*) displayed side furrows and pores, which could not readily be considered as direct precursors to a bifurcation.

How far a smooth subsurface or other local causes may have influenced different states of development or relative perfectability, the examination of only two specimens afforded no grounds for a satisfactory inference; but so far as observed the composition was similar in each case; and therefore it has been deemed correct not to separate, at present, the two fossils specifically.

Alecto gracilis, Milne-Edwards. (Tab. XVIII. A. figs. 1, 1 *a*, 1 *b*, 1 *c*.)

Ramifications irregular, dichotomous or issuing laterally, breadth variable, abdominal tubes essentially uniserial; position of apertures not central, more or less alternately inclined to the right and left, form oval, margin slightly projecting.

Milne-Edwards, Ann. Sc. Nat., 2nde série, Zool. tome ix. pl. 16. fig. 2, 2 *a*, or Recherches sur les Polypes, Mém. sur les Crisies, &c. p. 15. Chalk of Meudon. Norfolk chalk, Woodward in Morris's Cat. Brit. Foss. p. 30.

The coral (fig. 1) believed to be rightly referred to *Alecto gracilis* displayed no proofs of lateral structures. It was attached to a Micraster, and exhibited many signs of irregularity of development, some of which might be ascribed to the inequalities of the subjacent body, but some could not. Where most uniform, the surface of the tubes was rounded (*a*, *b*), and the sides nearly straight or parallel; occasionally however hemispherical swellings with curved sides occurred, and were evidently due to the tube passing over one of the larger papillæ of the Echinoderm. The distance between successive apertures was sometimes also considerably shortened, without any compensating lateral expansion of the tube, indicating, it is presumed, imperfect development. Such irregularities as those exhibited by figures 1* and 1 *c* clearly originated in causes totally independent of the nature of the subsurface, and were conceived to have arisen from the accidental association of many ova.

The most decided bifurcations gave two tubes issuing from the extremity of the parent, and diverging more or less symmetrically; but so far as the specimen examined was concerned, there was much less constancy of character in this respect than in M. Edwards's enlarged figure 2 *a*, a branch springing often at right angles from the proximal extremity of a tube, or even from the side; but the former at least are possibly only abnormal conditions influenced by local interferences. Occasionally the two branches ranged for a short distance parallel to each other and in close contact, and then diverged or one of them perished. An instance of this mode of growth is shown in M. Edwards's figure 2 *a*; and the apparent biserial apertures were referable to it. The mouths were generally oval, the greater diameter being in the direction of the tube; and the best-preserved were not mere tubular extremities, but in the plane of the general surface, with more or less of contraction: the margin, where retained, was thickened and slightly raised. The alternate inclination to the right and left was often very marked; but it is necessary to state, as a distinction from M. Milne-Edwards's genus *Criserpia*[1], that the arrangement did not arise from the tubes issuing laterally. Figure 2 *a* of the 'Annales des Sciences Naturelles' represents frequently an enlargement in the region of the apertures with a somewhat pear-shaped outline; nothing similar was detected in the English coral, and the discrepancy was most probably not an essential, but an accidental difference. The base or attached lamina of the tubes was very thin, scarcely concealing the papillæ of the Micraster, while the outer wall was thick and solid and transversely rugose.

No doubt was entertained that the coral represented by figure 1 *c*, and which was situated close to the specimen partly given in figure 1 *a*, was an example of irregular production of *Alecto gracilis*, every portion displaying the strongest

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[1] Ann. Sc. Nat. 2nde série, Zool. t. ix. or Recherches sur les Polypes, Mém. sur les Crisies, &c. p. 16.

proofs of disturbed growth or mutual interference. The uniserial mode of growth with developments from the upper extremity of the fixed portion of the tube demand however careful consideration; and every deviation should be duly investigated, with a view to ascertain whether an extension of generic characters should be proposed.

Diastopora Sowerbii. (Tab. XVIII. A. figs. 2, 2 *a.*)

Disks numerous, united by mutual extension, and forming successive layers; visceral tubes long, cylindrical, exposed portion very variable, sometimes considerable, sometimes small, concealed in aged conditions; apertures round or oval, closed in advanced stages, slightly inclined upwards, edges projecting.

In M. Milne-Edwards's valuable memoir on the genus *Diastopora*[1] the species are divided into three groups, the first consisting of those which develope a single layer; the second, of species which produce overlying, successive layers; and the third, of such as are formed of two layers placed back to back. This arrangement, simple in itself, requires however a good illustrative suite of specimens before, in many cases, a species can be determined, or a reference made to a group when a single example is the subject of examination. Thus *Diast. diluviana*, as described by M. Edwards, consists of numerous extended layers[2], which envelope each other like the coats of an onion, and every successive layer conforms to those inferior to it, the origin of each resembling a little circular crust. It would consequently be impossible to decide to which of the two first divisions a primary disk belonged, or to assign it positively to a known species. The chalk fossil under consideration presented many signs of more than one layer; but no evidence of its earliest condition. From *Diast. diluviana*, as well as M. Michelin's *D. microstoma*[3], it differs in the many centres of development or limited extension of each. Respecting the nature of the fundamental layer only a conjecture can be offered, but it possibly consisted of a single disk; and it is believed, that the actual surface of the specimen (fig. 2) arose, in the first place, from the development of two or more centres on that disk, the lateral extension of which beyond the original boundary producing a greater area; and secondly from one

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[1] Annales des Sciences Naturelles, 2de série, Zool. tome ix., or Recherches sur les Polypes, Mém. sur les Crisies, &c. p. 31.

[2] *Op. cit.* pl. 14. fig. 4, and pl. 15. fig. 3 to 3 *c.* *Berenicea diluviana*, Lamouroux, Exp. Méthod. p. 81. Consult his figs. 3, 4, tab. 80, for an example of a simple disk.

[3] Iconographie Zoophytologique, pl. 57. f. 1.

or more repetitions of the same process. The specimen itself exhibited three instances of two young circular crusts on a disk, with examples of others on its very margin, and the latter would clearly have enlarged the superficies still more had they attained their full growth. That the added centres did not originate in germs ejected from pre-existing tubes, but from the general polype-substance, may be inferred from the characters of other ascidian zoophytes. The genus *Lichenopora*[1] sometimes presents a single disk, and sometimes according to M. Michelin an aggregation of disks, as his *Lich. cumulata*[2], *L. conjuncta*[3], and *L. tuberosa*[4], and it would be difficult to imagine how the two last, at least, could owe their many-centred composition except to a reproductiveness in certain portions of the polype, not limiting the term to the viscera and appendages surrounding the mouth. Further examples may be noticed in the *Ceriopora diadema*[5] and *Cer. stellata*[6] of Prof. Goldfuss, also in M. Michelin's *Cer. papularia*[7]: it is likewise hoped that the reader will find proofs of such productive operations in the fossil to which in a subsequent page is applied the term *Atagma*.

The only specimen examined was about 1¼ inch in length by 8 to 9 lines in breadth, and it consisted of about eleven united disks, including those along the boundary, and of which only portions had been preserved. The whole formed an irregular but continuous layer, which had evidently coated an uneven perishable body. The greatest diameter of the disks was about 3 lines, the form being generally polygonal from mutual interference; and the margin was occasionally a narrow smooth band, in which could be detected the outline of tubes that had never attained a perfect development, no traces of a mouth being perceptible; but very frequently there was a crest-like intermingling of perfected visceral cavities. The outer surface of the tubes, where visible, was rounded or flat; and the exposed portion varied with the nature of the surface or its inequalities, amounting in some cases to fully half a line; while often successive apertures were in contact. The mouths were simple tubular apertures, with or without a slight contraction; but they were often wholly closed by polype secretions similar to those which coated the general surface, and concealed more or less the range of tubes that would otherwise be visible; and even in a few places leaving but faint indications of their existence.

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[1] De France, Dict. des Sc. Nat. tome xxvi. p. 257.

[2] *Op. cit.* pl. 77. f. 1.

[3] Pl. 63. f. 16.

[4] Pl. 14. f. 6.

[5] Petref. pl. 37. f. 3, not pl. 11. f. 12, identified by M. Michelin with his *Lich. conjuncta*, Icon. Zoophy. p. 277.

[6] Petref. pl. 30. fig. 12.

[7] *Op. cit.* pl. 32. f. 7; consult also M. Michelin's *Cer. Landriotii*, pl. 1. fig. 10.

The young circular crusts had no apparent fixed points of development, sometimes coinciding in position with the centre of the subjacent disk, but sometimes were nearer the edge. If rightly understood, the earliest observed state presented a few confused vertical cavities of limited extent (fig. 2 *a* +) ; while a little more advanced condition gave a disk-like form, with nearly horizontal, radiating tubes. The assumed earliest patches were not however always limited to so small an area as in the case delineated (fig. 2 *a* ‡), occasionally covering a relatively considerable space, as if the reproductive power had been more diffused. There was no distinct base lamina, like that which occurs in *Tubuliporæ* ; but in the immediate vicinity of the somewhat advanced disks, the old tubes of the subjacent layer had for the greater part closed mouths, and the general surface was thickened, as if a preparatory inseparable foundation had been laid for the future construction. From this subsurface projected, moreover, the sides of the tubes in progress of formation or laid open by fracture.

Diastopora ———. (Tab. XVIII. fig. 35* ; and XVIII. A. figs. 3, 3 *a*.)

Attached throughout, branched ; branches bifurcated with intermediate fan-shaped areas of limited growth ; tubes minute, produced either at the termination of the preceding or intermediately ; mouths simple, tubular extremities.

The above characters must be considered rather as those of the specimen examined, than of a species. In the branched mode of growth, a resemblance will be found in M. Michelin's *Diast. ramosa*[1] which is also a cretaceous zoophyte ; but if the English fossil exhibits a normal and not an accidental manner of development, a distinction exists in the points where the bifurcations commence not ceasing at once to be productive, but giving forth in two cases additional tubes which assumed a fan-shaped area : they had possessed, however, apparently a limited amount of vitality in comparison with the adjacent branches, and some of their tubes had not been provided with distinct apertures. Another difference from *Diast. ramosa* is the minuteness of the coral. A branch of M. Michelin's species, half a line in width, exhibited transversely only three to four apertures, as shown in his enlarged figure, 3 *b*, whereas a space of equal breadth in the English fossil gave at least eight.

The species to the extent displayed (figs. 3 & 3 *a*) would belong to M. Edwards's first division of the genus, or to that composed of *Diastoporæ*, which form a single layer. In having a branched plan of growth, a certain amount of resem-

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[1] Icon. Zoophy. p. 203. pl. 52. fig. 3.

blance with the *Criserpia* of that authority[1] exists, but in the development of the tubes, the agreement is with *Diastopora*, the additions in *Criserpia*, if rightly understood, springing in the typical species *C. Michelini* from the side or towards the lower extremity of a previous tube, and not from the upper end. The only specimen examined was barely visible to the unassisted eye, and was attached to the same *Micraster* as *Epiphaxum auloporoides* and *Alecto ramea*? ; it was also intermingled with them. The greatest extent in the direction of the oppositely diverging branches, measuring the chord and not around the arc, was under two lines, and the width of the largest fan-shaped portion was scarcely half a line.

Clypeina tubæformis, n. sp. (Tab. XVIII. A. figs. 4 & 4 *a*.)

Trumpet-shaped ; stem long, cylindrical, traversed vertically by lines defining the range of the visceral tubes, and transversely by irregular furrows ; expanded portion smooth on the under surface, but streaked by upward extensions of the divisional lines of the stem, also encircled by fine grooves ; margin of the expansion provided with two or three rows of tubular apertures ; interior of the funnel ribbed, and indented with transverse lines similar to those on the exterior ; floor broad, slightly convex ; base of the coral an irregular expansion of the stem, and like the latter tubular.

Under the designation *Clypeina marginiporella* M. Michelin[2] has described and figured a curious, minute tertiary fossil, found in the Paris basin. The specimen delineated in the ‘Iconographie Zoophytologique’ agrees generally with the upper portion of Mr. Dixon’s coral (fig. 4), the chief difference consisting in the rows of tubular openings on the margin of the funnel exceeding one in the English zoophyte : *Clyp. marginiporella* terminates, moreover, abruptly where it assumes a cylindrical outline, and it is stated to adhere “par une espèce de petite lamelle circulaire ;” the tubular structure is also apparently confined to the dilated portion, no trace of such a composition being represented in the inferior annular edge of M. Michelin’s figure 27 *b* ; whereas in *Clyp. tubæformis*, small tubuli are visible in the fractured margin of an expanded base. M. Michelin expresses a doubt respecting the nature of his fossil, and asks, “Est-ce un polypier ?” No doubt however is entertained of the English body belonging to the class *Bryozoa* or to Ascidian polypes, and to the family Tubuliporidæ ;

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[1] Annales des Sc. Nat., 2nde sér. Zool. tome ix., or Recherches sur les Polypes, Mém. sur les Crisies, &c., pl. 16. fig. 4.

[2] Iconographie Zoophytologique, p. 177. pl. 46. fig. 27.

while the resemblance to M. Michelin's minute production, only a line in diameter, justifies, it is conceived, a generic union.

Only one specimen of *Clyp. tubæformis* was examined. Its height was rather more than 3 lines; the breadth at the upper extremity was 2 lines; of the stem near the middle $\frac{3}{4}$ths of a line; and of the base 1 line; the exterior height of the funnel was 1 line; the interior depth $\frac{1}{2}$, and breadth at the bottom $\frac{3}{4}$ths of a line. The greatest breadth of M. Michelin's figured specimen of *Clyp. marginiporella* was half that of the English coral. The tubular openings around the margin were not perfect, and consequently no strict comparison could be made with those of the Paris basin fossil; but, as exhibited, they were in contact or had solid interspaces; while in the tertiary species, the edge of the apertures is more or less free. The form was round, transversely oval or polygonal according to space or mutual interference. The size varied also; but the differences were clearly due to interpolations, and inequalities of age. The full range of the visceral tubes was not ascertained: those connected with the apertures did not extend visibly downwards beyond the lower extremity of the funnel, terminating acutely; and those in the stem had also an apparently limited upwards extension; but their range was possibly continued inwards, and the actual end was probably in the marginal apertures. Respecting the central composition of the coral no information could be obtained. M. Michelin's figure 27 *b.* indicates a shallow hollow, with a transverse layer; and as concerns the equivalent, expanded portion of *Cly. tubæformis*, the structure was apparently similar, or else consisted of thin laminæ. Minute additional tubes appeared occasionally along the inner edge of the margin, and similar developments existed also on the outer edge, but that portion being abraded they were less distinct. No signs of a decided external thickening were visible,—a point of agreement with recent *Tubuliporæ*; but there was a total want of the lamina, which in some species of that genus constitutes a disk-shaped base; and in the *Tub. Fungia* of Mr. R. Q. Couch, which in mode of growth resembles *Clyp. tubæformis*, an investing plate[1].

Idmonea cretacea, Milne-Edwards. (Tab. XVIII. A. figs. 5 & 5 *a* to 5 *h*.)

Fixed only at the base; fan-shaped, erect; branches dichotomous, round or slightly compressed on the sides; rows of tubular apertures short, projecting,

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[1] Consult Dr. Johnston's British Zoophytes, 2nd edit. *T. penicillata* p. 270. pl. 48. figs. 1, 2; also Mr. Couch's Zoophytes of Cornwall, &c.

alternate, separated medially by a variable, longitudinal interspace; reverse surface strongly ribbed with intermediate, punctured furrows; base for attachment an irregularly expanded layer.

Idmonea cretacea, Milne-Edwards, Annales des Sc. Nat., 2nde série, Zool. tome ix. pl. 12. fig. 5–5 *b*, and explanation of plate; or Recherches sur les Polypes, Mém. sur les Crisies, &c. Description of plate p. 45, 1838.

Idmonea Dixoniana, Mantell, The Medals of Creation, vol. i. p. 284. Lign. 64. figs. 6 & 12, description, p. 287, 1844.

The fossil represented in Tab. XVIII. A. fig. 5 is believed to be identical with that delineated by M. Milne-Edwards from a minute fragment found in English chalk, and with the coral subsequently figured by Dr. Mantell. Three very illustrative specimens were obligingly lent by Mr. Dixon from his own cabinet. The largest was upwards of an inch in height, and had a lateral expansion of 1⅓ inch; the other two were smaller, but of great interest, as they afforded a base of attachment (figs. 5 & 5 *h*), similar to that of the recent species, *Idm. radians* (M. Edw. *op. cit.* pl. 12. fig. 4); and presented also the characters of inferior, aged portions of the coral. They all fully proved a free vertical growth, with a gradual, but unequal, lateral expansion, assuming thereby a fan-shaped and not bushy character. The mode of branching was essentially dichotomous, the bifurcations commencing almost at the base, and occurring invariably in the same plane. The distance between the points of separation varied from half a line to 4 lines, the least intervals being generally near the base: the breadth of the youngest branches was about a quarter of a line, and that of the oldest half a line.

The longitudinal interspace between the transverse rows of tubular apertures in what were regarded mature fragments, was sometimes indistinct, sometimes traversed by a ridge, and it occasionally exhibited a broad, flat area; while in some aged fragments it agreed with the character represented in M. Edwards's figure 5 *a* (*loc. cit.*). The breadth of the front of the branch, or the portion occupied by the tubular mouths, equalled that of the reverse side; but as the coral thickened the latter swelled out, and the free part of the tubes formed a kind of crest. The transverse rows rarely contained more than three apertures; sometimes only two were visible; and care was often necessary to distinguish more than one, the innermost being predominantly conspicuous, and masking the others. The whole of this surface, not occupied by tubular extremities, was apparently solid, under the magnifying powers employed in the examination, and smooth; and the most aged fragments gave no indications of a fibrous thickening; the additions having evidently been effected, as in many other Bryozoa, by local secretions through possibly, in this case, undetected pores (figs. 5 *a* to 5 *e*).

The reverse surface was rounded (fig. 5*f*), and the ribs were generally very prominent except at the base of the aged specimens (fig. 5 *h*). They were waved, often subdivided and occasionally anastomosed. The furrows were well-defined throughout the greater portion of the specimens, but near the base they became likewise less distinct. The foramina situated in the furrows were also strongly exhibited, forming single rows of elongated indentations, though in parts which appeared to have been injured during development they exhibited a perfect network; and in a slightly worn down reverse surface (fig. 5 *g*) they assumed the character of minute apertures to microscopic tubuli, which penetrated upwards and inwards.

Respecting the characters exhibited by the reverse surface one or two points deserve consideration. Lamouroux seems to have known only a single species (*Idm. triquetra*), and in his generic characters he says the reverse side is "légèrement canaliculée, très-lisse et sans aucune apparence de pores." (Expos. Méthodique, p. 80.) According to M. Michelin that species has either free or attached branches[1]; adding however that "l'espèce en discussion est adhérent, par exception, jusqu'à présent." (*loc. cit.*) An American *Idmonea*[2] exhibited on the reverse side in some fragments a complete flattening, but the surface was unevenly impressed; in others, though the triangular form was retained, the outline was slightly convex, and in one case partly flat, partly rounded, indicating an attached growth to a certain extent at least. Respecting the reverse side of *Idm. radians*, a decidedly free growing species, the author of these memoranda possesses no information; it will however be shown in the next article that some fossils referred to the genus have on that surface a structure very similar to the one exhibited by *Idm. cretacea*; but they are characterized by lateral fasciculi of visceral tubes, not transverse rows, a difference considered by M. Milne-Edwards[3] a sufficient basis for a generic separation. Notwithstanding therefore a resemblance in the dorsal composition, M. Edwards's determination respecting the present fossil is retained; the species nevertheless being regarded as possessed of transition characters between *Idmonea* and the corals about to be noticed.

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[1] Iconographie Zoophytologique, p. 234. "I. ramosa, ramulis divaricatis, adhærentibus vel liberis."

[2] Quarterly Journ. Geol. Soc. vol. i. p. 524–25.

[3] Edit. 1836 of Lamarck, t. ii. p. 283, art. *Retepora truncata*, &c. Recherches sur les Polypes, Mém. sur les Crisies, &c. p. 27.

Possibly when more is known of the genus, it will be found advisable to propose two sections or subgroups, one for creeping, affixed species, the other for those which have a free vertical growth.

Tab. XVIII. A. figs. 6 & 6 *a* to 6 *e*.

The fossil next to be noticed consists of free branches springing from a root, and characterized by two rows of protuberances the free extremities of fasciculi of visceral tubes: the surface of the branches presents a variable network and the interior is formed of downward extensions of the fasciculi, which compose the direct centre, also of a reticulated structure, the inward representative of the surface network. The visceral tubes open, so far as was ascertained, chiefly on the back of the fasciculi.

Five corals possessing characters more or less allied to those represented by figure 6, Tab. XVIII.A., have been described by different authorities:—namely, 1. *Retepora truncata* of Prof. Goldfuss[1], removed to *Idmonea* by M. De Blainville[2]; 2. *Idmonea semicylindrica*; and 3. *Idm. pinnata* of Herr Roemer[3]; 4. *Idm. aculeata*, with 5. *Idm. tetragona* of M. Michelin[4]. It is unnecessary to offer any remarks respecting Prof. Goldfuss's determination, the fossil delineated in the 'Petrefacten' being evidently not a *Celleporida*. It is stated in the preceding notice on *Idm. cretacea*, that M. Milne-Edwards[5] objects to the altered assignment of *Ret. truncata*, and he is of opinion that it should form the type of a particular division, intermediate between *Idmonea* and *Frondipora*. Respecting the former of those genera, the leading distinctions between Lamouroux's[6] original species *Idm. triquetra*, as well as those subsequently described by M. De France[7] or M. Edwards, and the fossil under examination, appear to be,—1st. that in the former the visceral tubes are arranged in transverse rows, the apertures having a similar disposition; whereas in the latter they constitute round fasciculi, the mouths opening, to the extent known, in two rows or irregularly on the back of the protuberances. Herr Roemer (*loc. cit.*), in his remarks on *Idm. semicylindrica* and

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[1] Petrefacten, p. 29. pl. 9. fig. 14, a Maestricht fossil.

[2] Manuel d'Actinologie, p. 420.

[3] Verst. Norddeutsch. Kreidegebirges, p. 20. tab. 5. f. 21 and p. 20. tab. 5. f. 22; also Michelin, Iconographie Zoophytologique, p. 203. pl. 52. fig. 9 *a*, *b*.

[4] Iconog. Zoophyt. p. 203. pl. 52. fig. 10; and p. 219. pl. 53. fig. 19.

[5] Lamarck, Anim. sans Vertèb., edit. 1836, tome ii. p. 283; also Annales des Sc. Nat., 2nde série, Zoologie, tome ix. Mémoire sur les Crisies, &c. or Recherches sur les Polypes, &c. 27.

[6] Exposition Méthodique, p. 80. pl. 79. figs. 13–15.

[7] Dictionnaire des Sciences Naturelles, tome xxii. pp. 564, 565.

I. pinnata, considers the distribution of the "cells" in one or more rows as not an essential difference, referring to *Aulopora* and *Defrancia* for examples of species with such variations. It is not advisable in this notice to inquire into the characters of those genera, but it is evident that the existence of one or more rows of tubes should be studied in conjunction with the whole composition of the polype or its stony representatives, in attempting to ascertain a generic basis. 2ndly. The rows of tubes in *Idmonea* range downwards exactly as they appear on the surface, constituting almost wholly the interior, being unaccompanied by any distinct structure. This feature is occasionally exhibited on natural surfaces[1], and its existence was ascertained in *Idm. cretacea*, by purposely wearing down a fragment of a branch. On the contrary, the fasciculi in the fossil under consideration form, except in the very centre, only a portion of the branch, being surrounded by a reticulation connected with the external network. 3rdly. The precise mode of developing successive rows in *Idmonea* is not known to the author, nor was it detected in the small specimen just alluded to; but from M. Edwards's statement and figures[2], as well as from the characters of that fragment, the tubes of one row spring directly at the back of those of the row next inferior, allowance being made in some cases for lateral additions. In the fossil under examination the fasciculi issue from the centre of the stem (Tab. XVIII. A. fig. 6 *e*), and after a limited upward growth blend into groups and incline outwards. The interior of *Idm. truncata*, or of the other four apparently allied fossils, is not described in the works consulted, but possibly no essential difference exists. 4thly. M. Milne-Edwards (*loc. cit.*) states, that the transverse rows of tubes do not, for the greater part, reproduce new branches; and their very nature would, it is conceived, prevent such developments; on the contrary, in the chalk fossil, the fasciculi are not unfrequently enlarged and become true branches, near the base of only one of which two or three oral apertures appeared, not on the back, but laterally. These branches were independent of terminal bifurcations. 5thly. The species of *Idmonea* described by MM. Lamouroux, De France and Milne-Edwards have no marked, foraminated structure on any part of the exterior, similar to the network exhibited in figure 6 *b*, Tab. XVIII. A. The reverse side of *Id. cretacea* (Tab. XVIII.A. fig. 5) is however boldly ribbed with intermediate rows of elongated foramina, which penetrate obliquely under some, if not all conditions;

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[1] Consult M. Milne-Edwards's Illustrations, *op. cit.* pl. 12. f. 3 *c* (by error 4 *c*); pl. 9. f. 2, &c.: also Goldfuss's fig. of *Idm. quadrata*, pl. 9. fig. 15 *f.* Corrigenda, p. 244, art. *Ret. disticha.*

[2] *Op. cit.* Mém. sur les Crisies, preliminary Remarks to Idmonea; also pls. 9 & 12.

but it differs in not being thickened, and in the portion near the base having to the extent observed no external prolongations of the pores. Among the corals more recently referred to the genus, but believed to possess structures allied to those of the English chalk fossil, the exterior seems to vary. *Idm. semicylindrica* is said to have "fein punctirte stämmchen" (Roemer, *op. cit.* p. 20), and the inner side is shown to be distinctly punctured; Roemer does not allude to the outer composition of *Idm. pinnata* beyond the observation respecting the oral apertures; but the fossil specifically identified with it by M. Michelin, "has one face almost smooth, and the other very porous[1]." *Idm. aculeata* is described as having the greater portion covered with little waved striæ[2], and the delineations show also a foraminated reverse surface at least; *Idm. tetragona* is striated and very porous on the under part[3]; respecting the exterior of *Idm. truncata* nothing is mentioned by Prof. Goldfuss. Thus in every species but the last a network occurs, though varied in its subordinate details, and possibly in the exceptional case it is not wanting.

The differences noticed in the preceding paragraph, taken in the aggregate, mark, it is conceived, an essential distinction between the polype which developed *Idm. triquetra* with the other allied corals, and that which formed the chalk fossil (Tab. XVIII. A. fig. 6), as well as its apparent analogues; regarding the portions commonly called the polype as only the visceral and oral structures of the animal. In all the five polyparia so repeatedly alluded to, an identity of composition moreover is evident; and the variations in the minor characters depictured as well as described by the authorities quoted, prove the existence of distinct species. The fasciculus of tubes partakes also of this want of uniformity, and therefore supports the inference that it is not a mere specific peculiarity. A similar unity of leading components is equally manifest in true *Idmoneæ*; and if in *Idm. cretacea* a structure is superadded to meet the wants of a free, upward growth, still being associated with the most important elements of typical, attached species, its existence should be regarded as indicative rather of a subgroup, than as a warranty for placing in the genus certain corals possessed of such a character, but differing markedly in other prominent particulars.

No doubt, it is presumed, can be entertained of the coral having been formed by an ascidian polype, or that it belongs to the family Tubuliporidæ, as at present constituted.

[1] Iconog. Zoophytol. p. 203. pl. 52. fig. 9 *a*, 9 *b*.

[2] *Ibid.* p. 203–4, pl. 52. f. 10 *a*, *b*.

[3] *Ibid.* p. 219. observ. pl. 53. f. 19 *b*.

Believing, for the reasons already given, that a distinction from *Idmonea* exists, the term *Desmeopora* (*δέσμη fasciculus*) it is suggested might be adopted as a generic appellation for the zoophytes noticed in the preceding remarks. Respecting the species of the English fossil, the resemblance is greatest with *Idm.* (*Desmeopora*) *semicylindrica* of Herr Roemer—a prior determination to that of Dr. Mantell; and as no marked differences have been detected, the name is retained provisionally, leaving to a careful comparison of specimens its final adoption or rejection.

Desmeopora, n. g.

Tubular; branched; tubes fasciculated, the free portion forming two rows of protuberances, apertures chiefly limited to the latter; surface of the branches foraminated wholly or in part; internal composition, downward extensions of the fasciculi with a surrounding variable structure.

Desmeopora semicylindrica. (Tab. XVIII. A. figs. 6 & 6 *a* to 6 *e*.)

Fixed at the base; branches flat in front, rounded on the back; free portion of the fasciculi protruded along the edges of the flat surface, conical in form, arranged alternately; apertures of the tubes disposed in vertical rows, or inordinately on the back of the cones; surface of the front including the projections traversed by slightly raised, variously inclined laminæ or ribs, with intermediate rows of foramina; reverse side, laminæ generally not raised, foramina very distinct; branches chiefly thickened on the back, and for the greater part by an increase of the foraminated structure, but near the base by downward extended tubuli.

Idmonea semicylindrica, Roemer? Versteinerungen des Norddeutschen Kreidegebirges, p. 20. tab. 5. fig. 21, 1840. Upper chalk of Rügen, upper chalk marl near Gehrden.

The fine specimen delineated in Tab. XVIII. A. was obligingly lent to Mr. Dixon by Mr. Bowerbank; and figure 6, of the natural size, represents fully the general surface characters. The base or root was not sufficiently perfect for its nature to be ascertained, but the branches issued directly from the preserved portion, diverging and subdividing almost immediately; and as they extended upwards, they were more or less contorted and reversed, also occasionally anastomosed. Respecting the mode of branching the principal subdivisions originated apparently in terminal partitions, each portion exhibiting an equal thickness, and a certain degree of symmetry with the other; but some of the truncated fasciculi had a considerable increase of dimensions, and a few were so far extended as to assume the character of lateral shoots, furnished in one case with conical projections. The plan of growth was shown to a certain extent in the perfect termination of a branch represented on a slightly enlarged scale by figure 6 *a*. The greatest breadth of the fragment was rather more than half a line, that of a mature branch being about one line; and the upper extremity consisted of a fasciculus of tubes situated nearly in the axis of the branch, but inclined a little towards the observer's right, the immediately subjacent projection bending to the left. By reference to figure 6 *e*, this position will be found to accord with that exhibited by an internal section, the centre of which is wholly tubular, and the fasciculi, springing entirely from that portion, diverge successively in opposite directions. The difference between the breadth of the fragment and that of a mature branch proves also, that a certain amount of increase took place progressively without an alteration in the structures, marking a continued development in the coral, not by irregular outer additions as in *Eschara* and many other ascidian zoophytes, but by an augmentation of the constituents of the polype itself.

The free portions of the fasciculi give a peculiar neatness of character to the front view of the branches (fig. 6 *a*), and when examined in detail the variations were found to depend chiefly on the degree of preservation. The form was very generally conical, tapering in the best examples to a point, but occasionally cylindrical, accompanied however in those deviations with signs of irregular production; and traces of a subdivision were detected in one case. Internally, the best-exhibited cones consisted wholly of tubes with a thin covering on the side facing the flat portion of the branch. The apertures were situated (fig. 6 *b*), with a few exceptions, on the back of the projections, and they were easily distinguished from the foramina by their size and other characters. The perfect mouths were inclined upwards or against the side of the cone, the direct opening being obliquely sloped downwards and outwards; and the margin was smooth and formed of a solid substance similar to that of the general reticulation. For the greater part the apertures were not arranged uniformly, but occasionally a biserial distribution occurred: in a few instances a single opening, or a greater number appeared in the network between adjacent cones; and a lateral row was noticed near the base of an enlarged fasciculus or side shoot.

The surface-structures of the front did not vary markedly to the extent observed, except towards the base, where the pores were much less distinct or obliterated. The component parts consisted, as already stated, of thin laminæ or ridges and foramina. In the youngest condition (fig. 6 *a*), the former were not conspicuous, but in more advanced stages they formed projecting thread-like ribs, which were variously contorted, subdivided and anastomosed, diverging also outwardly along the inner face of the cones. They were connected longitudinally by small transverse bars; and their substance was apparently penetrated by very minute pores. The foramina were distributed between the main ridges, generally in a single row, and they bore the character of indented punctures penetrating horizontally, but were somewhat variable in form and size. In the obliterated state their position was indicated by a minute, shallow pit, sometimes blended with the transverse bars. A fragment slightly worn down on the front presented a reticulated structure resembling that on the original surface, but necessarily with a uniformly flat plane, and intersected lateral fasciculi: when abraded a little deeper, the longitudinal lines or ribs became indistinct, as well as the pores in some places, and the bundles of tubes were exposed to a greater extent, penetrating into the body of the branch; while a still deeper wearing (fig. 6 *e*) gave a centre wholly composed of tubes, with diverging fasciculi and an intermediate, largely porous structure. The reverse surface (fig. 6 *d*) was similarly constituted, but the ribs were occasionally indistinct, and the foramina near the base were changed into short tubuli, which were inclined downwards, and occupied the whole area. Internally the characters were also similar to those on the opposite side, except that the thickness of the network was greater. A comparison of the front and back of a branch will prove however two differences; first, that the foramina adjacent to the foot of the coral are in one case filled up, in the other elongated downwards (fig. 6 *c*); and secondly, that the ribs on the front are not overlaid where the obliterations occur, while the equivalent reverse portion is wholly covered with short tubuli. Under every observed state, the foramina were bounded by the laminæ composing the reticulated fabric; and it is consequently inferred, that they had not an independent structure, previously to their altered character, but were simply canals in the substance of the coral.

Tab. XVIII. A. figs. 7 to 7*h*.

The fossil delineated in this Table agrees so closely with Herr Roemer's[1] representation of *Chrysaora pulchella*, that a specific identity can scarcely be doubted.

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[1] Verst. Norddeutschen Kreidegebirges, p. 24. tab. 5. f. 29. From the upper chalk-marl of Gehrden and Quedlinburg.

In the observations, however, on the German specimens, the coral is considered the type of a peculiar genus. Both the foreign and the English fossil consist of slender, round, forked stems, traversed vertically by smooth, projecting, straight ribs, between which occur the apertures to the abdominal cavities; also subordinate ribs of limited extent, and rows of minute pores. The branches are similarly occupied over the whole surface, except where irregularities occur or changes due to age. Herr Roemer says, his specimens formed cæspitose groups on a knotty base; and Mr. Dixon's bore full testimony to an aggregated mode of growth, though no base was observed.

The chief point of agreement with Lamouroux's[1] *Chrysaora* appears to consist in the lineal projections. How far ribs may be essential components of that genus remains to be ascertained; but judging from published delineations of *Chrys. Damæcornis*[2], they seem not to be persistent; on the contrary, in the English chalk fossil, they clearly form a leading constituent throughout the framework. Such ridges moreover are not confined to *Chrysaora*. They occur very markedly in M. Milne-Edwards's *Hornera striata*[3], but if considered in conjunction with the other structures, no agreement whatever will be found between that fossil and *Chrysaora Damæcornis*, or with the zoophyte under examination. *Chrysaora*, moreover, has no secondary openings, a prominent character in Herr Roemer's species and in the English equivalent. Again, no changes dependent upon age have, as yet, been mentioned in the notices of the corals referred to Lamouroux's genus; whereas great alterations are very manifest in Mr. Dixon's specimens of the chalk fossil; but admitting that they may exist, still, as in the latter instances they derived their peculiarities from those portions of the polype which formed the secondary pores and associated minor structures, and as no similar pores occur in *Chrysaora*, the changes would be very dissimilar. *Heteropora*[4] is the only other ascidian zoophyte known to the compiler of these memoranda which appears to require a remark. That genus has for a leading characteristic two sorts of pores distributed over the whole surface; but in the representations of the typical species[5], there is nothing to justify a belief of the fabric being similarly constructed to that of Herr Roemer and Mr. Dixon's fossil; and in the pub-

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[1] Exp. Méthod. p. 83. tab. 81. f. 6–7 & f. 8–9.

[2] *Ibid.* tab. 81. f. 8–9; also Michelin, Iconographie Zoophytologique, pl. 55. f. 9 *b*.

[3] Mém. sur les Crisies, &c., Ann. Sc. Nat. 2nde série, Zool. tome ix. pl. 11. f. 1 *a*; or Recherches sur les Polypes.

[4] De Blainville, Man. d'Actinol. p. 417.

[5] Goldfuss, as quoted by De Blainville, pl. 10. f. 3, 5 & 9.

lished descriptions no allusion is made to the nature or functions of the minor pores, nor to the effects which age had or might have produced on the exterior. From a careful consideration of the peculiarities of the coral under examination, and a comparison of them with the structures of other accessible or figured zoophytes, it is conceived that Herr Roemer was fully justified in forming the opinion before-mentioned; and as neither that authority nor any other, so far as is known, has proposed a distinctive appellation, the term *Petalopora* (πέταλον, *lamina*) is suggested in allusion to the vertical plates which constitute a leading component, not only as respects the primary, but the secondary characters also.

Petalopora, n. g.

Tubular, free except at the base; framework composed of vertical laminæ with an intermediate, foraminated structure; apertures to the visceral or tubular cavities distributed over the whole surface; exterior altered according to age.

Petalopora pulchella. (Tab. XVIII. A. figs. 7 & 7 *a* to 7 *h*.)

Cæspitose, dichotomously branched, branches slender, round; surface in a young state, composed of a general reticulation in which occur fine vertical laminæ, and the apertures to the visceral cavities—in a mature state traversed by bold longitudinal ribs, having between them the oral aperture, also subordinate medial ribs and rows of minute foramina—in an aged condition, apertures concealed, and surface wholly formed of a fine reticulation; openings to the visceral cavities large, circular, more or less projecting according to age, in general arranged quincuncially; surface irregularities numerous.

Chrysaora pulchella, Roemer, Verst. Norddeuts. Kreidegebirges, p. 24. tab. 5. fig. 29. Upper chalk-marl.

Mr. Dixon's cabinet contains a mass of chalk about 14 inches in length and nearly 5 in its greatest breadth, having its whole surface covered with prostrated branches of *Pet. pulchella*, and judging by the sides of this magnificent specimen, the thickness of the zoophyte-stratum exceeded an inch; but as no part of the base was detected, and the matrix was indented by the obtuse extremities of branches, the actual upward extension of the coral must have been much greater.

The mode of branching was evidently dichotomous (fig. 7), no lateral shoots having been observed; and the subdivisions very generally, but not invariably, succeeded each other in the same plane. The angle of divergence varied from

50 to 75 degrees, and the distance between the successive bi-partitions from eight to three lines. The branches were almost constantly cylindrical, and only slight differences were perceptible in the diameter of mature, unaltered fragments, that of the greatest being about a line: in immature terminations it was three-quarters of a line, and in thickened, greatly altered portions a line and a quarter.

Two upper extremities of a branch presenting a nearly perfect, young condition were observed. The finer (fig. 7*a*) exhibited an obtuse, round point; and the whole surface to the very apex displayed well-formed projecting apertures, and when examined in a lateral position, thin longitudinal lines were visible, between which could be detected rows of minute pores, but when vertically, only a reticulated structure was obvious. All the essential components of the coral's fabric, however, evidently existed as shown by the former mode of viewing the fragment. The surface of mature, unaltered, regularly formed branches (fig. 7*b*) was traversed by bold, longitudinal ribs, similar to those delineated by Herr Roemer (*op. cit.* tab. 5. fig. 29 *b*), and between them, occupying the whole breadth of the interval, occurred the tubular projecting mouths. The subordinate medial rib was most distinct when the branch was examined laterally, but it could be detected when in any position ranging generally from one aperture to the next; and on each side of it, a row of fine pores or indentations could be discovered with care. In fragments possibly a little older, the middle rib was stronger, and the pores more distinct. In consequence of numerous abnormal examples, some of which will be noticed presently, it was difficult to select specimens which actually gave a passage from an unthickened to a thickened state. Fig. 7*c* is however believed to represent a branch considerably altered. The apertures are much less prominent, exhibiting only a circle on a level with a surrounding porous structure, and they are often invisible, or their place is indicated by a small projection coated by the network: the longitudinal ribs are also similarly overlaid and in part concealed. In the lower portion of the specimen, the mature characters were even less apparent. Probably Herr Roemer's figure 29 *d* was delineated from a fragment which had undergone an equivalent amount of change. Fully altered states (fig. 7 *c*, *c*) displayed a surface wholly occupied by a fine reticulation, composed principally of limited rows of pores with very slender divisional lines. The point more immediately claiming attention in these aged conditions is the total obliteration of the most prominent structures in mature stages, and the great development of one which in such circumstances is very subordinate. In the altered surfaces however the same elements, with the exception of tubular mouths, are detectable as in young and perfected states, or rows of pores with intermediate laminæ, the essential difference being a great augmentation in the number of the rows, and a diminution in the boldness of the laminæ. This is another instance of the necessity for not regarding the viscera and associated tentacula as the only constituents of the polype.

Longitudinal sections (fig. 7*d*) gave more or less decomposed centres, but the best-preserved portions consisted of an axis of very slightly diverging, elongated tubes with slender interspaces or united walls; and on each side an outer band in which part of an almost horizontal extension of a tube was occasionally visible. Where the abrasion had not penetrated to the centre, the space between the obliquely intersected tubes exhibited minute pores and fine longitudinal lines; and the side bands showed throughout similarly arranged pores and laminæ; the whole of the interior presenting clear proofs of an inward continuation of outer structures. A transverse section (fig. 7 *e*) afforded equivalent characters, or a middle area composed of closely aggregated tubes increasing in size at the circumference, and a surrounding zone of considerable breadth, in which faint converging white lines could be perceived, also indications of pores, and very markedly two horizontally extended tubes.

Among the deviations from a regular construction, the following were noticed: first (fig. 7*f*), irregular spaces without apertures to visceral cavities, and occupied wholly by pores and longitudinal laminæ (consult Roemer, fig. 29 *d*): secondly (fig. 7 *g*), fragments which exhibited in the lowest portion regular mature characters, but midway a surface entirely porous, like that of aged conditions, a perfect gradation being evident from the regular to the abnormal state: thirdly (fig. 7 *h*), slender branches with totally irregular developments; the mouths being unequally distributed, very prominent, and occasionally covered by a solid plate, the subordinate structures being also very defective or indistinct. Deviations in the range of both primary and secondary ribs were common, as well as interminglings of the above and other variations.

The visceral tubes sprung solely from the centre of the coral, and formed simple hollows in the general fabric, being destitute of a distinct wall or lining; and their thoroughly foraminated sides afforded abundant canals for the transmission of nourishment and calcareous matter from the digestive organs to those portions of the polype which occupied or constructed the framework.

Pustulopora pustulosa, De Blainville ? and Michelin.

(Tab. XVIII. A. figs. 8 & 8 *a* to 8 *h*.)

Tubular, dichotomously branched; apertures to visceral cavities merely terminations of tubes, near together, more or less pustulous, arranged in annular rows or irregularly distributed; area of cavities circular, gradually contracted downwards; parietes thick, defined by a faint translucent line.

Ceriopora pustulosa, Goldfuss ? Petref. p. 37. pl. 11. f. 3. Maestricht.

Pustulopora pustulosa, De Blainville ? Man. d'Actinol. p. 418.

——— ———, Michelin, Icon. Zoophyt. p. 211. pl. 53. f. 4. Grès vert des environs du Mans.

Judging by external characters, the fossil delineated in Tab. XVIII. A. fig. 8, bears a great resemblance to the greensand coral of M. Michelin; but an agreement with Prof. Goldfuss's representations of the one found at Maestricht is considered less evident. The visceral cavities of M. De Blainville's[1] original species of *Pustulopora* are represented, with one exception, as simple, elongated hollows in the substance of the coral; and the species subsequently added by M. Milne-Edwards[2] have apparently a similar composition. The exception just mentioned, *Pust. radiciformis* (Goldf. tab. 10. f. 8), exhibits in a transverse fracture (fig. 8 *c*) several distinctly rounded tubes, and M. Edwards[3] says, "je doute beaucoup que le *Ceriopora radiciformis* présente intérieurement le mode propre aux Pustulopores." One of Mr. Dixon's specimens afforded an analogous cross-section (fig. 8 *a*); but it could not be regarded as a proof that the branch consisted of perfectly separable tubes, the rounded sides at the lines of contact being cemented together; other transverse fractures (fig. 8 *b*) presented also as little appearance of such a composition as the quoted delineations of M. Goldfuss, unless attention was particularly directed to indications of that structure, and even then they were not visible except under a proper light, depending on faint translucent lines; while a worn termination of what had been a natural extremity (fig. 8 *c*) gave not a sign of a tubular composition. It is therefore plain that the characters exhibited by a fracture depended on the nature of the intersection; and probably

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[1] Man. d'Actinol. p. 418. Consult Goldfuss's delineations of *Ceriopora madreporacea*, tab. 10. f. 12 *a*, *b*, and *C. pustulosa*, tab. 11. f. 3 *a*, *b*.

[2] Mém. sur les Crisies, &c., Ann. Sc. Nat. 2nde sér. Zool. t. ix. pl. 11. f. 4. pl. 12. f. 1, 2; or Recherches sur les Polypes.

[3] *Ibid.* M. Edwards (Ann. Sc. Nat. *loc. cit.*) likewise objects to *C. verticillata* being referred to the genus, regarding it as rather "d'un genre particulier voisin des Spiropores de Lamouroux, *Cricopora*, De Blainville."

those of an unbroken termination on the state of development at the time the polype was killed[1]; and the actual appearance of both occasionally on the obliterating effects of abrasion. Nevertheless M. Milne-Edwards's *Pust. proboscidea* (*op. cit.* pl. 12. f. 2) could not, it is conceived, yield under any circumstances a fracture similar to that of *Pust. radiciformis* or of Mr. Dixon's coral. Slightly worn surfaces (fig. 8 *b*) gave fine and faint, translucent lines which formed polygonal figures more or less midway between adjacent cavities; and they supported the inference that the visceral receptacles were not simple hollows in a homogeneous substance. They appeared nevertheless to have resulted from animal secretions filling up slight interspaces; and the small degree of translucency was probably due to a less proportion of mineral matter; but perfect exteriors, or those which were regarded as exhibiting a mature condition, presented a continuous layer resembling that of M. Goldfuss's original figures. From the preceding statements it would appear, that further information is requisite before a right opinion can be formed respecting the subordinate structures of M. De Blainville's genus; and consequently that the proposing of a new one for *Pust. radiciformis* or the English chalk fossil is inadmissible.

Four specimens of the cretaceous coral were examined, the finest being represented by figure 8. They varied not in the diameter of the branches, nor in the manner of dichotomosing; the only differences depending on irregularities of growth and state of preservation. A comparison with MM. Goldfuss and Michelin's figures proved that the dimensions were similar in all the three cases. So far as was observed, the branching was strictly dichotomous, but the separation was not always in the same plane; and M. Goldfuss says his specimen had a three-forked division. The mouths of the visceral cavities (fig. 8 *a*) were fully as pustular and salient as in M. Michelin's figure 4 *b*, and under some irregularities of development they projected to a still greater extent, assuming a free tubular character. In the 'Iconographie Zoophytologique' it is stated, that, "dans les échantillons bien conservés, les bords des pores sont presque tubuleux" (*loc. cit.*). In what appeared to be cases of great deviation from normal productions (fig. 8 *h*), the margin was cylindrical and narrow and protruded very little; the apertures being closed by a solid plate. The regular mouths (fig. 8 *a*) were round or oval, and simply tubular endings, without any indications of an operculum; they were arranged as before stated, for the greater part in annular rows, but very many deviations occurred. The surrounding intervals were small, and

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[1] Compare figure 4 *b*. pl. 53. M. Michelin, with figure 8 illustrative of Mr. Dixon's fossil.

in perfect exteriors presented a continuous layer, indicative, it was conceived, of the branch having attained its full lateral development. The abnormal fragments (fig. 8 *h*) gave a seeming greater distance between the apertures, but the intervals were traversed by straight ridges, which often united so as to form a polygonal figure, and they were believed to be the boundaries of tubes still more defective than those immediately adjacent with a circular outline, though the latter had evidently never attained a mature condition. The internal composition of the coral is exhibited in figure 8 *f*, which shows a considerable downward extension of the tubes with a gradual decrease in width. The cavities preserved however a round periphery throughout, though the interspaces were narrow; and the latter exhibited no signs of a separating fissure, or indications that a partition could be effected mechanically. Connected with some apertures was a long channel which ranged upwards along the surface of the branch, and was bounded on each side by a ridge (fig. 8 *g*). No case of an outer covering was observed, but as the channels occupied the position of ovarian capsules, it was conjectured that they might have performed the functions of those vesicles. The specimens examined afforded no satisfactory evidence of regular surface-thickenings, nevertheless as they consisted wholly of detached branches, without the least portion of a base, a progressive external alteration may be one of the characters of the fossil.

Tab. XVIII. A. figs. 9 & 9 *a* to 9 *g*.

Three figured corals exhibit characters somewhat analogous to those of the zoophyte about to be noticed :—1. the fossil referred by Faujas de St. Fond to the genus *Flustra*, and represented in plate 39, figures 1 *a*, 1 *b* of his work on Maestricht; 2. the *Retepora clathrata* of Goldfuss (Petref. tab. 9. f. 12), also from that locality; and 3. the *Apsendesia dianthus* of M. De Blainville (Man. d'Actinol. pl. 69. f. 2)[1]. Respecting the first of these generic determinations no remarks are necessary; with regard to the second, M. Milne-Edwards says, "nous doutons beaucoup que cette espèce soit un *Retepore*[2];" and the English chalk fossil most assuredly is not a *Retepora*; the third genus, *Apsendesia*, has not been described in sufficient detail to admit of its characters being fully understood; but on account of M. Michelin's careful delineations of *Aps. dianthus*, it is necessary to institute a comparison between the figured species and the ascertained structures of Mr. Dixon's coral. The genus was proposed by M. Lamouroux[3], amended by M.

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[1] Consult M. Michelin, Icon. Zoophytol. pl. 55. fig. 4 *a*, *b*, *c*, for more precise delineations, particularly fig. 4 *c*.

[2] Lamarck, edit. 1836, t. ii. p. 282.

[3] Exp. Méthod. p. 81–82. tab. 80. figs. 12, 13, 14.

De Blainville (*op. cit.* p. 408), and has been admitted into subsequent systematic works. In the ' Manuel d'Actinologie ' three species are mentioned, *Aps. cristata*[1], *Aps. dianthus*[2], and *Aps. cerebriformis*[3]. The first, M. Lamouroux's type, apparently consists, according to M. Michelin's beautiful delineations, of lamelliform branches progressively united by a dorsal layer, the upper edges and the extremities being free; and the whole forms broad, leaf-like expansions with a jagged margin. M. De Blainville states that the pores " existent au bord même des lames ou crêtes ;" but on the free reverse extremities of M. Michelin's fig. 5 *b*, pores are as evident and are extended nearly as far backwards as on the crests (fig. 5 *c*). No information respecting the characters of the apertures, except that the pores are " plus ou moins alveoliformes " (Man. d'Act. p. 409), or of the internal structures, has been published, though the genus has been invariably associated with true *Anthozoa*. It is almost needless to observe, that Lamouroux totally misunderstood the nature of the fossil described by him (consult De Bl. *loc. cit.*). *Aps. cerebriformis* is excellently represented in the ' Iconographie Zoophytologique[4],' and the author of these memoranda is indebted to M. Michelin for a labeled specimen of the coral. It consists, as will be seen by reference to the quoted figures, of convoluted bands composed of vertical tubes, which open only along the crests, the sides being covered by a continuous, thin layer without a vestige of a mouth. The tubular cavities have no furrows or other representatives of lamellæ, but they are crossed, as abundantly shown in the specimen received from M. Michelin, by transverse plates deemed a sufficient proof of the fossil having been constructed by an anthozoan polype. A comparison of figures 5 *a*, 5 *b*, 5 *c* (Icon. Zoophyt. pl. 55) with figures 5 *a*, 5 *b* (*ibid.* pl. 75) will raise doubts whether *Aps. cristata* and *Aps. cerebriformis* are generically identical; but so far as concerns the present inquiry, this is a question of little consequence, only a small amount of agreement being detectable between the chalk fossil and *Aps. cristata*, and none whatever between it and *Aps. cerebriformis*, or with the other species, provided that zoophyte has been rightly assigned to the class *Anthozoa*. So great indeed is the difference, that attention would not have been

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[1] Lamouroux, Exp. Méthod. *loc. cit.* in note [3]: also Man. d'Actinol. pl. 65. fig. 3, and Icon. Zoophytol. pl. 55. f. 5 *a, b, c.*

[2] Man. d'Actinol. pl. 69. fig. 2; Icon. Zoophytol. pl. 55. fig. 4 *a, b, c.*

[3] Icon. Zoophytol. p. 314. pl. 75. fig. 5 *a, b.*

[4] *Ibid.* p. 314. pl. 75. fig. 5 *a, b*: consult also M. Milne-Edwards's remarks on *Aps. cerebriformis*, Lamarck, edit. 1836, t. ii. p. 290.

solicited to the genus had its reception depended on *Aps. cerebriformis*, or if M. Michelin's delineations of *Aps. dianthus* had not displayed structures much more analogous to those of Mr. Dixon's fossil. M. De Blainville in his brief notice of that species says, it is " très remarquable par la forme et le dessin de ses crêtes, qui portent les cellules à tout leur bord externe " (*loc. cit.*) ; and this peculiarity is fully expressed in fig. 4 *c* of the ' Iconographie Zoophytologique ;' the actual crest, moreover, being a continuous layer without tubular apertures. By reference to Tab. XVIII. A. figs. 9, 9 *b*, 9 *c*, illustrative of these remarks, a general agreement, as respects plan of growth, will be found with *Aps. dianthus*, also in the sides of the branches being completely beset with mouths ; a medial line likewise occurs, though less prominently than in M. Michelin's figure 4 *c*. An enlarged portion (fig. 4 *b*) of fig. 4 *a* (Icon. Zoophyt. pl. 55) displays, if rightly understood, horizontally or obliquely connected branches, though a further magnified representation (fig. 4 *c*) shows merely simple disconnected ramifications. The English fossil had very generally similar, free branches (fig. 9) ; but one specimen (fig. 9 *a*), evidently of most irregular growth, gave also equivalent transverse junctions. These extensions, whether normal or not, differed however in both cases from the dorsal layer of *Aps. cristata* not only in position, but in being occupied equally with the branches by visceral tubes, whereas in the species just mentioned there is not a single aperture in the uniting structure. No information has been published, it is believed, respecting the nature of the mouths or the characters of the internal structure of *Aps. dianthus*. In the English coral the openings bordering the crest of the lamelliform branches (fig. 9 *b*) are large, or equal to the transverse dimensions of the tubes, with sometimes a slightly projecting margin ; but on the sides of the branches they are wholly depressed as well as contracted to a mere pore and occasionally obliterated, the periphery of the cavities being defined by a network of ridges (fig. 9 *c*). It is not quite clear whether the dorsal surface of *Aps. dianthus* is provided with apertures, but in the subject of this notice (fig. 9 *d*) they are as abundant in that portion as in any other. Internally (figs. 9 *e*, 9 *f*) Mr. Dixon's coral is wholly composed of tubes, those adjacent to the back of the branch ranging nearly parallel to it, and in the line of outward extension of the coral, the mouths opening also in the back itself ; while the cavities composing the chief part of the branch incline towards the crest terminating successively on the sides, and their apertures occupy the entire surface, so that no portion of the tubes is visible externally. Small pores were abundant in a slightly worn-down fragment (fig. 9 *e*) ; they were however considered as effects of unequal abrasion; and not due to the occurrence so near the surface of young cavities. All attempts failed to discover the precise point in the older tubes whence the young issued; but the great extent to which the cavities overlaid each other indicated that the development must have taken place towards the lower extremity of the parent tube. Not a vestige of a transverse plate was detected, the dimensions of the mature visceral receptacles not exceeding the requirements of an ascidian polype's digestive organs; and when once attained, no subsequent extension was made. It is not meant that the absence of transverse plates proves an extinct coral does not belong to the class *Anthozoa*, as they are wanting in true *Alcyoniæ*; nevertheless they are either present or wholly deficient throughout a genus of that great group; whereas, if the chalk coral were considered an *Apsendesia*, they would be absent or present according to the species. Moreover, the essential characters of Mr. Dixon's zoophyte are totally dissimilar from those of *Alcyonidæ*, and are much more nearly allied to the constituents of an ascidian than an anthozoan polype. Whether structures similar to those mentioned above exist in *Aps. dianthus* remains to be ascertained: they certainly do not occur in *Aps. cerebriformis*; but the characters of the genus depend solely on the composition of Lamouroux's type and only species. It has been already stated, that a small amount of agreement is apparent between the cretaceous fossil and *Aps. cristata*, the points being a somewhat analogous mode of branching, regarding the crests as representatives of branches, and in pores occurring on the back of the ramifications as well as on the front ridge, though in both cases to a limited extent (Icon. Zoophyt. pl. 55. figs. 5 *b*, 5 *c*). On the contrary the differences are many. It would appear from the published descriptions, that apertures are totally wanting on the sides of the pseudo-branches, and M. De Blainville alludes to the peculiarity of their existence in analogous portions of *Aps. dianthus*; but in the chalk coral they abound everywhere except along a non-persistent middle line; again, nothing resembling the dorsal layer to the leaf-like expansions of *Aps. cristata* occurs in Mr. Dixon's fossil, an important difference when the general composition of the two polypes is considered; still further, no allusion is made by the authorities quoted to a plate, whereby the mouth was progressively narrowed and occasionally at least obliterated, though such a structure, as before stated, characterizes the chalk zoophyte; lastly, if *Apsendesia cristata* be truly an Anthozoon, then no identity respecting even the class can exist. Leaving however that point open to inquiry, the other differences are believed to be fully sufficient to warrant the inference, that the chalk fossil should not be regarded as an *Apsendesia*; and it is conjectured that *Aps.*

dianthus, also the *Flustra* of Faujas de St. Fond, as well as the *Retepora clathrata* of Goldfuss, may possess similar essential constituents. It is therefore proposed to designate the chalk coral by the term *Holostoma* (ὅλος *totus*, στόμα *os*), in allusion to the surface being wholly occupied by apertures to visceral cavities; and in contradistinction to their limited distribution in *Apsendesia*.

Holostoma, n. g.

Tubular, branched, free except at the base; tubes simple, of limited growth; apertures distributed over the whole surface, progressively narrowed, ultimately obliterated; external thickening slight.

Holostoma contingens, n. sp. (Tab. XVIII. A. figs. 9 & 9 *a* to 9 *g*.)

Branches dichotomous, deep, thin, sides flat, back round, front slightly carinated with a discontinuous medial line; tubes in close contact arranged in opposite series, near the back parallel to that surface, elsewhere inclined towards the front; apertures circular or polygonal, large adjacent to the front and sometimes slightly raised; on the sides and back of branches depressed, more or less bounded by a projecting wall, gradually contracted by a lamina extended from the sides, ultimately filled up.

Five specimens of *Hol. contingens* were examined, and the finest is represented by figure 9; but not one of them exhibited a trace of a base or root. M. Michelin's figure 4 *a*, of *Aps. dianthus*, exhibits a symmetrical radiation from a centre whence four branches issue; and the plane of growth is nearly horizontal. One of Mr. Dixon's specimens displayed imperfectly a similar divergence; but the stratum of ramifications undulated, without however any indication of an upward range or cyathiform mode of development; and as other specimens agreed with it in this particular, the coral had also probably a tendency to a horizontal extension. The manner of branching was essentially dichotomous (fig. 9), but shoots sometimes issued laterally; and where great irregularities prevailed (fig. 9 *a*), it was not possible to detect any systematic bifurcations, the whole presenting an anastomosis not very unlike that of Faujas de St. Fond's fig. 1 *a* (pl. 39). The ramifications were uniformly near each other, the successive subdivisions filling up the spaces which radiation would otherwise have produced; and when a junction occurred, there was a limited union. The thickness of the branches varied very little; but the depth gradually increased from a perfect extremity, where it was merely an obtuse point, to fully a line and a half. The sides though flat were not uniformly even; and they occasionally exhibited transverse ridges of limited extent, due apparently to irregular protrusions of apertures; and they were regarded as belonging to an exceptional rather than an essential structure. The crest or front of a branch (fig. 9 *b*) consisted generally of a congeries of fully open tubes variable in size and form, a few of them occasionally projecting and assuming a transversely linear arrangement: the medial line was by no means persistent or conspicuous. The whole of the specimens examined had the front imbedded in the matrix, and it is therefore impossible to state what changes different conditions of growth might present; while a portion purposely exposed, as well as the fragments which were detached, exhibited no indications of a final cessation of development. Immediately adjacent to the front, the apertures were also fully open, with more or less of irregularity in the general surface (fig. 9 *c*); but the sides of the branches exhibited for the greater part the characters shown by figure 4, or a network of ridges, the place of the meshes or apertures to the cavities being represented by a shallow depression with a minute, central foramen; though in some cases no opening whatever could be detected. The back of the branches (fig. 9 *d*) displayed similar structures, only the concavities were often arranged in rows, and the ridges assumed in consequence partly the semblance of longitudinal ribs. As respects internal composition, figure 9 *e* exhibits the characters of a slightly worn-down lateral surface, or obliquely intersected tubes varying in size from a minute pore to the mature dimensions; and figure 9 *f*, a fragment abraded nearly to the centre of the branch, so as to expose the range of the cavities previously to assuming an outward inclination. In both cases the tubes adjacent to the back are nearly parallel to it, opening in that surface, and the outward or horizontal extension of the branches was due to them; whereas the tubes composing the greater portion of the ramifications are more or less shown in each figure to range obliquely upwards, the successive young developments giving the branches their great depth. Fig. 9 *g* displays the general appearance of a vertical cross section, or tubes diverging outwards with a medial plate; but the characters varied in every case examined, and the plate was sometimes scarcely detectable.

Diastopora ramosa, Michelin. (Tab. XVIII. B. figs. 1, 1 *a*, 1 *b*.)

Incrusting, dichotomously branched; branches very variable in breadth, when in contact anastomosed; apertures slightly projecting, irregularly distributed in two or more series.

Michelin, Icon. Zoophy. p. 203. pl. 52. fig. 3 *a*, 3 *b*. Neighbourhood of Mans, Depart. Sarthe, and of Ciply, Belgium, 1840–1847.

The fossil represented by figure 1, Tab. XVIII. B., occurred abundantly on a *Micraster* found by Lord Northampton in the Houghton chalk-pit ; likewise on the *Ananchytes* which gave the examples of *Marginaria Roemeri.* To the extent examined, no differences were detected from M. Michelin's delineations of *Diast. ramosa.* One of the localities mentioned by that authority is Ciply, the strata in the neighbourhood of which have been placed by Dr. Fitton[1] on a level with the Maestricht deposit or uppermost portion of the chalk ; and it is deserving of notice that other corals described in preceding pages have equivalents in St. Peter's Mount. M. Michelin's other locality is the vicinity of Mans, the bed from which his specimens were obtained being referred to the greensand. Assuming therefore that the corals are all rightly determined and geologically assigned, it follows that *Diast. ramosa* ranges nearly throughout the cretaceous series. Prof. Goldfuss[2], under the term *Cellepora echinata* (Munster), has figured an Astrupp tertiary fossil, which resembles externally both the French and English corals, and should not possibly be generically separated from them ; but the assignment to *Cellepora* is evidently incorrect.

The branched mode of growth of the three fossils agrees more nearly with that of *Criserpia*[3] than with typical species of *Diastopora* ; but in that genus additional tubes are wholly developed from the lower extremity and inner side of the preceding ; whereas in the English chalk zoophyte and most probably in the French, they issue partly from the extremity of the parent tube and partly from the side[4], and without limitation to an inner position. Another distinction from the typical species (*Cris. Michelini*) is in the form and position of the mouth, which is not a simple tubular extremity, but a raised or outwardly inclined aperture developed at a definite period. In these particulars as well as in the characters of the tubes, no difference from *Diastopora* was detected ; and if a branched mode of growth should be regarded as a generic distinction, it would be necessary to separate *Tubulipora fimbriata*[5] from its received genus ; also all corals generically in which a ramose or an expanded plan of production has hitherto been regarded only among specific distinctions. On the same *Micraster*, and intermingled with the fossil under consideration, was a species of *Alecto*, and the two Bryozoa were occasionally so intermingled that care was requisite to prevent

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[1] Proceedings Geol. Soc. Lond. vol. i. p. 162, 1829.

[2] Petref. p. 102. tab. 36. fig. 14, 1826–1833.

[3] Milne-Edwards, Ann. Sc. Nat., 2nde Série, Zool. tome ix. Mém. sur les Crisics, p. 16. pl. 16. fig. 4.

[4] Consult M. Edwards's fig. 1 *a* of *Diast. Eudesiana*, op. cit. pl. 14.

[5] Ann. Sc. Nat. 2nde Série, Zool. tome viii. pl. 14. figs. 2, 2 *a*.

their being regarded as different states of one zoophyte. The *Alecto*, however, preserved its essential character of a single series of tubes, and where it appeared to issue from one or opposite sides of the other coral, due attention showed an overlying; and the *Alecto* in its onward course dichotomosed without any structural enlargement; whereas the *Diastopora* assumed a club- or fan-shaped increase prior to subdivision, and the new branches had two or more rows of apertures: moreover, on the *Ananchytes* where a similar association occurred, the tubes of the *Alecto* exceeded in size those of the *Diastopora*.

The *Micraster* which afforded the most abundant display of this coral was about two inches in length and greatest breadth, and the zoophyte occupied about two-thirds of the upper surface. No direct centre of divergence was observed, the branches ranging in every possible direction; and springing from detached points where germs or ovi had settled. In the more regular portions, the plan of ramification was strictly dichotomous (fig. 1 *a*); but many deviations due to local or mutual interference occurred; and no uniformity existed either in the distance between the divergences, or in the alterations in the breadth of the branch precursory to bipartition. The narrowest, or what might be considered first-formed portions, had two or three series of apertures, the breadth increasing more or less rapidly, but without any uniform plan; while from this augmented development the new branches issued by a true dichotomization, though not always into two equal portions of the previous number of tubes (consult the figures of MM. Michelin and Goldfuss). The range of the tubes was almost constantly visible, the surface being slightly convex; but the amount exposed varied greatly. The apertures were uniformly inclined upwards, and to about an equal extent; and no changes depending upon age, as a marked filling-up or thickening of the surrounding general surface, by which they would be depressed, were noticed. The plan of developing additional tubes was best shown in abraded branches (fig. 1 *b*), where interpolations as well as terminal developments could be clearly detected.

Tab. XVIII. B. figs. 2 & 2 *a*.

The curious fossil represented by the above figures consists, so far as it is known, of long blade-like foliations, which are composed of two opposite layers of tubes; and the exterior displays transversely diverging rows of apertures with an intermediate, minutely tubular lamina, extended marginally beyond the area occupied by the mouths.

In the mode of growth, and in the existence of lateral bands without visceral cavities, this coral resembles *Ptilodictyum lanceolatum*[1]; but that fossil is tubular, and is distinguished by its subordinate structures from the subject of the present inquiry. For certain cretaceous and subcretaceous *Bryozoa*, Herr Roemer has proposed the genus *Rosacilla*; and one chalk species, *Ros. serpulæformis*[2], is represented with a marginal lamina resembling that of the zoophyte under consideration, also with an approximation towards a transverse arrangement of apertures; and the fossil is stated to be formed of fine, long tubes, invisible externally: the genus, moreover, is placed among the *Tubuliporidæ*, and described as consisting of circular, less frequently of irregular incrustations, composed of one or more layers of cells (tubes) with projecting mouths. These structures afford some points of agreement with those of the chalk coral, and the concealment of the tubes externally does not appear to have resulted from a thickening due to age—the mode of growth also, as well as the occasional existence of more than one layer of cells or tubes, cannot likewise be regarded as satisfactory generic distinctions. Of the five cretaceous species mentioned by Herr Roemer, four however have the form of the tube visible externally, three of the number having besides a distinct furrow between the cells. This character indicates, it is conceived, the want of an external lamina similar to that of Mr. Dixon's fossil, and consequently that an essential difference existed in the composition of the polypes; but it must be stated that in two species of *Rosacilla* the tubes are described as streaked across or obliquely ("queergestreift"), though without any allusion to capillary tubes constituting a structure independent of the integument of the visceral cavity. The mode of producing additional tubes is not mentioned; nor the extent to which those composing one layer overlie each other; but the enlarged figure of *Ros. serpulæformis* exhibits possibly in the transverse fracture a considerable overlapping, no allusion being made in the description to successive layers. In the chalk fossil the cavities apparently covered each other very slightly, if at all, the additions, so far as could be ascertained (fig. 2 *a*), springing either from the point where the preceding tube inclined outwards, or from the portion of the side immediately adjacent to it. The latter character will most probably be considered of little importance, the composition of the genus not

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[1] See Goldfuss, *Flustra lanceolata*, p. 104, tab. 37. f. 2; also Hisinger's Lethæa Suecica, p. 104, tab. 29. f. 10; likewise Sir R. I. Murchison's Silurian System, p. 676, *Ptilodictya lanceolata*, pl. 15. figs. 11 to 11 *c*; and Lieut.-Col. Portlock's Geol. Rep. on Londonderry, &c. p. 339, pl. 21. figs. 3 & 6.

[2] Verst. Norddeuts. Kreidegebirges, p. 19. tab. 5. figs. 16 *a*, *b*.

having been fully detailed; but the external lamina is believed to constitute a most marked distinction from *Rosacilla*; and even if the minuteness of *Ros. serpulæformis* prevented its being detected, still should it exist, as such a structure does not enter into the generic characters, nor is noticed in the descriptions of the species, its presence would rather justify a separation of that coral from *Rosacilla*, than a union of the chalk fossil with Herr Roemer's genus. Among *Tubuliporidæ* which exhibit partial agreements with the subject under consideration, as a similar arrangement of the apertures, accompanied by an external lamina, may be mentioned the *Obelia* of Lamouroux[1]; but that genus has been united by M. Milne-Edwards[2] to *Tubulipora* (*T. verrucaria*) and the lamina, instead of being tubular, is minutely foraminated similarly to the tubes themselves. As respects *Tubulip. patina*, the area occupied by visceral cavities is surrounded by a delicate zone traversed by radiating lines[3], and presenting an appearance somewhat resembling that of the exterior layer of the chalk fossil; but in the recent zoophyte the marginal plate is a dorsal or inferior, not an upper structure; and the striæ instead of indicating microscopic tubes are, for the most part, at intervals equivalent to the breadth of visceral cavities; and they define in some English specimens usually assigned to the species, the commencement of side walls to future tubes[4]. Sometimes only a very narrow interval is visible between adjacent striæ, the precursor apparently of an interpolated abdominal receptacle. The upper lamina of this coral, designed, it is conceived, to support the protruded portion of the tubes, is moreover minutely foraminated as in the case of Lamouroux's *Obelia*; nor can the depressed openings or "sorte de tissue aréolaire de consistence pierreuse" of M. M.-Edwards[5], and observable in some British specimens, be regarded as an equivalent structure to the surface layer of the cretaceous zoophyte, not being of constant occurrence, and exhibiting distinct apertures, whereas the microscopic tubuli of the chalk fossil are closed at their extremity. Another coral which resembles in the surface arrangement of the tubes or cells, the organic body under examination, is a tertiary production to which M. Michelin[6] has applied the term *Adeona lamellosa*, though possibly without being perfectly assured of the generic identity: it is sufficient for the present inquiry

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[1] Exposition Méthodique, p. 81. tab. 80. figs. 7, 8.

[2] Ann. Sc. Nat. 2nde série, Zool. tome viii., or Recherches sur les Polypes, Mém. sur les Tubulipores, p. 7–8.

[3] Consult Milne-Edwards, *op. cit.* pl. 13. fig. 1.

[4] Dr. Johnston's Brit. Zoophytes, 1st edit. pl. 31. figs. 2, 3; and 2nd edit. pl. 47. figs. 2, 3.

[5] *Op. cit.* p. 9. pl. 13. fig. 1.

[6] Icon. Zoophyt. p. 326, pl. 78. fig. 5.

to state, that no agreement whatever exists between Mr. Dixon's zoophyte, and the species of *Adeona* represented by Lamouroux and other authorities[1]. The foregoing remarks show that in some characters the subject of this inquiry accords with more than one established genus, but that it differs in the aggregate of structures in each case; and the compiler of these memoranda, believing that the peculiar layer which forms the exterior does not exist in any described *Bryozoa,* as well as that it was developed by a most important part of the polype, proposes to distinguish the fossil by the term *Siphoniotyphlus* (*σιφώνιον tubulus, τυφλὸς cæcus*), in allusion to the closed or blind tubuli constituting the lamina.

Siphoniotyphlus, n. g.

Tubular, tubes invisible externally as respects range and outline at all periods of growth, slightly or not at all superimposed; additional tubes formed at or near the extremity of pre-existing; exterior a thin layer closely united to the visceral cavities, and composed of microscopic tubuli without surface-apertures; developed also contemporaneously with the primary tubes.

Siphoniotyphlus plumatus. (Tab. XVIII. B. figs. 2 & 2 *a.*)

Slender, elongated, slightly convex expansions, formed of two opposite layers of tubes; apertures slightly protruded, disposed in transverse rows diverging from the centre and occupying about half the breadth of the expansions; surface lamina extended laterally in a thin band without tubular apertures; interior of middle area wholly occupied by abdominal tubes; external changes due to age slight.

The specimen on which the present notice depends, forms part of the series obligingly lent by Mr. Dixon for examination. The greater part is represented of the natural size in figure 2; and the blow which had detached the upper portion (fig. 2*) had happily exposed a cast of the opposite surface, and proved that the fossil consisted of two similar layers united dorsally. The full length of the specimen was about an inch and a quarter, and the greatest ascertained breadth two lines, the tubular apertures occupying about half the transverse area; but this measurement must not be regarded as accurate, the margin being fractured nearly throughout its extent: the thickness in the middle of the expansion was

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[1] Exposition Méthodique, p. 39–40, tab. 70. fig. 5, or Histoire des Coralligènes flexibles, p. 481, pl. 19. fig. 2; consult also Schweigger, Beobachtungen, &c., taf. 2. figs. 5, 6, 7; as well as taf. 1 with descriptions of the plates, and p. 69; likewise De Blainville's Man. d'Actinologie, p. 431. pl. 76. fig. 2.

apparently half a line. The contour was nearly uniform from the lower to the upper extremity, but neither termination was perfect; and the slightly convex surface was confined to the region occupied by the visceral cavities, arising solely from their existence, the marginal bands being very thin and flat. Of the general habits of growth no opinion can be offered. The number of apertures in a transverse row, including both the curves, varied from six to nine, smaller series prevailing in the lower portion of the specimen, and greater towards the upper extremity, but without any change of distribution indicative of a bifurcation: the number of apertures in opposite arcs was also often dissimilar, omitting from the calculation the central opening, the defect being generally towards the observer's right, or if that mouth were included to equalize the enumeration, then the opposite curves were unsymmetrical in position, but without becoming alternate. The series forming the direct centre was arranged nearly in a straight line, but those on the sides quincuncially. The margin was equally raised and sharp throughout the specimen, proving no surface-change with respect to that structure, so far as the amount of evidence was concerned, the inner area of the mouth being likewise invariably open. The tubuli constituting the general surface-layer were defined by translucent lines in general very distinct, except near the lower extremity of the coral, where a slight thickening had apparently taken place. That the narrow opake intervals between those lines were hollow was clearly shown in the fractured section (fig. 2 *a*); also near the upper extremity of figure 2*, a defective portion exhibited a congeries of minute, obliquely penetrating openings, which viewed in some directions bore the semblance of cells; and in other parts, where the distance between the apertures was small, the lines formed a fine reticulation, which might also be regarded, if considered alone, as marking a cellular composition; on the contrary, whenever the polype had ample space for development, especially in the lateral bands, the interval between the lines was so greatly elongated as far to exceed the dimensions ordinarily assigned to a cell. In the immediate centre the tubuli ranged vertically, but elsewhere more or less outwardly, though always nearly coincident with the direction of the visceral tubes. The breadth was for the greater part much less than the diameter of the apertures to the abdominal cavities, varying however considerably, and being often unequal in an individual example: the greatest uniformity occurred in the side bands. The layer constituting the general surface had commonly a single series of these minute hollows, disposed horizontally, but in the depressions between the visceral tubes was an inferior row to fill up the inequality; and where irregularities existed similar to those before mentioned, the tubuli had an oblique position with a considerable underlay. In the central portion of the specimen the interior of the minute hollows was cylindrical; while in the flattened marginal bands it was oval or compressed, and the cavity disappeared possibly altogether adjacent to the attenuated edge of the coral. As already stated, no apertures were visible similar to those which form the secondary pores in many genera of *Bryozoa*; and as a further proof that the end of the tubuli was structurally shut, no distinct openings were detected in the margin of the large mouths, though the lines marking the boundaries of the subordinate structure ranged up the side of the projecting portion of the tube. The only means of communication between the animal matter which occupied these little hollows, and the visceral cavities or the exterior of the coral, was apparently the microscopic pores so prevalent in the integuments of *Bryozoa*. The portion shown in figure 2 *a* bore the semblance in one part of a mechanical separation in the laminæ of the outer bands, but the evidence was not conclusive, a similar appearance accompanying an irregularity plainly due to a laceration in the membranes of the polype. Internally (fig. 2 *a*) the central area was occupied by visceral tubes in close juxtaposition, but not arranged in two regular rows parted by a medial layer, nor could the opposite series be parted evenly; nevertheless the tubes terminating on each surface sprang apparently from the side to which the openings belonged, without any interlacing, though with a clear structural blending in the parietes. So far as the small portion exposed justified an inference, the underlay was very little, and the outward bent portion of the tube was also small. The observed surface-changes were very trifling. In the upper part of the fragment represented by figure 2*, the lines bounding the tubuli, if rightly understood, projected slightly, but lower down the outer covering was apparently thicker and on a level with the edge of the side wall; while in the lowest portion of figure 2 the tubular outline was less distinct.

Tab. XVIII. B. figs. 3, 4 & 5.

The fossil about to be noticed is believed to be the *Retepora flexuosa* of Dr. Mantell[1]; and M. De France[2] referred doubtfully to the same genus a Maestricht coral which exhibits in Faujas de St. Fond's[3] rough delineation, some resem-

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[1] Medals of Creation, vol. i. p. 284, Lign. 64. fig. 11.

[2] Dict. Sc. Nat. t. xlv. p. 283, *Ret.*? *ramosa.*

[3] Hist. Nat. de la Mont. de St. Pierre de Maestricht, p. 191. pl. 35. figs. 5, 6.

blance to detached fragments of the English cretaceous zoophyte. That body however is considered by M. Milne-Edwards[1] to have no analogy with *Reteporæ*; and the fossil under consideration belonging to the family *Tubuliporidæ* cannot also be assigned to that genus.

It consists, as shown in figs. 3, 4 & 5, Tab. XVIII. B., of numerous main branches diverging from a centre, and giving off many lateral shoots of variable extension. The exterior presents on one side (fig. 3 *a*) two sets of pores, one large and constituting the visceral cavities, the other smaller, but differing from the former structurally only as respects dimensions: the opposite or reverse side (fig. 4 *a*) is altogether destitute of pores, and exhibits more or less distinctly longitudinal translucent lines with opake intervals, the representatives of tubes; also irregular longitudinal ridges, and curved furrows in the points of partition of the branches. The interior of the coral was greatly obscured in some cases by mineralization; but in the best exhibited transverse sections, large and small tubes or pores were intermingled, occupying the whole area, and they had a considerable downward range at a variable angle (figs. 4 *b*, 4 *c*).

In the tubular cavities opening on only one side, a resemblance with *Hornera* exists[2], but there is otherwise no outer agreement, that genus not being provided with a secondary series of pores on the front surface, the characters of the reverse side being also different, as well as the general mode of thickening the coral. The occurrence of primary apertures on but one side, and the form of the protruded portion of the cavities, present agreements with the *Pherusa* of Lamouroux[3]; but if the description of that genus be rightly understood, "the cells" differ in their characters, being stated to be tubular in the projecting part, large and compressed below[4], whereas in the chalk fossil they are tubular throughout. Whether such a deviation exist or not, *Pherusa* has no series of secondary pores, and necessarily wants the important peculiarities which are noticed in the following paragraph. As respects *Heteropora*[5] and *Siphoniodictyum*[6], it may be sufficient in this place to remark, that in the former genus the primary tubes are

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[1] Lamarck, edit. 1836, t. ii. p. 284, *Ret.? ramosa.*

[2] Consult M. M.-Edwards, Mém. sur les Crisies, &c., art. *Hornera*, Ann. Sc. Nat. 2nde série, Zool. t. ix., or Recherches sur les Polypes.

[3] Exposition Méthodique, p. 3. tab. 64. figs. 12–14; also Hist. Polyp. corallig. flexibles.

[4] Hist. Pol. coral. flexibles, English Trans. p. 52.

[5] Man. d'Actinol. p. 417.

[6] Journ. Geol. Soc. Lond. vol. v. pp. 90, 94 *et seq.*

distributed over the whole surface; and in the latter the secondary pores are also disseminated over the back as well as the front of the branches.

The point which peculiarly demands attention in an attempt to assign the present subject of examination to a generic position, is the nature of the secondary pores, the composition of the coral being extremely simple, and the visceral cavities presenting no marked peculiarities. These minor openings belong, as already stated, to a tubular structure, which differs from the visceral cavities only in dimensions. They varied in number in different specimens, and in different portions of a specimen, being prevailingly fewest near the upper extremities of the branches and of the lateral pinnæ; and most abundant on the sides and in the axillæ, occupying in those positions the whole surface (figs. 3*a*, 3*b*); but along the front of the ramifications, the number depended on the distance between the abdominal cavities, being least where the interspaces were small, and entirely wanting when the cavities were separated only by their parietes. In longitudinal sections nearly coincident with the centre of a branch, small pores were likewise very rare. Viewed generally, a marked distinction was apparent between their dimensions and those of the apertures to the visceral receptacles, but some among them bore the semblance of partially matured abdominal tubes. It is nevertheless believed that no conversion from one condition to the other took place; and this opinion appeared to be supported by the observed nature of the component parts of the coral. The abdominal cavities to the extent observed in prepared sections (figs. 4*b*, 4*c*) obtained rapidly their full transverse area; whereas the minute tubuli maintained their narrow dimensions. The conical extremities of the off-shoots consisted moreover almost entirely of large tubes (fig. 3 *a*), and supported the inference of an early perfecting in that character; while the manner in which the size of the branches augmented, strengthened, it was conceived, the conclusion respecting a functional difference between the two sets of tubes. A branch situated near the upper extremity of the specimen represented by figure 3, but which had acquired sufficient maturity to have numerous secondary pores, had a breadth of $\frac{3}{4}$ of a line with a depth of one line; while another main branch near the base of the specimen a line and a quarter in breadth, had not markedly increased in depth, indicating a want of relative augmentation, or a greater development of visceral cavities on the sides of the branches than in the middle; as well as that a sufficient upward increase had not taken place to admit of more than a very limited amount of interpolated abdominal tubes. An examination of the same specimen with reference to the distribution of the pores, showed likewise a marked difference between an early arrangement and of a more advanced state of production. In the former condition, and along the middle of the branches (fig. 3 *a*), the equivalent representative, the large apertures were disposed longitudinally though not lineally, conforming to the lengthwise growth of the coral; whereas on each side of this band they were for the greater part distributed in transverse rows (fig. 3 *b*), the component tubes issuing laterally, and apparently from near the back of the branch; and this mode of production will account for the disproportionate augmentation of breadth. Besides, were all the minor tubes in the front of a branch successively converted into greater, their abundance at the base of the coral would indicate a long-continued growth of previously matured cavities in the oldest portion; a property which, it is believed, does not exist among *Bryozoa*, even in the genus *Tubulipora*. The lateral shoots were considered as affording also evidence of the abdominal tubes having been original, or distinct structures. They sprang, as shown in figure 3 *b* and in prepared sections (fig. 4 *d*), from the portion of the side immediately adjacent to the back; and consisted in that position almost solely of tubes of nearly full transverse dimensions. Lastly, the tubuli composing the perfected sides and axillæ of the branches, presented no indications of intermediate sizes. From these statements it is believed, that though structurally identical except in diameter, the two sets of pores or tubes were permanently occupied by portions of the polype, which performed essentially distinct functions.

With regard to genera which are furnished with two series of apertures, the nature of the subordinate set in *Heteropora* is doubtful. Some of the typical species, as *Het. cryptopora*[1] and *H. anomalopora*[2], possess apparently pores of every intermediate size; and the same may be said of *H. conifera*[3] and *H. dumetosa*[4], while *H. dichotoma*[5] exhibits, as delineated, two very distinct sets. Whatever may be the true nature of those openings, or of the structures connected with them, the depictured characters convey no idea of tubuli inclined against the surface of the branch, a marked property in the cretaceous fossil. M. Michelin has placed in the genus *Ceriopora*[6], a coral which has also two sets

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[1] De Blainville, Man. d'Actinol. p. 417; Goldfuss, Petref. *Ceriopora cryptopora*, tab. 10. f. 3.

[2] *Ibid. Ibid.* tab. 10. f. 5.

[3] Milne-Edwards, Lamarck, ed. 1836, t. ii. p. 318; also Lamouroux, *Millepora conifera*, Exposition Méthodique, tab. 83. figs. 6, 7.

[4] Lamarck, edit. 1836, t. ii. p. 317; Lamouroux, tab. 82. figs. 7, 8.

[5] De Blainville, *op. cit.* p. 417.

[6] Iconog. Zoophytol. p. 124. pl. 32. fig. 7.

of pores; but if in the notice on *Atagma* its characters are rightly understood, no generic identity exists between *Cer. papularia* and the fossil under consideration; and the latter is perfectly distinct in every particular from the genus *Ceriopora*. Under the term *Petalopora* another zoophyte is described in a preceding page, as supplied with a secondary series of pores; those openings however, or the canals with which they are connected, penetrate horizontally into the branches, and in the general composition of the coral very marked deviations from the one forming the subject of the present notice are apparent. Again, in an article on some Atherfield zoophytes[1], the designation *Siphodictyum* is applied to a *Bryozoon* which has a large and a small set of pores, but the characters of the latter are dissimilar from those of the chalk coral, though the two extinct polyparia agree in having the apertures to the visceral cavities on only one surface of the branches. The compiler of these memoranda is not aware of any other published genus of *Tubuliporidæ* which possesses an analogous bifold structure. Of its existence in many unexamined cases, no doubt can be entertained; but wherever it occurs, the properties of the subordinate openings must be studied with reference to the interior of the zoophyte, including all the component parts; and in no case can the mere intermingling of large and small apertures justify the assigning of a specimen to M. de Blainville's genus.

The lateral shoots present characters deemed worthy of attention. These offsets were very numerous, but their growth, both longitudinal and lateral (figs. 3, 4), depended evidently on the extent of the interspace, for the increase in either direction had almost invariably ceased, when a certain proximity had been obtained, many of the shoots having a conical outline, others an almost lineal form, and several were merely rudimentary; and no perfecting of the sides of the pinnæ by the formation of a surface composed wholly of tubuli was observed, indicating not only a cessation in the completion of visceral receptacles, but an entire limitation of polype development. These peculiarities prevailed in even the lowest part of the specimen. Figure 4, which represents a dorsal surface, shows longer lateral shoots; but the intervals are greater, while many similarly restricted instances are observable.

It must be also stated, that changes resulting from age were of a limited nature in the specimens examined, the pores remaining open even at the very base of the supposed oldest example (fig. 3); and the only observed alteration being in the intermediate substance.

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[1] Quarterly Journal of the Geological Society of London, vol. v. p. 90 *et seq.*

Believing that on the grounds stated above, the fossil is not admissible into any established genus known to the author, the designation *Homœosolen* is proposed for it, in allusion to the composition (ὁμοῖος *similis*, σωλὴν *tubus*).

Homœosolen, n. g.

Tubular, fixed, tubes of two sorts—one large for the viscera, the other small—variously intermingled, both inclined in the same direction, partially visible on the surface, or wholly concealed, limited to one side of the coral; mouths simple tubular extremities; back without pores, composed of a continuous lamina.

Homœosolen ramulosus. (Tab. XVIII. B. figs. 3, 4 & 5.)

Branched, lateral shoots numerous, variable in extent, sometimes rudimentary; rarely if ever anastomosed; apertures to large tubes disposed longitudinally along the centre of branches, generally in transverse rows adjacent to the sides; secondary openings varying in number according to amount of interspace, most numerous on perfected sides and in axillæ of branches; exposed portion of each set of tubes inclined upwards or against the branch; when perfect semicylindrical; within the branches and on the sides inclined more or less towards the surface; reverse side, a thin lamina variously ridged.

Eight specimens of different dimensions were examined. Two of them, obligingly lent by Mr. Bowerbank, are represented by figures 3, 4, and the remaining six belonged to Mr. Dixon's cabinet. Some differences of character not wholly assignable to opposite surfaces are visible in those figures, the breadth of the branches being chiefly dissimilar, also the length as well as the number of the lateral shoots; and as they distinguished the whole of Mr. Dixon's series, they ought therefore apparently to be regarded as belonging to the normal condition of the coral. In those specimens the minor pores were likewise generally less numerous than in the example figure 3. Nevertheless no differences considered of sufficient importance to warrant specific separations were observed; and one specimen in Mr. Dixon's collection, which gave a front view, presented an approximate thickness in the main stems. The little example (fig. 5) is moreover believed to exhibit only a young condition, the visceral and other tubes having full dimensions; and the small intervals for increase of breadth in the branches are not very different from those which existed in the large specimen figure 4, where the stems at the lowest extremity are aggregated and partially united so far as the back lamina is concerned, though elsewhere a want of anastomosis is apparent.

Four of the specimens exhibited portions of a root, or the part of the coral immediately adjacent to that structure (figs. 3, 5). The root itself was composed of the small tubuli, and the best example (fig. 5*) presented a short thickish stem with a slight but fractured expansion at the base, the under side of which had been moulded upon a rough convex surface. From this base the branches in all cases diverged almost horizontally or at an approximation to a right angle ; but the development was apparently unequal, as if the root had been attached to a more or less vertical surface, and the coral had grown upwards, and to a certain degree laterally but very slightly in an opposite, which would have been a downward, direction. This supposition, if correct, would account for the apparently horizontal position of the branches, and allow of a cyathiform mode of growth, if a base had been attached to a suitable surface. The mode of branching was essentially lateral, no direct bifurcation having been noticed, but the development of shoots was very unequal, depending clearly on the amount of interspace, and being entirely wanting where two parallel branches were in close proximity. Where most regularly produced, the pinnæ issued alternately on opposite sides, and when space permitted them to assume the character of secondary branches, they gave off in their turn other pinnæ, the only limit to ramification depending on the intervals. So far as was observed they sprang from near the back (figs. 3 *b*, 4 *d*), and consisted almost wholly of large tubes. On some few occasions branches touched, but without perfectly anastomosing, the points of contact being generally the extremity of one branch and the side of another. The surface characters of the tubes, particularly of the larger series, was seldom well exhibited. In the best preserved cases it presented a semicylindrical, thin lamina of variable extent, projecting more or less boldly, and covering the furrow which extended upwards from the usually preserved aperture, the true mouth being a simple tubular extremity. The characters of the small tubuli were often well shown on the sides of the branches (fig. 3 *b*), and exhibited, as before stated, no essential deviations except in size from the visceral tubes. The general characters of the interior of the coral may be gleaned from the sections, figs. 4 *b*, *c*, *d*. The first (fig. 4 *b*) exhibits the termination of a young branch, and consists almost wholly of abdominal cavities with thin parietes ; the second (fig. 4 *c*) gives the composition of a mature branch, not far from the middle and nearly equivalent in position to the preceding young case, and it exhibits numerous partially exposed large tubes with greater intervals, due partly at least to the section passing through side walls ; but a few small tubuli also are interspersed ; and the figure (fig. 4 *d*) represents a side of the same branch not very deeply worn down, major tubes being comparatively few, and tubuli very numerous. The commencement of a side branch is also shown close to the back.

The only signs of an exterior affected by age occurred in the specimen fig. 3, (fig. 3 *c* gives a portion on an enlarged scale,) which, except near the upper extremities of the main branches, presented no furrows or tubes deprived of their outer lamina, but oblique, oval apertures, surrounded by the intermediate structure ; and this condition is believed to have arisen from an increase in that portion of the coral, whereby the part of the tube which in earlier stages was exposed became overlaid.

The fossil represented in Tab. XVIII. B. figs. 6 to 6 *g*, consists of numerous, long, diverging and anastomosing branches, which are slender, round, smooth and simple in their composition during an early state, but afterwards thick, verrucous and complex by the addition of unequal cellular layers ; the mouths of the cells are round or oval, and often truncated at the proximal extremity, not raised, irregularly distributed, and closed under certain conditions ; internally the cells are elongated and inclined downwards, and centrally in the younger or axeal portion of a branch, but in the wart-like additions they are short and variously inclined ; the intermediate structure is porous or reticulated.

In some of the preceding particulars the English coral resembles M. Michelin's *Ceriopora papularia*[1], found in the "craie chloritée" of France, as in the general mode of growth, the external characters of the branches, the two sets of pores, and the thickening by irregular layers being similar ; but in a specimen of *Cer. papularia* liberally presented to the compiler of these memoranda, the earlier conditions of the fossil were not exhibited, nor are they delineated in figs. 7 *a*, 7 *b*; no traces also of cellular mouths closed by an appendage like that noticed in a subsequent paragraph were detected, though M. Michelin says the pores "dans certains états de pétrification sont invisibles." The want however of ascertained agreements in those two points, the means of comparison being moreover limited, is not deemed sufficient to separate the English fossil from the French generically or even decidedly as respects the species ; nevertheless it will be necessary to offer a few remarks on the assignment to *Ceriopora*.

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[1] Iconog. Zoophyt. p. 124. pl. 32. f. 7 *a*, 7 *b*.

That genus was proposed by M. Goldfuss for numerous zoophytes, and he ascribed to it the following leading characters:—enveloping layers of cells, the cells being tubular or sub-prismatic, sub-contiguous, parallel or diverging (Petref. p. 32). The name *Ceriopora* has been retained by M. De Blainville, M. Milne-Edwards, and other authorities, but limited by the first to four[1], and by the second positively to only two[2] of the original species; one of those regarded by M. Edwards as doubtful has been also removed by Prof. Goldfuss to *Stromatopora* (Petref. p. 215, observations on *Strom. polymorpha*). M. De Blainville's characters, adopted by M. Milne-Edwards, are poriform, round cells, irregularly distributed, and forming by their union and accumulation in concentric layers a calcareous, polymorphous coral. One of the retained species (*Cer. micropora*), as delineated by Prof. Goldfuss[3], consists evidently of concentric strata (*loc. cit.* fig. 4 *b*), conformable to each other, and composed of oval cells (fig. 4 *c*); the terminating apertures being round (fig. 4 *d*), and so far as can be ascertained they constitute direct openings into the cells: no secondary pores are represented, the small interspaces having apparently a solid composition. Another species absolutely retained, *Cer. polymorpha* (*op. cit.* pl. 10. f. 7 *a* to 7 *d* and pl. 30. fig. 11), presents diversities of form; but the layers are stated to be not thicker than paper (p. 34, *obs.*), and the cells are said to be round and of equal dimensions (pl. 10. fig. 7 *d*); the apex of the warts also to be hollow (pl. 10. fig. 7 *b*). The structural objections mentioned with reference to *Cer. micropora* apply equally to this coral. M. De Blainville's last species, *Cer. compressa* (Goldf. pl. 11. f. 4 *a*–4 *b*), is not retained by M. Milne-Edwards, and it presents peculiarities of composition, which would require a careful investigation before its true nature could be determined.

If the characters of the *Cerioporæ* noticed in the preceding paragraph be compared with those of the English chalk fossil, numerous essential differences will be evident. The surface-openings in M. Goldfuss's figures are uniform in size (pl. 10. f. 4 *d*, pl. 10. f. 7 *d*); it is likewise stated as respects *Cer. polymorpha*, that the "cells" (apertures) are of equal dimensions (p. 34). M. De Blainville moreover proposed the genus *Heteropora* for certain *Cerioporæ*, which have "two sorts of pores" (Man. d'Actinol. p. 417). The chalk fossil has clearly two sets,

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[1] Man. d'Actinol. p. 413.

[2] Lamarck, 2nd ed. 1836, t. ii. p. 313. Consult Observations on *Cer. verrucosa*.

[3] *Op. cit.* tab. 10. f. 4 to 4 *d*, also Man. d'Actinol. pl. 70. f. 2, for representations of the original figures 4 *a*, 4 *d*.

nevertheless it is not a *Heteropora.* No allusion is made in either the 'Petrefacta' or in the 'Manuel d'Actinologie' to an intermediate structure, an exceedingly important part, whether simple or otherwise, when the viscera and oral appendages are regarded as only portions of the polype. The coral under consideration has, however, a complicated intercellular composition, and on it depended the peculiarities of the protuberances with the unconformable position of the cells successively accumulated. An intermediate animal structure necessarily existed in *Cerioporæ*; but if the encrusting series of visceral cavities be regular and uniform[1], the portions of the polype which produced the general framework, and prepared the receptacles for the digestive organs, must have been differently constituted from those of Mr. Dixon's coral. Again, no allusion is made to the apertures differing in outline or size from the cell, or to their being covered under any condition by a solid, calcareous plate, the whole upper surface having possibly been membranaceous and perishable; but in the English fossil, though the cell near its upper termination is round and ample, yet the aperture is variable in shape, of limited dimensions, and often provided with a solid covering in both young (fig. 3 *b*) and thickened branches. The cells likewise present many marked differences. In *Cerioporæ* they apparently maintain a constancy of character; while in the cretaceous production, they have in the centre of a stem an attenuated, downward extension of considerable range, conforming in this respect to the upward growth and circumscribed area of the axis; whereas in the added protuberances, the cells are relatively short, and variously disposed, often radiating horizontally but irregularly from a centre; the successive increments also being totally unconformable. This aggregate of differences is considered sufficient to warrant a separation from *Ceriopora*; and as the observed structures are not known to co-exist in any established genus, it is proposed to distinguish the chalk zoophyte by the term *Atagma* (α deprivative, *τάγμα ordo*), in allusion to the want of agreement in the position of the cells, constituting successive layers.

Atagma, n. g.

Cellular; cells variable in shape, grouped in cylindrical branches and irregularly accumulated in successive layers; mouth operculated; intermediate structure porous.

Atagma papularium. (Tab. XVIII. B. figs. 6 to 6 *g*.)

Branched; branches dichotomous, the first formed or axeal portion round and

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[1] Consult Goldfuss, *Cer. micropora*, pl. 10. figs. 4 *b*, 4 *c*.

smooth, thickened surfaces with broad protuberances; cells in the axis elongated downwards occupying wholly the central area, slightly and regularly inclined outwards; in external additions range of cell limited, position very variable; aperture arched at the distal extremity, sometimes nearly straight at the proximal end, margin not raised, position uniform in unthickened branches, very irregular in thickened; operculum solid, surrounded by a furrow; intermediate structure reticulated or porous.

Ceriopora papularia, Michelin? Iconographie Zoophytologique, p. 124, pl. 32, fig. 7.

The fine specimen submitted to examination (fig. 6) consisted of numerous dislocated branches, but without a trace of a base. It was five inches in one direction, two in another, and nearly three in the third. The branches diverged generally at a considerable angle, and occasionally anastomosed. The longest fragment measured 3¼ inches, and presented two bifurcations. The mode of branching appeared to be almost invariably by terminal subdivisions, and not by lateral shoots; the plane of divergence, to the extent ascertained, was also nearly similar in successive partitions. The measured axeal branches did not exceed a line in diameter; while the corresponding dimension of the most thickened was three lines, every intermediate breadth occurring in the specimen. It was not possible to reduce the increments to regular concentric layers, though transverse sections gave sometimes the semblance of such an arrangement: even in those cases, however, the circle was never complete; and in vertical sections, the greatest irregularity was manifest (fig. 6 *e*, *f*). There was nevertheless what might be termed successive levelings, effected apparently by the intermediate structure. Purposely worn-down specimens often exhibited a seemingly partial absence of visceral cavities, but this character was conceived to be due in part to unequal mineralization. Operculated or solidly closed apertures would necessarily present great impediments to infiltration, and the cavities thus provided would be less liable to a complete filling up than those not similarly guarded. In one case, the calcareous matter carried inwards by water through the textile pores would afford only pure crystallizable carbonate of lime; whereas in the other, the open apertures would admit particles of chalk, which by aid of the crystalline matter would assume a character very like that of the solid portions of the coral. Only one instance of what was regarded the termination of a branch deprived of vitality during development was noticed. It was worn, but presented an obtuse cone, the apex of which consisted of numerous minute tubuli, the commencements or inferior extremities of visceral cavities ; and lower down occurred larger openings, while the cylindrical edge gave regular-sized apertures.

The cellular mouths of unthickened, axeal portions had a somewhat quincuncial arrangement (fig. 6 *b*) ; and they were strictly conformable to each other in situation, as shown by the position of the proximal edge ; the slightly abraded surface of such specimens gave also a similar distribution, or even one more decided (fig. 6 *c*). Immediately below the nearly straight edge was generally a limited area (fig. 6 *d*), distinguishable likewise where the operculum existed, and when added to that plate, or to the open aperture, it made up an oval, which strictly agreed with that of an abraded cavity. This minor structure is considered of importance, as it proves that the cellular mouths were constructed at a particular period ; and its existence independently of the plate which occupied very many of the openings, supports the inference of that covering being truly an operculum. Immediately within the margin of the aperture (fig. 6 *b*), or between it and the closing plate, was a well-defined furrow, and no clear indications of a progressive filling up from circumference to centre were observed. In a few cases the surface extremity of the cavity was wholly occupied by a layer similar to that which constituted the small space below the regular mouths ; but these instances were considered one of the abnormal developments common in zoophytes. The operculum exactly fitted the apertures, and, though of very frequent occurrence in unthickened branches, it was often absent. It will recall to mind Ellis and Solander's delineation of the equivalent appendage in *Myriopora* or *Millepora truncata*[1], but in the recent coral it is horny, while in the extinct it was evidently calcareous. The slender form of the cavities in the middle of a branch (fig. 6 *d*) was apparently ill-adapted to digestive organs folded back upon themselves ; but possibly the long and confined character of the cell in that portion of the coral was an adaptation to a branched mode of growth ; and the viscera were most probably not developed till the cavity attained its full diameter. In thickened stems covered with protuberances (fig. 6 *e*), the outline of the apertures was less regular than in axeal portions, being often round ; and they had also occasionally a raised margin. In those points agreements will be found with M. Michelin's enlarged delineation (*op. cit.* pl. 32. fig. 7 *b*), and the irregularities, if such they may be called, were due apparently to the deviations in plan of growth. The position of the mouth also, as shown by the proximal edge, varied throughout, according with that of the cell, or the nature of the protuberance, and not

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[1] Natural History of Zoophytes, or Lamouroux's Exp. Méthod. tab. 23. f. 1–8.

with an elongated development of the coral. Several opercula were observed, but they were less abundant than in axeal branches. In the thickest and apparently oldest examined fragment (fig. 6 *g*) the surface characters were obscure, and to a great extent obliterated by an overlying layer, secreted by the polype itself, and not adventitious. Figures 6 *c*, *d*, *e*, *f*, fully illustrate the form, range and variable position of the cells in thickened branches unequally worn down; and the diversities might clearly have been as numerous as the sections which the specimen would have afforded.

The intermediate structure changed in aspect with the condition of growth. In the direct centre of an axis it was small, but it gradually acquired importance as the visceral cavities radiated, constituting on the surface of unthickened fragments a prominent feature (fig. 6 *d*). The pores were very numerous and variable in form as well as, dimensions; they were generally also open, but often partially or wholly closed, and the boundary slightly projected. Their inward range was not ascertained; and their characters in thickened branches were generally very indistinct, either from mineralization or friction. To the portion of the polype which occupied this intermediate structure, no doubt the successive additions were due; and a comparison of the peculiarities exhibited by the latter, with those of other genera which have also outer increments, furnished or not with visceral cavities, will impress upon the mind the importance of a frequently neglected part of a coral.

According to M. Milne-Edwards's classification, *Atagma* on account of its operculum must be regarded as referable to the family *Escharidæ*[1].

Marginaria Roemeri. (Tab. XVIII. B. figs. 7, 7 *a* to 7 *c*.)

Incrusting, cells egg- or pear-shaped, surrounded by a furrow; aperture large, semi-oval, arched margin thick, slightly raised, proximal margin nearly straight, very thin, depressed; exterior covering to the cell nearly flat or very slightly convex, sloped downwards towards the aperture; gemmuliferous capsules semiglobular, resting wholly on the next succeeding cell.

The fossil (fig. 7) to which the above characters are applied, possesses apparently the structures assigned to *Marginaria* by Herr Roemer[2]; it even agrees with his species *Marg. denticulata*[3], except that it wants the tubercle on the

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[1] Mémoire sur les Tubulipores, Ann. des Sciences Nat., 2nde série, Zool. tome viii., or Recherches sur les Polypes, p. 5.

[2] Verst. Norddeutsch. Kreidegeb. p. 12.

[3] *Ibid.* p. 13. tab. 5. fig. 3 *a*, *b*.

proximal margin of the aperture. The specimen submitted to examination by Mr. Dixon incrusted an *Ananchytes*, which was found by the Marquis of Northampton in a chalk-pit at Houghton ; and it afforded some additional information to the account of the genus already published. In the remarks on *Escharina? intricata*, allusion is made to certain corals figured by Goldfuss[1] as *Celleporæ*, but assigned to *Marginaria* by Herr Roemer, and characterized, so far as delineated, by having the interior of the cell completely exposed, as well as its outer limits defined by a furrow. The coral immediately under examination afforded many examples of similarly uncovered cells, the defect being however evidently due to injury; besides innumerable tracings or lace-like ground-plans from which all superstructures had been removed by abrasion ; but it gave also instances near the margin of some portions of the specimen of cells equally open from immaturity, and others with a narrow lamina at the proximal end, indicating that the covering was commenced at the extremity and not laterally. Another point on which the specimen supplied information, and one of greater importance, was the existence of gemmuliferous or ovi capsules. These structures were of limited occurrence and small dimensions. The form was semi-globular (fig. 7 *b*), and they were entirely situated on the surface of the next cell, leaving the mouth of that with which they were functionally connected totally free from impediment. Their own aperture was a small segment of a circle. It may be further stated, that the specimen which was distributed over a large portion of the *Ananchytes*, exhibited no external changes due to age, the furrows remaining constantly well defined ; nor were any satisfactory examples detected of a normal filling up of the mouth.

Very few remarks respecting minor details can be submitted to the reader's consideration. The cells in regularly developed portions (fig. 7 *a*) were arranged with great uniformity in alternate rows, and exhibited considerable agreement in size and shape, exactly adapting themselves to the outline of those immediately adjacent. The length of the cells was rather less than a third, and the greatest breadth was about one-eighth of a line, the mature aperture occupying half the area. Where the growth of the coral had been greatly disturbed, the deviations in form and construction were often so considerable as to present no resemblance to the normal condition, exhibiting sometimes a slightly concave or convex surface with a central foramen or no mouth, and in other cases an outline approaching that of a spherical triangle (fig. 7 *c*). The boundary furrows did not penetrate

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[1] Petref. *Cell. velamen*, tab. 9. fig. 4, and *C. bipunctata*, tab. 9. fig. 7.

deeply downwards, the walls of adjacent cells being structurally united; and where irregular interspaces occurred they were solidly filled up. The attempts to detect connecting foramina in the walls totally failed. The back lamina of the cell was very thin, the minute papillæ of the *Ananchytes* rising through it.

On the same Echinoderm occurred specimens of *Flustra? inelegans* and *Escharina? intricata.*

Escharina? intricata. (Tab. XVIII. B. figs. 8, 8 *a*, 8 *b*.)

Incrusting; cells arranged in alternate rows or irregularly, not successively overlaid; form oval, boundary a furrow; perfect, surface convex, with a foramen near the centre; mouth at the distal extremity, ovarian capsule a distinct chamber between successive cells.

The genera with which this fossil presents points of agreement, are *Marginaria* of Herr Roemer[1], and *Escharina* of M. Milne-Edwards[2]. The former is stated to consist of an incrusting layer, composed of cells with thick, distinct edges, separated by a furrow, the covering being flat and often quite wanting. Herr Roemer refers to his genus the *Cellepora Velamen* as well as *C. bipunctata* of M. Goldfuss[3]; and Herr Geinitz[4] the *Cellep. elliptica* of Von Hagenow. If the delineations of those zoophytes be compared with figure 8, illustrative of Mr. Dixon's coral, an agreement will be found in the large open spaces, bold boundaries and surrounding furrows or interspaces; and to that extent the English fossil accords also with the generic characters: but the figures of the foreign species can be only regarded as representing either immature states, or cells deprived of their external covering, whether calcareous or membranous; and the open areas of Mr. Dixon's coral, shown in figure 8 *a*, undoubtedly had been divested of a solid lamina. Imperfect conditions also, from whatever cause they may arise, are not by themselves grounds for generic determinations; and without questioning the correctness of Herr Roemer or Herr Geinitz's decision, no zoological identity ought to be established between the figures quoted or given by them and the English fossil. Moreover, a flat exterior is one of the characters of *Marginaria*, and the enlarged representation of *M. denticulata*[5] has a level surface; a projecting boundary wall in a mature state is another, the plate forming the exterior being situated below

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[1] Verst. Norddeutschen Kreidegeb. p. 12. tab. 5. f. 3.

[2] Lamarck, ed. 1836, t. ii. pp. 217, 230.

[3] Petrefacten, p. 26. tab. 9. f. 4. and p. 27. tab. 9. f. 7. Locality for both species Maestricht.

[4] Charak. Petref. sächsisch-böhmischen Kreidegeb. p. 93. tab. 22. f. 16 *a*, B.

[5] Roemer, *op. cit.* tab. 5. f. 3.

or within the edge ; but in the fossil under examination, a perfect exterior is convex, and the lamina composing it springs from the margin of the boundary, and so totally conceals the side wall, that adjacent complete cells exhibit shield-like discs surrounded merely by a furrow. M. Milne-Edwards[1] has besides referred *Cellepora Velamen* and *C. bipunctata* to *Discopora* as limited by himself[2]. One of the essential characters of that genus is, however, an almost or entire obliteration of the outline of the cells, so that the free surface of the coral " ne présente que de faibles ondulations dans les lignes correspondantes à leur soudure, et que la position de ces loges n'est guère indiquée que par leur ouverture[3];" on the contrary, in the fossil forming the subject of this notice, such a condition was detected only where irregularities prevailed. M. De Blainville[4], again, includes *Cellepora bipunctata* among his extinct *Membraniporæ*, but in recent types of that genus the exterior is never wholly composed of a calcareous layer; and whatever may have been the mature condition of that fossil, the chalk coral had undeniably an earthy lamina which extended over the whole area of the cell. The foregoing statements, although very limited with reference to component structures, justify it is believed the inference, that Mr. Dixon's zoophyte is not a *Marginaria*, a *Discopora*, or a *Membranipora*.

The characters of *Escharina* (M. Edw. *op. cit.* p. 230) are, cells more or less calcareous, regularly and horizontally arranged in incrusting layers, and partly superimposed or not; surface convex; boundary always visible and without a projecting edge, aperture lateral rather than terminal; and it may be added, that in immature and abraded states, the surface of the cells presents open areas, bounded by the edge of the side wall; while in some species an irregular furrow occurs similar to that of *Marginaria*. On submitting the chalk fossil to the test of these characters, the cells will be found to be horizontally situated, forming a single layer, to have a convex surface when perfect, and in that condition to be bounded only by a furrow; while immature or abraded exteriors display closely analogous appearances to those mentioned above: and to the extent observed, the circumference of the cells was not obliterated in aged states by external additions. These points of agreement might be regarded as constituting a sufficient approximation towards a generic identity; the manner however of developing the outer, calcareous lamina remains to be ascertained, especially when studied

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[1] Lamarck, ed. 1836, t. ii. p. 253. †16 & †18.

[2] *Ibid.* pp. 218, 247.

[3] Consult Goldfuss, tab. 36. f. 11 (*Cell. annulata*), for one of the fossils assigned to the genus by M. Edwards, Lamk. t. ii. p. 253, † 15.

[4] Man. d'Actinologie, p. 447.

in connection with the small swelling regarded as an indication of the true mouth; also the probable nature of the central foramen.

Of figured ascidian corals which present a central foramen, more or less analogous to that of Mr. Dixon's coral, may be mentioned *Eschara dubia* of M. Milne-Edwards[1], *Escharites incrustata* of Herr Roemer[2], and *Vaginopora fragilis* of M. DeFrance[3]; yet no structural agreement is believed to exist between those openings and the large pore of the coral under examination, the former being clearly more or less altered, true apertures, whereas in the present case the mouth is conceived to have been situated at the distal extremity of the cell.

Though a fully satisfactory identification with *Escharina* could not be established, yet as a greater number of resemblances were noticed than with any other genus known to the author, it is deemed most advisable to assign the coral provisionally to it[4].

The only specimen which was examined, incrusted a *Micraster*, and part of its irregularities were possibly due to the nature of the subsurface. The area occupied by it was rather more than half an inch square, the margin being to a certain extent quadrilateral; but there was an evident divergence from a centre. The perfectly covered cells were unequally distributed, and fully as abundant near the boundary of the specimen as towards the middle; they were also occasionally wanting throughout relatively large intervals, which presented only cavities analogous to those of *Marg. elliptica*, *M. Velamen* and *M. bipunctata*. Such of the marginal cells as exhibited apparently an early state of development had rudiments of a side wall, but no distinct back lamina, the small papillæ of the *Micraster* being quite visible: in cases a little distant from the extreme edge, the periphery had its full dimensions; and proofs of a furrow and of a back wall were also shown. The characters of uncovered cells, whether in a supposed immature condition, or deprived of their exterior by abrasion, are given in fig. 8*a*. The progressive steps by which the outer covering was formed were not observed, but the lamina was possibly developed from the sides to the centre; or if the

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[1] Mémoire sur les Eschares fossiles, Ann. Sc. Nat. 2nde sér. Zool. t. vi. pl. 12. f. 17 *a*.

[2] Verst. Norddeuts. Kreidegeb. p. 17. tab. 5. f. 8; not f. 10, a misprint in p. 17.

[3] De France, Dict. Sc. Nat. t. lvi. p. 428; or De Blainville, Man. d'Actinol. p. 441. pl. 72. f. 3, 3 *a*: also Michelin, Icon. Zoophy. p. 176. pl. 46. f. 22 *a*, *b*.

[4] Objections have been made to the word *Escharina* (see *Lepralia*, Brit. Zoophytes, 1st and 2nd edits.), but as it is employed in the present case provisionally, and as the division of *Celleporidæ*, to which *Escharina* or *Lepralia* belongs, claims an extended investigation, the retention of the name may not perhaps be altogether inaccurate.

exterior was in one condition membranous, the calcareous matter was, it is conceived, successively added in a similar manner, though in neither case always continuously, faint indented lines being sometimes detectable within the area. By whatever means the covering was formed, the construction of the distal protuberance (fig. 8 *b*), representing it is believed the aperture, appears to have been simultaneously effected, as no open space marking a mouth was noticed. At first these small swellings were suspected to be ovarian capsules, but on carefully laying one of them open, no distinct chamber appeared beneath, similar to that represented in fig. 8 *b*+, which is regarded as a true capsule; and on removing the remainder of the covering, the whole interior was found to be a simple cell. They were small and often difficult to detect, the best-defined being a segment of a circle; such examples also consisting frequently of casts of the external lamina. In all cases they were surrounded by a faint furrow, and occasionally a minute central pore could be detected. The foramen near the middle of the exterior of the cell (fig. 8 *a*) occurred very generally, but varied in form, being circular, oval or elongated, also narrow, resembling a slit; and occasionally two foramina were visible, one being situated close to the distal protuberance. Figure 8 *b* + represents what was considered an ovarian capsule. The position of the little chamber is clearly without the cell to which it belonged, having its own boundary, but a channel of communication apparently existed at the upper extremity of the cell.

Flustra? inelegans. (Tab. XVIII. B. figs. 9, 10, 11.)

Incrusting or in free lobes composed of two opposite layers structurally united; outline of cells pear-shaped, truncated at the proximal extremity, boundary a projecting ridge intimately united in adjacent cells; surface wholly exposed, flat or very slightly convex; aperture at distal end, semicircular with a raised margin, and generally a notch at each extremity of the straight side; ovarian capsules semicylindrical, situated partly over the mouth of the cell and concealing it, entrance semicircular, edge sharp; exterior of the cells unaltered by age.

The fossil represented by figs. 9, 10, 11 (Tab. XVIII. B.) possesses in the complete exposure of the range of the cell, the raised, united margins, flattened surface, and to the extent observed, in the unchanging exterior, the characters of true *Flustræ*; while it differs in these particulars, especially the last, from *Escharæ*. The incrusting in addition to the free mode of growth, affords a further agreement with the former genus; and if *Escharæ* be constantly free, except at the base, and always formed of two layers, another distinction between them and the chalk fossil exists. When a *Flustra* is composed of opposite strata of cells, a separation, as is well known, can be effected mechanically; but among existing *Escharæ* and extinct species generally[1] no division with a smooth surface can be made: one of the distinguishing characters between the two genera has moreover been stated to be a want of agreement, as respects position, in one case, and an agreement in the other. In *Eschara foliacea*, however, when the examination was sufficiently extended, numerous deviations occurred; and they could not be regarded as merely exceptions[2]. On instituting a comparison between the structures just mentioned and those of the cretaceous fossil, it will appear, that the resemblance is with *Eschara* in one particular, the opposite layers not being separable with smooth dorsal surfaces; while in the total want of conformity in the situation of the cells the greatest agreement is with *Flustra*. So far as the original composition could be inferred from the mineralized state, it seemed to have been much more calcareous than among *Flustræ*, and the parietes to be considerably thicker. The ovarian capsules of the fossil under consideration were well and abundantly exhibited (fig. 9 *a*), being situated at the distal extremity, resting also partly on the next cell and blending with it, but the forepart in perfectly preserved examples so projected over the mouth of the cell to which it belonged, that that aperture was totally concealed, when the general surface was viewed perpendicularly. In *Flustra foliacea*, usually regarded as the type of the genus, the capsule is similarly placed, but is more crescent-shaped, and its opening (in dried specimens) is sufficiently inclined backward to permit the free egress of the tentacula, if they existed; and Dr. Grant[3] in his elaborate memoir states, that when the ovum has escaped from the cell " a new polype " is produced within the cavity. It would therefore follow that either a portion of the capsule in the fossil was displaced, or the viscera and tentacula were not renewed, provided they had ever been developed. The blending of the capsule with the surface of the next cell indicates its having been formed contemporaneously with the cells; and its highly calcareous nature facilitated the detection of a cicatrice. A few instances of such marks were observed, and their limited number proved, it was conceived, that only certain cells had been ovigerous. Whether they could ever

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[1] For an example of a fossil *Eschara*, with dorsally divided layers, consult M. Milne-Edwards's memoir, Sur les Eschares Fossiles, Ann. Sc. Nat. 2nde sér. Zool. tome vi. pl. 11. f. 8; or Recherches sur les Polypes, &c.

[2] Consult M. Edwards's Mem. *op. cit.* pl. 9. f. 1 *e.* and pl. 11. f. 8 *a.*

[3] Edinb. New Phil. Journ. vol. iii. p. 341–342.

have been provided with viscera and tentacula remains to be shown by investigations among recent *Celleporidæ*; but it must be remembered, that cells, and ova also[1], are produced without the direct agency of those portions of the polype. Among recent and fossil *Escharæ*[2], so far as is known to the author of these notes, the capsule would not interfere with the egress by the cellular aperture; but in some species of existing *Escharinæ* or *Lepraliæ*[3], and in an American cretaceous Bryozoon[4], it is situated as in Mr. Dixon's fossil, directly over that opening. Dr. Grant especially alludes to the lineal regularity of the cells in *Fl. carbasea* (*op. cit.* p. 112); and a similar uniformity appears to pervade the genus as at present limited, also to a great extent recent and extinct *Escharæ*[5]; the relative dimensions of the cells in a species being likewise very constant. The specimens of the chalk fossil, submitted to examination, presented, on the contrary, numerous deviations from a direct lineal succession; also considerable variations in the proportions and outline of the visceral cavities, independent of those which had a spindle-shape and filled narrow interspaces. The incrusting specimen (fig. 9) displayed, as mentioned in a subsequent paragraph, still greater irregularities with proofs of overlying layers, no examples of which have been observed in the very few species of *Flustræ* known to the author; but somewhat analogous cases, though limited in dimensions, have been noticed in specimens of *Es. foliacea.*

Among fossils which present points of agreement with the one under examination, but with cells more symmetrical in form and distribution, may be mentioned, *Eschara pyriformis* and *Cell. hippocrepis* of M. Goldfuss[6], also *Es. Andegavensis* of M. Michelin[7]; likewise *Es. affinis* of M. Milne-Edwards[8], and the *Diastopora cervicornis* of M. Michelin[9]: it remains, however, to be shown whether any of those *Escharæ* undergo the surface-changes which characterise in part that genus. *Cellepora hippocrepis* has been removed by a very high authority to *Discopora*[10] without any additional information; but one of the essential characters of also that genus[11] is an obliteration or want of cellular boundaries, a condition not indicated by M. Goldfuss's figure 3 *b* (*loc. cit.*).

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[1] Edinb. New Phil. Journ. vol. iii. p. 115.

[2] Consult M. Edwards's Memoirs on Recent and Fossil Escharæ, *op. cit.*

[3] Dr. Johnston's British Zoophytes, 2nd ed. p. 301, 1846.

[4] Quarterly Journ. Geol. Soc. vol. i. p. 71, woodcut letter *c.*

[5] Consult M. Edwards's Memoirs.

[6] Petref. tab. 8. f. 10 *a*, *b*; tab. 9. f. 3 *a*, *b*.

[7] Icon. Zoophyt. pl. 78. f. 11 *a*, *b*.

[8] Memoir on fossil *Escharæ*, pl. 10. f. 6. Michelin, *op. cit.* pl. 79. f. 4 *a*, *b*.

[9] *Op. cit.* pl. 56. f. 12 *a*, *b*.

[10] 2nd edit. Lamarck, t. ii. p. 252. no. † 13.

[11] *Ibid.* pp. 218, 247.

A perusal of the foregoing statements will necessarily raise doubts respecting the generic position of the chalk coral; and the difficulties are such as almost constantly occur, when an attempt is made to refer a secondary fossil zoophyte to an existing genus. It has nevertheless been deemed better to assign the cretaceous Bryozoon, most imperfectly investigated, provisionally to *Flustra*, than to propose a new term, leaving to a competent authority, with ample means for inquiring into the characters of the whole of the *Celleporidæ*, living and extinct, the establishing of a final determination.

The free specimens (figs. 9 & 10) were either regularly bifurcated, or had lateral shoots; and one of them (fig. 10) was tinged throughout light-red. The upper extremities of the finer example (fig. 9) were nearly perfect, and exhibited a few immature cavities consisting of strong side-walls, and partially formed upper surfaces. The cells along the sides of the lobes were occasionally of ample dimensions though irregular in form, but others were very small and defective, and plainly unfitted for the reception of digestive organs. Within the area of the specimens, the shape, as before stated, varied considerably, and to the greatest extent in the one which was tinted. The regular cells (fig. 9 *a*) were pear-shaped with a flat or slightly convex surface; and they had frequently a slight furrow-like depression at the foot of the projecting margin. Their position was nearly vertical in the middle of the lobes, but more or less inclined outwards nearer the sides. The interpolated, spindle-shaped cavities (fig. 9 *a*) were numerous, filling narrow interspaces; but they could not be regarded as the precursors of additional rows[1], and their aperture was centrally situated and elongated. The tinted example (fig. 10) seldom afforded regularly-formed cells, but instances were noticed, which perfectly agreed with the most symmetrical of figure 9; the ovarian capsules were also similar, as well as the interpolated cavities; but the projecting boundary-ridges were generally replaced by discontinuous variable furrows.

The incrusting specimen, fig. 11, differed not as respected the normal and abnormal characters of the cells, or the nature of the ovarian capsule from the lobed. The line of growth had extended in every direction so as to envelope completely the body to which the coral was attached; and from mutual interference, want of space or inequalities in the subjacent surface, the deviations in size and outline of the cells were innumerable. There were also many proofs of layers which extended over others; also instances of knobs composed of concentric layers.

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[1] Consult Dr. Grant's remarks on the arrangement of cells in *Fl. carbasea*, Edinb. New Phil. Journ. vol. iii. p. 112.

In the *Eschara foliacea* of the English coast, similar superpositions have been noticed as well as protuberances, but, as before stated, nothing of the kind has been observed among *Flustræ*. Such occasional structures, however, cannot be regarded as essential characters, though their existence to a limited extent, and under certain conditions, as interference from extraneous bodies, or the form of the enveloped substance, would, if the conditions were more influential, give rise to the occurrence, in these and other genera likewise, of specimens in which overlying layers would appear to be the true mode of development. In the Sicilian coral, to which M. Michelin[1] has lately applied the term *Eschara nobilis*, identifying it with the *Cellepora nobilis* of Esper[2], a series of complete envelopments is apparently an essential character; but the mode of incrusting is different, and must be studied in connection with all the component parts of the zoophyte, depending clearly, not on adventitious circumstances, but on the innate properties of the polype.

ADDENDUM TO ANTHOZOA.

Stephanophyllia Michelini, n. s. (Tab. XVIII. B. figs. 12, 12 *a*, 12 *b*.)

Very small, lamellæ alternately simple and trifid at the extremity, upper surface regularly convex from centre to circumference, periphery composed of simple plates, terminations of the lamellæ; under surface indistinctly radiated and foraminated.

The genus *Stephanophyllia*[3] was established by M. Michelin for three tertiary corals found at Astesan and Tortone, one of which had been assigned to *Fungia*, and another to *Turbinolia*. From the former of those genera *Stephanophyllia* is stated to be distinguished by the grouping of the lamellæ (Dict. Sc. Nat. Sup. *loc. cit.*); and there is apparently this difference from true *Turbinoliæ*, that the minor plates diverging from the extremities of the lamellæ issue from the latter, and not from the periphery of the coral. The author of these memoranda is indebted to M. Michelin for specimens of *Steph. elegans* and *S. Italica*; and a comparison of them with the minute chalk coral forming the subject of this notice, proved a perfect structural identity in generic essentials. Three specimens of the cretaceous species were procured many years since from a mass of Sussex or Hampshire chalk by wearing down the block with a soft brush under water, and then letting a stream from a cistern pour into the vessel till the water

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[1] Iconographie Zoophyt. p. 329. pl. 79. f. 1 *a*, 1 *b*, 1 *c*.

[2] Pflanzenthiere, *Cellepora*, tab. 7.

[3] Dict. Sc. Nat. Supplem. tome i. p. 484 (1841); and Icon. Zoophyt. p. 31–33, pl. 8. figs. 1, 2, 3.

became colourless. They are believed to be the first proofs of the existence of the genus in a secondary formation: whether the English fossil which has been assigned to Goldfuss's *Fungia coronula* belongs to it, remains to be shown[1].

M. Michelin states that the characters of the lamellæ in *Steph. elegans* vary with the growth of the zoophyte (Icon. Zoophyt. p. 32). From only three specimens of the chalk coral having been examined, it is impossible to hazard an opinion respecting the characters of fully perfected or aged structures; and the smallest of them, less than half a line in diameter, differed not in composition from the largest, which exceeded very slightly that measurement. The proportion which the latter specimen (fig. 12) bore to the inner area of M. Michelin's figure 2 *a*, the part with which a comparison could only be made, was about one to five. Supposing therefore that an individual of *Steph. elegans* of similarly limited growth were examined in connection with the English coral, and in that state a perfect, structural identity would be evident, still the great difference in the dimensions of every component part would clearly justify a specific separation. The periphery of the fossil under consideration (fig. 12 *a*) was simple, or composed of only lamellæ extremities, whereas in the foreign species just mentioned, it consisted of a curious oval reticulation or union of previously subdivided lamellæ, the whole constituting in the fine specimen examined a nearly vertical boundary of considerable thickness. This outer structure forms apparently a leading specific character. In *Steph. Italica*, though the earliest state of the lamellæ is essentially similar to that of *Steph. elegans* and *Steph. Michelini*, yet in the outer zone, which in that instance is in the same plane as the inner area, the composite lamellæ have two triple subdivisions, while the originally simple plates preserve an unchanged character throughout their range. The centre of the chalk fossil formed the apex of a regular convex exterior (fig. 12 *a*), and was not marked, in its state of preservation, by any peculiar structure. In *Steph. elegans* the centre is depressed, one of the results probably of age or a thickening of the outer boundary; but in *Steph. Italica* the whole of the lamellated area is very slightly convex or nearly flat. The under surface (fig. 12 *b*) was obscurely ribbed or radiated, and had a few indistinct punctures or foraminæ; and presented marked differences, although not well preserved, from both of the foreign species.

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[1] Morris's Cat. British Fossils, p. 38; Goldfuss, p. 50, tab. 14. fig. 10.

Notes on Cretaceous Echinodermata. By PROFESSOR E. FORBES, F.R.S.

STAR-FISHES.

Table of the Star-fishes enumerated in this Work.

Family ASTERIADÆ.

Genus *Oreaster.*

1. coronatus.
2. Boysii.
3. squamatus.
4. bulbiferus.
5. pistilliferus.
6. ocellatus.
7. obtusus.

Genus *Goniaster.*

SECTION I.

(*Goniodiscus.*)

1. rugatus.
2. uncatus.
3. sublunatus.
4. Hunteri.
5. Parkinsoni.
6. Mantelli.
7. Bowerbankii.
8. compactus.

SECTION II.

(*Astrogonium.*)

1. lunatus.
2. latus.
3. Smithii.
4. mosaïcus.
5. Coombii.
6. angustatus.

Genus *Stellaster.*

1. Comptoni.
2. elegans.

Genus *Arthraster.*

1. Dixoni.

Family OPHIURIDÆ.

Genus *Ophiura.*

1. serrata.

Radiate animals of the orders Asteriadæ and Ophiuridæ are seldom found in a fossil state, and when so found are rarely perfect. All star-fishes are fragile animals, and difficult of preservation; hence the scarcity of their organic remains in ancient formations is not to be wondered at. They appear to have commenced their existence at a very early period, for more than one species have been discovered in the Silurian rocks. They are known also as oolitic fossils; it is however in rocks of the cretaceous age that their fossil remains are found in greatest number and beauty.

Living star-fishes are found in various depths of water, and on all varieties of sea-bottom: some live among rocks; such are usually so formed as to adapt them conveniently to their habitat, have long and round arms and well-knit skeletons. Others living upon mud are more or less stellate and flattened. Pentagonal species live in all localities, and those with large marginal plates are usually from the deep sea in our regions, though in tropical countries they are found on the coral sand near the shore and in shallow water.

The skeleton of the star-fish is a very complex and beautiful organism. It is composed of an immense number of little bones (*ossicula*), which are so articulated with each other, as to form a framework of great perfection and elegance. The *ossicula* vary in form in the several parts of the skeleton. The careful determination of their forms is of great consequence to the palæontologist, as no other parts of the animal are preserved in the fossil state. Fortunately the shape of an ossicle is as truly indicative of genus and species among the star-fishes, as that of a bone among the vertebrata; but hitherto little has been done in the study of the skeleton of the Asteriadæ, and fossil species have mostly been defined on purely empirical characters.

Every star-fish presents an upper and an under surface or disc, which in certain tribes are margined by two or more rows of large plates (marginal plates or ossicles). The centre of the disc is of greater or less extent according as the arms which radiate from it are longer or shorter. The surface is covered with a membranous and porous skin supported by small ossicula, various in form and more or less closely placed together. These extend over the surface of the arms also. On one side of the centre is a little plate different from all the others and marked by radiating grooves. This is the madreporiform tubercle; not far from it, in most star-fishes, is a small pore regarded as an anal aperture. The surface of the plates of the disc and arms often bears spines, granules or tubercles; also the curious pincer-like bodies called *pedicellariæ*. At the extremities of the arms the plates are modified to form an eyelid or protecting apparatus for the rudimentary eye which is at the end of each. The centre of the under surface of the disc presents the mouth with its protecting apparatus. In the cavity are the viscera of digestion; from the mouth run as many long grooves as there are arms; they extend to the ends of the latter. These grooves are bordered by peculiar plates (ambulacral plates or ossicula), and mark the course of the aquiferous system of vessels, which in the living animal supply and inject with fluid the contractile tubes or suckers which fill the grooves, and by means of which the creature walks. In the interior of the arms extend the ramified ovaries, which have their openings in the interspaces. The surface of the under disc not occupied by the ambulacral plates is supported by ossicula, similar, but not quite of the same form, with those of the upper surface.

These arrangements are somewhat different in the *Ophiuridæ* or brittle stars. In this tribe the ovaries do not extend into the arms; the disc is round and shaped like a piece of money. It is usually covered with plates and spines, and presents a pair of peculiar plates opposite the origin of each of the five arms; the latter are slender and snake-like, and extend to considerable distances from the body. In the living state the Brittle-stars are very active animals, but very fragile and irritable, casting away and breaking into pieces their arms whenever laid hold of.

Genus OREASTER, *Müller and Troschel.*

Very convex, more or less stellato-pentagonal star-fishes, having strongly constructed skeletons, often bearing on the disc large tubercles or spines. Two rows of large plates form the borders.

This genus is synonymous with *Pentaceros* of Linck, but that name is objectionable, since it has been applied to a genus of fishes by Cuvier and Valenciennes. It formed part of *Goniaster* as defined by Agassiz. The fossil species are found in the upper and lower chalk, and some of them bear considerable affinity to existing forms. Those now living are all tropical, and often of very great size.

Oreaster coronatus. (Tab. XXI. fig. 7, 7 *a*, 7 *b*, 7 *c*, 7 *d*.) R. 4.

Body pentagonal with prolonged arms; disc thick, convex, and coronated with a circle of large, more or less polygonal nodose pyramidal tubercles (spines). Ossicles of disc variable in size and very irregular in shape; those towards the centre for the most part largest.

Arms bordered by two rows of plates (marginal ossicula); those of the superior row transversely oblong, lobed, convex, marginated, centrally punctated and imbricated; the inferior border composed of more regular, very long, curved, margined, obliquely truncated plates. Between the two series are small tubercular ossicles. The summit of the arms is flat, and composed of a central series of depressed, middle-sized, lobed, oblong ossicles with intermediate smaller ones.

Lower chalk, Washington, Sussex. Mrs. Smith of Tonbridge Wells has a beautiful example of this species found in Kent.

Oreaster Boysii. (Tab. XXI. fig. 6.) R. 4, Kent.

Body pentagonal with prolonged arms. Disc convex, with a circle of large, subglobose, margined, punctated tubercles (spines), and intermediate smaller ones, similar but depressed. Rays steep-sided, bordered by oblong, margined, imbricated, centrally punctated plates, forming two rows. There are a few intermediate ossicles on the upper surface of the arms near their bases.

Upper chalk, Kent. The specimen figured was discovered by Major Boys, and formed part of his interesting collection.

Oreaster squamatus. (Tab. XXIII. fig. 7.) R. 4.

Disc and arms similar in shape to *O. coronatus*, the former covered in the centre with large, depressed, conoidal, truncated, polygonal ossicles, of which there are nine and a central one; also a few intermediate smaller ones. The remainder and less convex portion composed of lobed, imbricated, convex ossicles, very nearly of a size. A double series of these, with a single set of small intermediate ossicles, go to form the summits of the arms, the sides of which are formed by a double series of oblique subreniform plates.

Upper chalk, Kent; in Mr. Catt's cabinet.

Oreaster bulbiferus. (Tab. XXIV. fig.27.) R. 2.

Disc very convex, covered in the centre with flat, many-lobed, punctated plates, some of which are very large. Opposite the origin of each ray is a large tubercular, very convex conic plate, with a wide and lobed base. The surface of all these plates is punctated; a few similar plates, but less, and more regular in form, run down the origins of the arms. They gradually decrease and separate the origins of two series of transversely oblong, overlapping, lobed, bordered and centrally punctated plates, which alternate at the sides with a smaller row, and these are succeeded by smaller ones.

The extremity of each ray is swollen into a pyriform shape, forming an eye-protecting apparatus. The summit of this is formed by very large convex, subglobose punctated plates which correspond to those at the origin of the ray. These alternate at the sides with five very large, nearly flat, oblong, similarly ornamented plates, which articulate with others half their size, corresponding to the inferior row; beneath them are others much smaller, which (with minute ossicles) border the avenue, corresponding to the under row. All the plates of the bulbous terminations of the arms are much larger than those to which they correspond, except the last.

This is one of the handsomest and most curious of all the fossil star-fishes. It is seldom seen perfect. One or two living species of *Oreaster* have a similar, but not equal development of the plates at the extremities of the rays. The specimen figured is from Kent, and in the collection of Mr. Catt, who has also an example of this species from Sussex. It is also in the cabinet of the Marquis of Northampton, Mr. Bowerbank, and Mr. Tennant.

Oreaster pistilliferus. (Tab. XXI. fig. 15.)

A species very distinct from those just described, and remarkable for bearing towards the circumference of the disc five elongated, conical, nearly smooth rounded spines or prolonged tubercles; their summits obtuse, round and slightly swollen; their bases much but regularly dilated. The ossicula of the arms are nearly equal and regularly arranged in longitudinal series. Each ossicle is transversely somewhat shuttle-shaped, rather narrow, tumid in the centre, and slightly impressed towards each extremity.

Upper chalk, Kent and Wiltshire.

Oreaster ocellatus. (Tab. XXI. fig. 13.) R. 4.

Large irregular, nodose ossicles in the shape of depressed spheroids with truncated and finely radiated summits, and ocellato-punctated sides; small impressed and angulated ossicula are interspersed.

Evidently the fragments of a very distinct species of *Oreaster*.

Upper chalk, Sussex and Kent.

Oreaster obtusus. (Tab. XXI. fig. 12.) R. 4.

The very obtuse extremities of the arms of an *Oreaster* distinct from any of the preceding. The marginal plates of this species are greatly enlarged, and there are no intermediate central ossicula. The superior marginals are regularly curved, oblong, convex, and punctate; the inferiors are similar, but smaller. Two series of minute ossicles, each of which is furrowed by three grooves, border the avenues; they bear small spines.

Upper chalk, Lancing, Sussex.

Genus GONIASTER, *Agassiz.*

This genus, as established by Professor Agassiz (Mém. Soc. Sc. Nat. Neuchatel, 1835), included all those pentagonal star-fishes which have their margins bordered by a double series of large plates bearing spines, and the upper surface nodulose. The species composing it are grouped by Müller and Troschel in their 'System der Asteriden,' under their genera *Oreaster*, *Astrogonium* and *Goniodiscus.* Mr. Gray's genera *Hippasterias*, *Goniaster*, *Pentagonaster*, *Tosia*, *Paulia*, *Randasia* and *Anthenea*, are synonymous with *Goniaster*, excluding *Oreaster.*

I restrict the name *Goniaster* to the more or less pentagonal or slightly stellate, depressed star-fishes, margined by a double series of large plates which are bordered, or in many cases covered by granules (minute spines); these in fossil specimens are most frequently rubbed away. The avenues are bordered by a double series of short spines; the inner series are transverse and often comb-like. The ambulacral plates are furrowed. In many species the superior lateral plates at the extremity of the arms are enlarged so as to form subsidiary eye-plates. Such have a definite and small number of intermediate laterals, usually 4, 6 or 8. They form the subgenus *Goniodiscus.* The species, in which the lateral plates are numerous and even decrease to the extremities of the somewhat produced rays, may be arranged under the subgenus *Astrogonium.* The fossil chalk species of both genera are most nearly allied to tropical forms.

SECTION I.

Goniaster (*Goniodiscus*) *rugatus.* (Tab. XXI. fig. 2 & 2*.) R. 2.

Body pentagonal, with short angles and nearly straight sides. Superior intermediate marginal plates four, oblong convex, gibbous, rugose in consequence of bearing two, three or more rows of obtuse tubercles, which are sometimes obsolete, and when present form a ridge on their centres. Inferior marginals smooth, or minutely punctate. Superior oculars triangular; not so long or broad as the laterals: in other respects similar to them. Ossicula of disc hexagonal, granulated, unequal.

Not a rare species from the upper chalk; variable. The specimen engraved is from the cabinet of the late Channing Pearce, found in Wiltshire; it occurs also in Kent and Sussex.

Goniaster (*Goniodiscus*) *uncatus.* (Tab. XXI. fig. 4, 5, 8.) C.

Body pentagonal, with projecting angles and nearly straight sides. Superior intermediate marginal plates four, broad, tumid and centrally rugose, with an impressed nail-like border on the inner side: externally sloping, and marked with a broad nearly obsolete groove. Inferior laterals plain, broader than the superior, smooth or minutely punctate. Superior oculars acuminate, triangular, marginate, mitrate, tumid and irregular centrally. Ossicles of disc rather large, hexagonal, punctate. Madreporiform tubercle flat, small, polygonal.

A common species. Easily distinguished by the large, pointed, and as if pinched pair of ocular plates at each angle. Kent and Sussex.

The specimen figured, from Mr. Pearce's cabinet, was discovered in the Wiltshire chalk.

Goniaster (*Goniodiscus*) *sublunatus.*

Body pentagonal, with gently lunated sides. Superior intermediate marginal plates four, nearly equal, plain, smooth or minutely punctate. Inferiors similar. Superior oculars mitrate, large, triangular, acuminated. Ossicula of disc punctate.

Easily distinguished from the last species by its flattened marginals and from the next by its lunated sides.

Mus. Bowerbank, from the white chalk; also in the collection of the Geological Survey.

Goniaster (*Goniodiscus*) *Hunteri.* (Tab. XXI. fig. 1.) C.

(*Goniaster regularis*, Mantell, Medals, vol. i. p. 335, cut 73.)

Body very obtusely pentagonal, sides nearly straight or projecting. Superior intermediate marginal plates four, equal, broadly oblong, coarsely mammillato-punctate, conspicuously marginated. Inferiors similar. Superior oculars large, depressed, rather obtuse, similar to the intermediate laterals, but broader outwardly and slightly tumid. Ossicula of disc hexagonal.

Upper chalk. A very fine species, not uncommon. The specimen figured formed part of John Hunter's collection, and may be seen in the College of Surgeons.

Goniaster (*Goniodiscus*) *Parkinsoni.* (Tab. XXI. fig. 10, 11; Tab. XXII. fig. 4, 5, 7.) C.

(*Asterias regularis*, Parkinson, O. R. iii. t. 1. f. 3.)

Body pentagonal, with gently lunated sides. Superior intermediate marginal plates six, oblong, plain, gently curved, granulato-punctate or nearly smooth, and margined according to their state of preservation. Inferiors wider. Superior oculars triangular, obtuse, as long and much broader externally than the laterals, gibbously convex, sculptured like the rest. Ossicles of disc hexagonal, granulated. Ambulacral ossicula transversely oblong, 3–4-grooved. Oral plates broadly triangular.

The commonest of all the white chalk star-fishes. Parkinson wrongly identified it with the figure and name of a living species.

Upper and lower chalk. Kent, Sussex, &c.

Goniaster (*Goniodiscus*) *Mantelli.* (Tab. XXIII. fig. 11 & 12.) C.

(*Asterias semilunatus*, Parkinson.)

(*Goniaster semilunata*, Mantell, Medals, vol. i. p. 338, cut 75.)

Body pentagonal, with lunate sides and projecting angles. Superior intermediate marginal plates six, oblong, narrow, tumid, abrupt, punctate, marginate: markings distant and coarse, sometimes presenting the appearance of moniliform granules. Inferiors nearly plain. Superior oculars much larger than the marginals, very prominent, punctate. Ossicula of disc punctate.

Some specimens of this not rare upper chalk species approach very near the last, but usually they are easily distinguished.

Parkinson wrongly identified it with the figure and name of a recent species.

Goniaster (*Goniodiscus*) *Bowerbankii.* (Tab. XXII. fig. 4.) R. 3.

Body pentagonal, sides very slightly lunated, superior intermediate marginal plates eight, rather narrowly oblong, flattened, margined, punctate. Inferiors similar. Superior oculars triangular, obtuse, punctate. Ossicles of the disc granulated.

Rather larger than *G. Parkinsoni,* and easily distinguished from all its allies by the eight superior intermediate marginals.

From the upper chalk of Kent.

Goniaster (*Goniodiscus*) *compactus.* (Tab. XXII. fig. 3.) R. 4.

Body pentagonal with straight sides. Superior intermediate marginal plates six, very narrow, tumid along their centres, smooth except at their edges where there is a row of punctations, abrupt at their sides with rounded angles : inferiors rather wider and not so abrupt. Superior oculars triangular, shorter than the laterals, gibbosely tumid towards their obtuse points. Ossicles of disc punctate.

About the size of *G. uncatus*, and intermediate in aspect between that species and *G. rugatus*, but differing materially from either.

Upper chalk of Haughton, Sussex. In the cabinet of G. A. Coombe, Esq.

SECTION II.

Goniaster (*Astrogonium*) *lunatus*, Woodward, Geol. Norf. t. 5. f. 1.
(Tab. XXIII. fig. 7.)

Body stellato-pentagonal, sides lunate. Each side bordered by two rows (a superior and inferior) of twelve or more slightly tumid, curved, oblong, lineato-punctate, moniliformly-pitted, narrowly margined plates. Those of the inferior series often bear groups of small raised tubercles. Ambulacral ossicles 4–5-grooved, bearing very short obtuse spines. Similar spines appear to have been scattered over the under surface. Ossicula of disc mostly quadrate; punctate like the plates.

Upper chalk of Wiltshire, Kent, and Sussex, from C. Pearce's cabinet.

Goniaster (*Astrogonium*) *latus.* (Tab. XXIII. fig. 4 & 5.) R. 2.

Body pentagonal, with produced angles. Marginal plates of each row more than 20 on a side, oblong, depressed, closely and almost reticularly pitted with moniliform pits interspersed. Ossicles of the margins of the rays gradually widening. Ossicula of avenues 6-grooved. Ossicula of disc tetragonal, pitted; those of the rays more or less hexagonal.

A very flat and compressed species.

Lower chalk. Washington and Amberley, Sussex.

Goniaster (*Astrogonium*) *Smithii*. (Tab. XXII. fig. 1 & 2.)

Body pentagonal with produced angles. Marginal plates of each row about 40 on a side, the central 12 largest, oblong, slightly tumid, abrupt externally, punctate. Those of the rays broader with deep and rounded external sides, subtuberculated in consequence of having articulations for spines, varying from 1–3 in number. Ossicula of disc mostly tetragonal, punctated. Ambulacral ossicula 3–4-grooved.

Fig. 2. This is one of the most beautiful and perfect star-fishes that have been discovered. It was found in Kent, and forms part of the valuable collection of Mrs. Smith of Tonbridge Wells, to whom it is dedicated. Fig. 1 belongs to Mr. H. Catt, and from Sussex. Both specimens are from the lower chalk. Mr. Dixon and Mr. Coombe have also this star-fish in sulphuret of iron, discovered in Amberley pit, Sussex.

Goniaster (*Astrogonium*) *mosaïcus*. (Tab. XXIV. fig. 26.)

Body pentagonal with produced angles. Marginal plates of each row nearly 50 on a side, 16 of which belong to the body. These are narrow, curved, very short above, and minutely punctate; those of the arms are rather wider. All are small in proportion to the breadth of the disc. Ossicles of disc polygonal, punctate.

Lower chalk. In Mr. Bowerbank's, Mrs. Smith's, and Mr. Dixon's cabinets.

Goniaster (*Astrogonium*) *Coombii*. (Tab. XXIII. fig. 6.)

Body with deeply lunated sides and tapering angles. Marginal ossicles of each row above 30 on a side, oblong, slightly convex, coarsely punctate, abrupt at the sides, those below rounded; when perfect covered with minute hexagonal granules. Ambulacral ossicula 3–4-grooved. Ossicles of disc polygonal, coarsely punctate.

The marginal ossicles of the arms in this species have very angular sides.

Lower chalk. This beautiful and rare specimen was found by G. Coombe, Esq. at Balcombe pit, Amberley, and is a distinguished ornament in Mr. Dixon's cabinet.

Goniaster (*Astrogonium*) *angustatus.* (Tab. XXIII. fig. 10.) R. 3.

Body deeply lunated at the sides, and having the angles much produced. Marginal ossicles of each row about 24 on a side, the 8 central ones nearly equal; steep-sided and thick with a short superior surface, tumid and punctate; their exposed side smooth. Those of the arms differ from the corresponding plates in *G. Coombii* in having more rounded outer sides and less regularly tumid summits.

Upper chalk, Kent. Two specimens and a fragment in Mr. Bowerbank's collection, also from Sussex; and a fine specimen in the British Museum.

STELLASTER, *Gray* (including COMPTONIA, HOSIA and DIAGONA, *Gray*).

The star-fishes of this genus are five-rayed, and more or less pentagonally stellate. The upper disc is slightly convex and covered with closely-set pentagonal plates, which, when the animal is alive, bear closely-set, very small granules, giving them a frosted appearance. The interstices of the plates are porous. In some species, small conical spines are borne on the upper disc at distant intervals. The madreporiform tubercle is very distinct, and near it is the vent. The sides are margined by two rows of large plates, those of the upper and lower row being nearly equal. In some species both upper and lower marginal plates bear one or more spines, in others the lower only. In rubbed or dead specimens these spines disappear. Linear sessile pedicellariæ are seen on both marginal and body plates in some living species, but are entirely absent in others. The rays are terminated by an eye-plate, which is usually larger than the lateral eye-plates. The avenues are bordered by comb-like series of spines, backed by a row of stronger ones. The surface of the plates, both of the margin and disc, is more or less frosted, but is not covered by minute granules. The living species are tropical or Australian, and fossil ones from the lower greensand closely approach them in structure.

Stellaster Comptoni, Gray. (Tab. XXII. fig. 8.) R. 2.

Disc broadly pentagonal, with moderately long produced arms. Marginal plates narrowly oblong, widening on the arms: those bordering the disc superiorly presenting a great part of their surface. Many of them marked by oblique grooves for the reception of pedicellariæ. Ossicles of disc polygonal, those opposite the arms arranged in rows, the central row longest, and eventually forming broad plates on the surface towards the terminations of the arms. Many of them, especially below, marked with grooves for the pedicellariæ.

In the collection of the Marquis of Northampton, and in the British Museum.

The *Asterias Schultzii* of Roemer, from the Quader-sandstein of North Germany, appears to be this species.

Stellaster elegans. (Tab. XXII. fig. 9.) R. 4.

Disc narrow in proportion to the arms, which are long and slowly tapering. Marginal plates of upper surface centrally narrow widening upon the arms, and becoming nearly square, rounded at sides. Ossicles of disc forming three radiating rows opposite the arms and becoming rapidly transformed on the latter into square plates. No traces of pedicellariæ.

Differs from the last in proportions, and in the smoothness of its plates, which present no grooves for the reception of pedicellariæ.

In Mr. Bowerbank's collection.

Greensand of Blackdown; also in the Greensand (upper) at Folkstone, where it was observed by Capt. Ibbetson and myself.

ARTHRASTER (ἄρθρον a joint, ἀστὴρ a star), *Forbes*.

One of the most beautiful and singular of cretaceous star-fishes is that figured in Tab. XXIII. fig. 1. It is quite new generically and specifically, and closely allied to the living genus *Ophidiaster*, but the ossicula of the arms are very compactly articulated together, and much fewer in number. Their arrangement is also very different: exclusive of the ambulacral ossicula, which are unknown, only seven bones enter into the composition of the framework of the arm transversely, and these alternate in such a manner as to form a compact skeleton without conspicuous interstices. All the seven ossicles are similar in form, each consisting of a transversely oblong expanded though linear base, terminating at each end in an acute angle, and bearing along the centre a linear crest or ridge with steep sides; the central one is largest. I propose to name this beautiful species *Arthraster Dixoni*. The only known specimen consists of the remains of six or seven long and rounded arms, each of which, when perfect, probably measured nearly 8 inches. It is from the lower chalk of Balcombe pit, near Amberley, Sussex.

Family OPHIURIDÆ.

Genus OPHIURA, *Linn.*, *Ag.*

Ophiura serrata, Roemer. (Tab. XXIII. fig. 20.)

This pretty species has been already described in the Geological Proceedings. It occurs in the white chalk, and was first observed in Germany.

The specimen figured from the collection of the British Museum has a very perfect disc, showing the plates at the base of the arms; found by Mr. Dixon in Kent and Sussex.

SEA-URCHINS.

The *Echini* or Sea-Urchins are radiated animals of a more or less globular, egg-shaped or disc-like form, whose bodies are completely encased with shelly plates, regularly articulated together, and so arranged as to leave conspicuous openings only for the mouth and vent, the former being invariably on the under side or base of the body, the latter changing its position in different genera. From the mouth to the vent, or from the mouth to the dorsal summit, or around the pores which open into the oviducts, and which are always on the dorsal surface, there are radiating avenues of pores called ambulacra, out of the perforations in which are protruded soft sucker-tipped tentacles or feet. The mouth is often armed with a complicated apparatus of teeth. On the surface of the plates covering the body are tubercles, bearing articulated to them spines of various sizes, sometimes very large and heavy. By the joint action of these spines and the suckers before mentioned, the Sea-Urchins can progress, in a creeping fashion, with considerable rapidity. Among these spines in many kinds are found curious, sensitive, minute pincer-like organs called pedicellariæ. The fossil Sea-Urchins are all constructed on the same plan with the living species, but there are several genera among them of which we have no living examples.

In consequence of the untimely death of the lamented author of this work, the following catalogue of *Echinidæ* must be little more than a bare enumeration of the species which he collected in Sussex, or which were contributed for delineation by his friends on account of their beauty or novelty. Several of the specimens figured have been returned to their original possessors, or dispersed, before Mr. Dixon resolved to abandon the task of describing the fossils of this tribe, and requested my assistance. Some of the rarest and most distinct are consequently recorded only from the very beautiful drawings in which they are represented.

Genus Cidaris, *Lamk.*

1. *C. clavigera*, König. White chalk.

var. *a. communis.* (Tab. XXV. fig. 10, 11, 18, 19, 20.)

var. *b. major.* Body larger in proportion to the spines. (Tab. XXV. fig. 22.)

var. *c. minor.* Spines longer than usual in proportion to the body, the larger ones more oblong and with fewer serrated ridges.

In the Museum of the College of Surgeons. Tab. XXV. fig. 14.

2. *C. sceptrifera*, Mantell. White chalk. (Tab. XXV. figs. 2, 6, 7.)

And var. *spinis truncatis.* (Tab. XXV. fig. 32, 33.)

3. *C. vesiculosa*, Goldfuss. White chalk. (Tab. XXV. figs. 1, 4, 13, 21 (not the spine).

4. *C. serrifera*, sp. nov. (Tab. XXIV. figs. 15 to 19; Tab. XXV. fig. 2.)

Nearly allied to the last species, but differing in several important respects. Interambulacra composed of large plates with impressed areolæ around the spiniferous tubercles, four to six in the perpendicular row. Tubercles larger in proportion to the areolæ than in the last species. Superior plates with indistinct tubercles, but not so obsolete as in *C. vesiculosa.* Granulated portion of the plates finely grained. The sutures are not impressed. The avenues of pores, of which about fourteen correspond to the largest plate, are broader in proportion to the ambulacra. There is a tubercle between each pore, and an oblong transverse ridge between each pair.

The spines are long, slender, cylindrical, few- (seven or so) ridged; ridges coarsely serrated, the interspaces granulated.

White chalk.

5. *Cidaris Bowerbankii*, sp. nov. (Tab. XXIX. fig. 4.)

The body of this *Cidaris*, which is very nearly allied to *C. clavigera*, is a depressed spheroid, more compressed above and below than in that species. The ambulacral segments are slightly broader in proportion to the interambulacrals, and instead of their breadth being occupied by transverse series of about four granular tubercles, two of which are very small and inconspicuous, there are four, or centrally, even six nearly equal granular tubercles in each transverse row. The large spinigerous tubercles of the ambulacral plates are placed in areolæ, much smaller in proportion to the entire body than in *clavigera*, and the tubercles themselves are also smaller. The spaces between the rows of spinigerous tubercles are wider; they are thickly studded with nearly equal granules. The spines are similar in shape to those of *clavigera*, though rather more inversely conical, and none of them appear to have long stems. Their surface is minutely granulated with small spinous points which are arranged in irregular rows.

The specimen figured is in the cabinet of Mr. Bowerbank, and came from the grey chalk of Dover.

6. *Cidaris perornata*, nov. sp. E. F. White chalk. (Tab. XXV. fig. 8.)

Body melon-shaped. Ambulacral plates large, seven or eight in a row, each bearing a spiniferous tubercle, in the midst of a very large area, the margins granulated and the edges bordered with small moniliform granules, the sutures depressed. Pores of the ambulacral avenues about fifteen to each central plate. Avenues about one-third the breadth of the ambulacra, which are sutured and ornamented with a triple series of depressed granules twice repeated, and very small intermediate ones.

Spines long, cylindrical, several-ridged; ridges irregular towards the base, serrated, their interstices granulated.

A very beautiful and large species, reminding us of the oolitic *C. maximus*.

7. Spine of a distinct species, of which the body is unknown. (Tab. XXIV. fig. 8.)

8. A spine possibly also belonging to a distinct species. (Tab. XXIV. fig. 25.)

Genus Cyphosoma, *Agassiz.*

This genus differs from *Cidaris* in having broad and tuberculiferous ambulacral plates, and from *Diadema* in the tubercles not being perforated.

1. *C. Milleri*, Desmarest, Agassiz; *C. granulosus*, Goldfuss; *C. Konigi*, Mantell. (Tab. XXIX. figs. 17, 26, 27.). White chalk.

2. *C. corollare*, Parkinson? White chalk.

3. *C. variolaris*, Goldfuss; *ornatissimum* and *Tiara*, Agassiz? (Tab. XXV. fig. 29.) White chalk.

4. *C. spatulifera*, sp. nov. (Tab. XXIV. fig. 20.)

This species is remarkable for its extremely flattened spines, smooth except near their bases, where they are closely striated. The rows of ambulacral pores are only slightly undulated superiorly. The spinigerous tubercles are middle-sized, gradually diminishing, and separated by comparatively few miliary granules.

Genus Glypticus, *Agassiz.*

1. *G. Koninckii*, Desor?? White chalk. (Tab. XXV. fig. 30.)

Genus Echinopsis, *Agassiz.*

1. *E. pusillus*, Roemer. (Tab. XXV. fig. 31.)

Genus Salenia, *Gray.*

1. *Salenia scutigera*, Agassiz, var.?? (Tab. XXV. fig. 23–25.)

Genus Galerites, *Lamarck.*

1. *G. albo-galerus*, Lamarck (see Desor, Monog. Gal. tab. 1. fig. 4–11, and tab. 13. fig. 7.)
White chalk of Sussex, &c.

2. *G. vulgaris*, Lamarck (see Desor, Monog. Gal. tab. 2. fig. 1–10, and tab. 13. fig. 4–6).
White chalk of Sussex, &c.

3. *G. subrotunda*, Agassiz (see Desor, Monog. Gal. tab. 2. fig. 11–14).
White chalk of Sussex.

4. *G. globulus*, Desor (see Desor, Monog. Gal. tab. 4. fig. 1–4).
White chalk of Sussex.

(Subgenus DISCOIDEA.)

1. *Galerites* (*Discoidea*) *cylindricus*, Lamarck. (Tab. XXIX. fig. 3.)
Chalk marl.

2. *Galerites* (*Discoidea*) *subuculus*, var. B.
The little subglobose, white chalk variety. White chalk of Sussex.

3. *Galerites* (*Discoidea*) *Dixoni*, sp. nov. (Tab. XXIV. figs. 13, 14.)

In form and size this species resembles *Discoidea subuculus*; also in the proportional number of ambulacral as compared with the interambulacral plates, and the granulation of their surfaces. It is distinguished, however, by the proportions and dimensions of mouth and anus, as compared with the whole ventral surface. The mouth, instead of being (as in *subuculus*) nearly equal in diameter to the distances between its sides and the margin of the inferior surface, is scarcely half that size, and the anus, instead of occupying the greater part of the space between the mouth and the margin, fills less than half of it.

White chalk of Sussex.

Genus ANANCHYTES, *Lamarck.*

1. *A. ovata*, Lamarck.
    var. 1. *ovata*, Goldf. t. 44. f. 1.
    var. 2. *striata*, Lamk.
        A. conoideus, Goldf. t. 44. f. 2.
    var. 3. *gibba*, Lamk.
        A. striata, Goldf. t. 44. f. 3.

White chalk of Sussex, &c.

Genus HOLASTER, *Agassiz.*

1. *Holaster subglobosus*, (sp.) Leske. (Tab. XXIX. fig. 1; and, variety, Tab. XXIV. fig. 2.)
Chalk-marl.

2. *Holaster planus*, Mantell (Geol. Suss. pl. 17. f. 9–21).
Chalk-marl.

3. *Holaster pillula*, Lamarck. (Tab. XXIV. fig. 10–12).
White chalk of Sussex.

4. *Holaster cor-avium*, Lamarck? (Tab. XXIV. fig. 7; figs. 8 & 9—the anal plates.)

The curious species of *Holaster*, figured as above, is referred with doubt to the *Ananchytes cor-avium* of Lamarck, with the brief notices of which it agrees very well. Unfortunately there is no good figure of the Lamarckian species for comparison.

From the white chalk of Sussex.

Genus Micraster, *Agassiz*.

1. *Micraster gibbus* (*Spatangus*), Lamarck. (Tab. XXIV. figs. 5, 6.)

This is not the *Spatangus gibbus* of Goldfuss. The *Micraster gibbus* of Agassiz and Desor is said, in the 'Catalogue Raisonné des Echinides,' to have very slightly impressed ambulacra. The species here figured, however, has the avenues rather strongly impressed. It agrees so well with the figures in the 'Encyclopédie Méthodique' (pl. 156. figs. 4–6), referred to by Lamarck as representing his *Spatangus gibbus*, that I do not hesitate to identify it with that species.

Chalk of Sussex.

2. *Micraster cor-bovis*, sp. nov. E. F. (Tab. XXIV. figs. 3, 4.)

The body of this fine and large *Micraster* is ovate and slightly cordate, broadest in the region of the antero-lateral ambulacra. The posterior end is obtusely subtruncated. The dorsal surface is depressed and but slightly elevated in the anterior region above the rest of its surface. The ovarian circle is placed nearer the anterior than the posterior end. The frontal groove is shallow. The lateral ambulacra are placed in gentle depressions. The postero-lateral ambulacra are very short, and little more than half the length of the antero-laterals. There are about thirty pair of pores in each row in the latter, and about seventeen in each row in the former. The larger tubercles of the dorsal plates are much scattered and minute in proportion to the size of the shell. The interstices are minutely granulated. The areolated tubercles of the ventral surface are also proportionally small. The post-oral spinous space is triangularly lanceolate.

Length 3 inches; breadth 2 inches $\frac{7}{12}$ths; height 1 inch $\frac{9}{12}$ths.

Chalk of Sussex.

CRINOIDS.

In the plates to this work, many very interesting and beautiful specimens of cretaceous *Crinoidea* are figured. The originals of these figures had not been submitted to my examination before the author's death, and many of them are in private collections to which I have no access. I can therefore offer only a few notes which may serve as a clue in consulting the figures.

MARSUPITES, *Mantell.*

Three species of this curious genus are represented in Tab. XX. The figures 4, 5 & 9 agree well with the *Marsupites Milleri* of Dr. Mantell. Fig. 10 appears to be a variety of *Marsupites ornatus*, Miller; and fig. 8, from a specimen in the rich collection of Mr. Catt of Brighton, is probably new. If so, it might be appropriately named *Marsupites lævigatus*, since it is distinguished from all its allies by having smooth plates, undulated however by strong radiating ribs.

APIOCRINUS, *Miller.*

The figures in the lower portion of Tab. XX., from 11 to 39, possibly include representations of fragments of more than one cretaceous species of this genus, but probably for the most part belong to the *Apiocrinus ellipticus* of Miller.

PENTACRINUS, *Miller.*

Several fragments of the stems of this genus are figured in Tab. XX., and appear to belong to several distinct species. Fig. 1 is from Washington, Sussex. Fig. 2 is from Bromley in Kent. Fig. 3 is a portion of a Kent Pentacrinite in Mr. Catt's collection. Fig. 6 is from Houghton in Sussex.

In Tab. XIX. fig. 2, is a representation of the finest specimen of a chalk *Pentacrinus* extant. It is in Mr. Catt's collection, and a minute analysis of it would go far to clear up the obscurity at present affecting our knowledge of the cretaceous Pentacrinites. A recent Pentacrinite, fig. 1, is figured in the same plate for comparison. Figs. 3 to 15 are portions of chalk *Pentacrini.*

Notes on the Crustacea of the Chalk Formation. By Professor Thomas Bell, Sec. R.S.

CRUSTACEA.

MACROURA.

Palæastacus Dixoni, Bell. (Tab. XXXVIII*. figs. 1, 2, 3, 4, 5.)

The unique and beautiful fossil, represented of the natural size in figs. 1 & 2, appertains to a species of a Macrourous genus nearly allied to *Astacus* and *Homarus,* to which I have applied the name of *Palæastacus Dixoni.* It is characterized by the extremely tuberculous surface of the whole of the crust, passing into spines on the sides of the abdominal segments. The transverse division of the exterior caudal lamina was so slightly indicated in this specimen as scarcely to be recognizable; but the whole character of the animal points out clearly its close affinity to the typical *Astacidæ.* The division in the caudal lamina above adverted to is perhaps to be traced in fig. 5.

The carapace in this species exhibits the nearly cylindrical form of the lobster and the crayfish, but is a little more contracted anteriorly; the rostrum is triangular and slightly spinous at the sides, as seen in figs. 1 & 3. The different kinds of tubercles are very remarkably distinguished on different portions of the carapace, and are separated by a distinct line of demarcation. Thus the lateral and latero-posterior portion, comprising the whole of the branchial region, is covered only with small, close, and low tubercles; whilst the anterior and median portion, covering the hepatic, gastric, genital and cardiac regions, has in addition to the slightly tuberculated surface, a considerable number of large and distinct tubercles. The claws, which are very large in proportion to the size of the animal, are covered with still larger and more elevated tubercles than those of the carapace. The hand is robust, rounded, and almost ventricose; and the fingers meet only at the points, the immoveable one being straight and the other considerably curved. Judging from the fragments of the smaller legs which remain, these were doubtless, as in the other species of the family, slender and filiform. The segments of the abdomen are studded, particularly at the sides, with strong, almost spinous tubercles; the terminal segment, or middle lamina of the tail, is rounded at the extremity and tuberculated over the surface.

Fig. 3. A fragment of the same species, consisting of the anterior part of the carapace and part of the left claw.

Fig. 4. A fragment too imperfect to afford any satisfactory determination of its true characters. The thick, short hand has the appearance of a monstrosity or of a restored limb.

Fig. 5. This is probably a younger, and perhaps a female specimen of the same species as figs. 1 & 2.

Palæastacus macrodactylus, Bell. (Tab. XXXVIII*. fig. 6.)

Two claws of a very different form from those of the other species, in which the hand is comparatively much shorter, and the fingers much longer and more slender, both being curved equally and in the same direction, so that they are in contact through their whole length. This specimen may be referred provisionally to a species called *Palæastacus macrodactylus.*

Fig. 7. Inner view of the claw of probably another species of the same or a nearly allied genus.

BRACHYURA.

Platypodia Oweni, Bell. (Tab. XXXVIII*. fig. 9.)

The carapace, fig. 9, obviously belongs to a species of *Platypodia*, to which I beg to give the name of *Pl. Oweni*, as one which my lamented friend Mr. Dixon would have been particularly pleased to recognize and sanction.

GRAPSIFORM BRACHYURE. (Tab. XXXVIII*. fig. 12.)

The figure above-cited represents certain *legs* of one of the most remarkable forms hitherto observed amongst the fossil crustacea of the chalk. The general *primâ facie* character of the two larger feet gives the impression that they belong to a *Grapsus*, or to one of the land-crabs, or some allied form; but the small foot posterior to them leads almost to the conclusion that the species belonged to that aberrant type in which the posterior feet are diminutive and almost rudimentary. The claw, fig. 11 *a*, obviously belongs to the same species, and is very grapsoid in its character.

Descriptions of the Shells of the Chalk Formation.

By James de Carle Sowerby, Esq.

MOLLUSCA.

BRACHIOPODA.

Terebratula sexradiata. (Tab. XXVII. fig. 10.)

Spec. Char.—Lenticular subpentagonal, minutely granulated; central area flattened with three obscure rays on each side; beak very short with a large aperture.

Somewhat resembling *Magas pumila* in form, but the valves are both convex; the rays, which form its strongest character, are slightly elevated.

Terebratula Bulla. (Tab. XXVII. fig. 11.)

Spec. Char.—Short oval, inflated, smooth; beak incurved, with a round aperture in the adpressed apex; front broad, elevated.

More elongated and larger than *Terebratula subglobosa.*

Terebratulæ. (Tab. XXVII. figs. 15, 16, 17.)

In the present unsettled state of the genus *Terebratula,* I will not venture to name these shells from the single specimens which alone have come into my hands.

CONCHIFERA DIMYARIA.

Teredo rotundus. (Tab. XXVIII. figs. 27 & 28.)

Spec. Char.—Nearly globose, finely striated; anterior extremity nearly closed, posterior extremity short.

A small shell from the chalk of Kent.

Mus. Sowerby.

Leda pulchra. (Tab. XXVIII. fig. 10.)

Spec. Char.—Ovate ventricose, concentrically striated; posterior lobe small, pointed, beak-shaped.

Found in the chalk of Kent.

Modiola quadrata. (Tab. XXVIII. fig. 13.)

Spec. Char.—Elongated, curved, longitudinally punctato-striated, gibbose; sides and disc flattened.

The sides and middle of this shell are so flattened as to give a nearly square section.

Lower chalk.

CONCHIFERA MONOMYARIA.

Lima læviuscula. (Tab. XXVIII. fig. 14.)

Spec. Char.—Semicircular, anteriorly truncated, one side straight, compressed; surface marked with numerous radiating striæ.

An imperfect specimen.

Lima? spinosa. (Tab. XXVIII. fig. 33.)

Spec. Char.—Semicircular, anteriorly truncated, ribbed; surface minutely corrugated; ribs numerous, rounded, with here and there a squamaform spine.

A rare shell. The generic characters are imperfectly shown in the specimen.

Lima granosa. (Tab. XXVIII. figs. 24 & 25.)

Spec. Char.—Oblong or elongated, slightly compressed, striated with granulated interstices; striæ numerous, equidistant, radiating; hinge-line short; ears small, indistinct.

This neat, well-defined species of *Lima* seems to be liable to much variation in its general form; one valve is flat; the lines of growth are conspicuous at distant intervals.

Pecten jugosus. (Tab. XXVIII. fig. 26.)

Spec. Char.—Orbicular, flat, radiated with ribs and striæ; ribs about fifteen, broad, slightly elevated, angular in their middle; ears large and narrow, ribbed; lines of growth irregular; striæ few.

The ears of this Pecten are shorter than the diameter of the shell; the ribs are so wide as to meet each other with their flat inclined sides; they are very slightly raised. At first sight this bears some resemblance to *P. Beaveri*, but the ears are much smaller and the ribs sharp in the middle.

Pecten Asellus. (Tab. XXVIII. fig. 5.)

Spec. Char.—Suborbicular, radiated, squamose; radii about ten, acute; ears distinct, long and narrow, squamose at the edge.

Well-distinguished by its long, narrow, free or distinct ears; only one specimen has fallen under our notice.

Plagiostoma Hoperi, var. (Tab. XXVIII. fig. 21.)

This variety strongly resembles *Lima Santonensis* of D'Orbigny. The species varies much in form as well as in the number of striæ.

Ostrea virgata. (Tab. XXVII. fig. 1.)

Spec. Char.—Orbicular, convex, ornamented with numerous, branching, thin ridges; surface otherwise nearly smooth.

Remarkable for the thin ribs on the surface, by which, although the specimen is very imperfect, this shell is readily defined.

MOLLUSCA GASTEROPODA.

Dentalium? difforme. (Tab. XXIX. fig. 10.)

Spec. Char.—Tube irregular, ribbed; ribs about seven, prominent, rounded, crossed by indistinct lines of growth; mouth small.

Although this shell is irregular and strongly ribbed, yet its general form is that of a *Dentalium*; it tapers too quickly for a *Serpula*, and shows no mark of having been attached to any other body.

Occurs in chalk marl.

Hipponyx? (Pileopsis?). (Tab. XXVII. fig. 8.)

We have not seen the free valve of this shell, and cannot therefore determine the species. The gradual progress of the animal in changing its position is well shown. Similar specimens occur in the neighbourhood of Valognes in Normandy.

Emarginula affinis. (Tab. XXVII. figs. 20 & 25.)

Spec. Char.—Conical, obtuse, with many thin ribs connected by regular lines of growth; mouth oval.

The striæ between the ribs, which give a cancellated figure to most of the species of this genus, are numerous and slender in the one before us. The vertex is slightly bent forward.

Fig. 25 represents the cast of the surface in the chalk.

Avellana. (Tab. XXVII. fig. 34.)

The toothed aperture and large blunt spire distinguish this from similar shells (especially *Cassis Avellana* of Brongniart) grouped under this genus by D'Orbigny.

Scalaria compacta. (Tab. XXVII. fig. 32.)

Spec. Char.—Whorls rather square, close; ribs very numerous, slightly elevated.

A very defective specimen is the only one we have seen of this species.

Solarium catenatum. (Tab. XXIX. fig. 5.)

Spec. Char.—Depressed; margin smooth?; upper surface of each whorl marked with a concentric band of four or five striæ, which approach each other at regular intervals, so as to resemble an ornamented chain.

The under surface of this shell is unknown to us.

Pleurotomaria perspectiva. (Tab. XXVII. fig. 27.)

This beautiful specimen is from Buriton in Kent.

Turbo gemmatus. (Tab. XXVII. figs. 26 & 33.)

Spec. Char.—Conical, short, with six spiral, beaded ridges on each whorl and about as many on the base, the lower ridges less deeply cut than the two or three upper ones; umbilicus open.

A common shell in the chalk of Kent. Can it be *Cirrus striatus*? of Woodward's Geol. of Norfolk, tab. 6. f. 20?

Turritella turbinata. (Tab. XXIX. fig. 2.)

Spec. Char.—Conical, elongated, concentrically striated; striæ very numerous; the lower part of each whorl slightly convex.

Shorter than most species of *Turritella*, and the largest of the genus.

Found in chalk marl.

Cassidaria incerta. (Tab. XXIX. fig. 7.)

This is evidently *Pterocera incerta* of D'Orbigny, but why he has referred it to *Pterocera,* I am at a loss to guess. The present specimen is sufficiently perfect to show that it belongs to the genus *Cassidaria.* The *Dolium nodosum* (Min. Conch. t. 426 & 427) is nearly related, and may even be an old specimen of the same species D'Orbigny obtained from the lower chloritic chalk of Mans.

Found in Sussex.

CEPHALOPODA.

Hamites angustus. (Tab. XXIX. fig. 12.)

Spec. Char.—Much elongated, scarcely diminishing in breadth, compressed; sides ribbed; ribs numerous, rounded, equal, discontinued over the concave margin.

A remarkable species.

Turrilites triplicatus. (Tab. XXIX. fig. 16.)

Spec. Char.—Much elongated, costated; volutions convex; costæ obliterated near the lower part of the whorl by a plain band, below which are three rows of small tubercles united by three spiral ridges.

This species is distinguished from all others by the triple row of small tubercles at the base of each whorl. The costæ are numerous, distinct and rounded, and each has a slight constriction before it reaches the obliterating band. I have seen specimens much larger than the one figured.

CATALOGUE

OF THE

ORGANIC REMAINS OF INVERTEBRATE ANIMALS

FROM

THE CHALK FORMATION.

PLANTÆ.

(Dicotyledonous and Coniferous Woods in Flint. Also Palm Wood. Tab. XVI.)

AMORPHOZOA.

(Choanites or Ventriculites, perhaps Sponges, in Flint. Tab. XVII.)

ZOOPHYTA.

FORAMINIFERA.

NAUTILOIDEA.

	British localities.	*Foreign localities.*
CRISTELLARIA ROTULATA, C. Tab. XXVII. f. 19. *D'Orbig. Mém. Soc. Géol. de la France*, v. 4. 26. t. 2. f. 17, 18. *Morris*, 61. Lenticulites rotulata, *Lam. Hist. Nat.* v. 7. 620. Nautilus Comptoni, *Min. Con.* t. 121.	. . . .	Everywhere.

TURBINOIDEA.

	British localities.	Foreign localities.
Lituola Nautiloidea, C. Tab. XXVII. f. 14. *Lam. Ann. du Mus.* v. 5. 243. t. 62. f. 12. *D'Orbig. Mém. Soc. Géol. de la France,* v. 4. 29. t. 2. f. 28. *Morris,* 62.	England generally.	France, &c.
Rotalia ? . . . . C. Tab. XXVII. f. 14. Rotalia, *Mantell, Phil. Trans.* 1846, 465. t. 21. f. 12.	Brighton. Chichester, &c.	

ANTHOZOA.

FUNGINA.

Monocarya centralis, Tab. XVIII. f. 1–10.
———— cultrata, Tab. XVIII. f. 11–13.
Diblasus Grevensis, Tab. XVIII. f. 14–28.
Axogaster cretacea, Tab. XVIII. f. 29–34.
Epiphaxum auloporoides, Tab. XVIII. f. 35*–37.
Spinopora Dixoni, Tab. XVIII. f. 38, 39.
Stephanophyllia Michelini, Tab. XVIII. B. f. 12.

BRYOZOA.

TUBULIPORIDA.

Alecto ramea, Tab. XVIII. f. 35‡, 40, 41.
——— gracilis, Tab. XVIII. A. f. 1.
Diastopora Sowerbyi, Tab. XVIII. A. f. 2.
———— ramosa, Tab. XVIII. B. f. 1.
———— . . . . . . Tab. XVIII. A. f. 3; and Tab. XVIII. f. 35*.
Clypeina tubæformis, Tab. XVIII. A. f. 4.
Idmonea cretacea, Tab. XVIII. A. f. 5.
Desmeopora semicylindrica, Tab. XVIII. A. f. 6.
Petalopora pulchella, Tab. XVIII. A. f. 7.
———— pustulosa, Tab. XVIII. A. f. 8.
Holostoma contingens, Tab. XVIII. A. f. 9.
Siphoniotyphlus plumatus, Tab. XVIII. B. f. 2.
Homeosolen ramulosus, Tab. XVIII. B. f. 3–5.

CELLEPORIDA.

Atagma papularium, Tab. XVIII. B. f. 6.
Marginaria Rœmeri, Tab. XVIII. B. f. 7.
Escharina intricata, Tab. XVIII. B. f. 8.
Flustra inelegans, Tab. XVIII. B. f. 9.

ECHINODERMATA.

Tabs. XIX. to XXV., & Tab. XXIX. figs. 1, 3 & 4.
(See the Table and Descriptions furnished by Prof. E. Forbes, pp. 325–34.)

ARTICULATA.

ANNELIDA.

SERPULACEA.

	British localities.
Serpula Plexus, C. Tab. XXVIII. f. 12. *Min. Con.* t. 598. f. 1. *Morris,* 66.	Norwich. Kent, &c. Isle of Wight and Blackdown (greensand).
———— annulata, new, R. 4. Tab. XXIX. f. 9.	

CIRRIPEDIA.

PEDUNCULATA.

Xiphidium maximum, C. Tab. XXVIII. f. 6–8. Pollicipes maximus, *Min. Con.* t. 606. f. 3. *Morris,* 68.	Norwich. Kent, &c.
———— angustum, new, R. 4. Tab. XXVIII. f. 9.	

MOLLUSCA.

BRACHIOPODA.

	British localities.	*Foreign localities.*
Hippurites Mortoni, R. 3. Tab. XXVI. *Mantell, Geol. S.-East of Engl.* 130. *Morris,* 118.	Lewes. Kent.	
Crania Parisiensis, C. Tab. XXVII. f. 9. *Def. Dict. des Sc. Nat.* v. 11. 313. *Lam. Hist. Nat.* v. 6. 239. *Min. Con.* 408. *Morris,* 121. *Goldf. Petr.* v. 2. 293. t. 162. f. 8.	Sussex. Kent. Norfolk, &c.	France.
——— costata, R. 1. Tab. XXVII. f. 4 & 5. *Goldf. Petr.* v. 2. 294. t. 162. f. 11.	Norfolk.	Nehou. Riga.
——— striata, R. 1. Tab. XXVII. f. 6. *Def. Dict. des Sc. Nat.* v. 11. 313. *Lam. Hist. Nat.* v. 6. 239. *His. Petr. Suec.* t. 3. f. 12? *Woodward, Geol. Norf.* t. 6. f. 15. *Morris,* 121. *Goldf. Petr.* v. 2. 294. t. 162. f. 10.	Sussex. Norfolk.	Sweden.
Terebratula sexradiata, new, R. 4. Tab. XXVII. f. 10.		
——— bulla, new, R. 4. Tab. XXVII. f. 11.		
Terebratulæ, three species, Tab. XXVII. figs. 15, 16, 17.		
——— striatula, V.C. Tab. XXVII. f. 21. *Mantell, Geol. Suss.* 131. t. 25. f. 7, 8, 12. *Min. Con.* t. 536. f. 3–5. *Morris,* 136.	Everywhere in chalk. Kent, in London clay, also recent.	France. Sweden, &c.

CONCHIFERA DIMYARIA.

PHOLADARIA.

Teredo Amphisbœna, C. Tab. XXVIII. f. 35. *Min. Con.* 7. 17. t. 618. f. 3, 4. *Morris,* 102. Serpula amphisbœna, *Goldf. Petr.* v. 1. 239. t. 70. f. 16.	Sussex. Kent. Norfolk.	Maestricht. Westphalia.
——— rotundus, new, R. 3. Tab. XXVIII. f. 27, 28.	Kent.	

MYARIA.

	British localities.	*Foreign localities.*
Pholadomya decussata, C. Tab. XXIX. f. 6. *Morris,* 97. *in part.* Cardium ? decussatum, *Mantell, Geol. Suss.* 126. t. 25. f. 3. *Min. Con.* 552. f. 1. *Goldf. Petr.* v. 2. 222. t. 145. f. 2.	Sussex. Specton ?	Westphalia.

ARCACEA.

Byssoarca Marullensis, R. Tab. XXVIII. f. 11. Arca Marullensis, *D'Orbig.* v. 3. 205. t. 310. f. 3–5.	Kent.	France (Neocomian).
Leda pulchra, new, R. 3. Tab. XXVIII. f. 10.		

MYTILACEA.

Modiola quadrata, new, R. 3. Tab. XXVIII. f. 13.		
Pinna decussata, R. 1. Tab. XXVIII. f. 20. *Goldf. Petr.* v. 2. 166. t. 128. f. 1. Pinna sulcata ? *Woodw. Geol. Norf.* t. 5. f. 23. *Morris,* 99 ?	Sussex. Norfolk.	Westphalia.

CONCHIFERA MONOMYARIA.

MALLEACEA.

Inoceramus Lamarckii, R. 1. Tab. XXVIII. f. 29. *Brong. & Cuv. Env. de Paris,* 338. *Goldf. Petr.* v. 3. 114. t. 111. f. 2. *D'Orbig.* v. 3. 518. t. 412. *Morris,* 110. Inoceramus Brongniarti, *Mantell, Geol. Suss.* 214. t. 27. f. 8. In. Lamarckii, *ib.* 214. *in part.*	Norfolk. Sussex.	Westphalia. France.
———— involutus, R. 1. Tab. XXVIII. f. 32. *Min. Con.* t. 583. *D'Orbig.* v. 3. 520. t. 413. *Morris,* 110.	Norfolk. Sussex. Kent.	

PECTENIDES.

Lima læviuscula, new, R. 3. Tab. XXVIII. f. 14.		

	British localities.	*Foreign localities.*
Lima, species uncertain, Tab. XXVIII. f. 15. *like* L. Royeriana *of D'Orbig.* v. 3. 527. t. 414. f. 5–8.		
—— spinosa, new, R. Tab. XXVIII. f. 33.		
—— granosa, new, R. 3. Tab. XXVIII. f. 24, 25.		
Pecten jugosus, new, R. 4. Tab. XXVIII. f. 26.		
—— subinterstriatus, R. Tab. XXVIII. f. 19. *D'Archiac, Mém. Soc. Géol. Fr.* 2nd ser. v. 2. 311. t. 15. f. 10.	. . . .	Hainault.
—— Dujardinii, R. 4. Tab. XXVIII. f. 4. *D'Orbig.* 3. 615. t. 439. f. 5–11.	. . . .	Tours.
—— Asellus, new, R. 4. Tab. XXVIII. f. 5.		
—— æquicostatus, C. Tab. XXVIII. f. 17, 18. Janira æquicostata, *D'Orbig.* v. 3. 637. t. 445. f. 1–4. Pecten quinquecostatus, *Min. Con.* t. 56. f. 6, 7, 8. *not* f. 4 & 5.	Sussex. Chute Farm, &c. in greensand.	France.
—— quinquecostatus, C. Tab. XXVIII. f. 1, 2, 3. *Min. Con.* t. 56. f. 4, 5. *Mantell, Geol. Suss.* 201. t. 26. f. 14, 19, 20. *Morris,* 115. Janira quinquecostata, *D'Orbig.* v. 3. 632. t. 444. f. 1–5.	Sussex. Norfolk. Kent.	France.
Plagiostoma Hoperi var. C. Tab. XXVIII. f. 21. *Min. Con.* t. 280. *Morris,* 117. Plagiostoma punctatum, *Nils. Petr. Suec.* 24. t. 9. f. 1. Lima Santonensis ? *D'Orbig.* v. 3. 565. t. 425. f. 1, 2.	Sussex. Kent. Norwich. Isle of Wight.	Balsberg.
———— parallelus, C. Tab. XXVIII. f. 16. *D'Orbig.* v. 3. 539. t. 416. f. 11–14. Modiola parallela, *Min. Con.* t. 9. f. 1. Plagiostoma elongatum, *Min. Con.* t. 559. f. 2. *Morris,* 117.	Sussex. Kent. Norfolk, in chalk. Folkstone, in gault. Isle of Wight, in greensand.	Touraine.
Spondylus latus, C. Tab. XXVIII. f. 30, 31. Spondylus lineatus, *Goldf. Petr.* v. 2. 97. t. 106. f. 3. Dianchora lata, *Min. Con.* t. 80. f. 2. *Morris,* 108.	Sussex. Kent.	
——— fimbriatus, C. Tab. XXVIII. f. 34. *Goldf. Petr.* v. 2. 97. t. 106. f. 2. Dianchora spinosa ? *Woodw. Geol. Norf.* t. 5. f. 24.	Sussex. Kent. Norwich.	

OSTRACEA.

	British localities.	Foreign localities.
Gryphæa globosa var. depressa, C. Tab. XXVII. f. 3. *Min. Con.* t. 392. *Morris,* 109. Ostrea vesicularis, *Lam. Hist. Nat.* v. 6. 219. *Nils. Petr. Suec.* 29. t. 7. f. 3, 4, 5. t. 8. f. 6. *D'Orbig.* v. 3. 742. t. 487.	Norfolk. Sussex, &c.	France. Sweden.
Exogyra Rauliniana, R. 1. Tab. XXVII. f. 7. Ostrea Rauliniana, *D'Orbig.* v. 3. 708. t. 471. f. 1, 2, 3.		
Ostreæ, two species, uncertain. C. Tab. XXVIII. f. 22, 23.		
Ostrea virgata, new, R. 4. Tab. XXVII. f. 1.		
——— carinata, jun. R. Tab. XXVII. f. 2. *Goldf. Petr.* v. 2, 9. t. 74. f. 6. *Morris,* 112.	Kent. Norfolk.	Westphalia.

GASTEROPODA.

DENTALIACEA.

Dentalium difforme, new, R. 1. Tab. XXIX. f. 10.

CALYPTRACEA.

Hipponyx or Pileopsis? new, R. 1. Tab. XXVII. f. 8.	Kent.	Normandy.
Emarginula affinis, new, R. 4. Tab. XXVII. f. 20, 25.		

MACROSTOMATA.

Natica Dupinii, R. 2. Tab. XXVII. f. 35. *Leymerie, Mém. de la Soc. Géol.* v. 5. 13. t. 16. f. 7. *D'Orbig.* v. 2. 158. t. 173. f. 5, 6.	. . . .	Near Ervy.

PLICACEA.

Avellana, *D'Orbig.*, imperfect, C. Tab. XXVII. f. 34.	Kent.	

SCALARIANA.

Scalaria compacta, new, R. 4. Tab. XXVII. f. 32.

	British localities.	Foreign localities.
TURBINACEA.		
Solarium catenatum, new, R. 4. Tab. XXIX. f. 5.		
Pleurotomaria perspectiva, C. Tab. XXVII. f. 27. *D'Orbig.* v. 2. 255. t. 196. *Morris,* 158. Cirrus perspectivus, *Mantell, Geol. Suss.* 194. t. 18. f. 12, 21. *Min. Con.* t. 428. f. 1, 2.		
Turbo gemmatus, new, C. Tab. XXVII. f. 26, 33.	Sussex. Kent. Norfolk.	
Turritella turbinata, new, R. 4. Tab. XXIX. f. 2.		
ALATÆ.		
Aporrhais stenopterus, R. 1. Tab. XXVII. f. 31, 36. Rostellaria stenoptera, *Goldf. Petr.* v. 3. 18. t. 170. f. 6.	Sussex.	Westphalia.
PURPURIFERA.		
Cassidaria incerta, R. 4. Tab. XXIX. f. 7. Pterocera incerta, *D'Orbig.* v. 2. 308. t. 215.	Sussex.	Mans.
CEPHALOPODA.		
DIBRANCHIATA.		
Belemnites semicanaliculatus, C. Tab. XXVII. f. 23. *De Blainville, Mém.* 67. t. 1. f. 13. *D'Orbig.* v. 1. t. 5. f. 10–15.	Sussex.	St. Paul-Trois-Chateaux.
——— Baudouini, R. 2. Tab. XXVII. f. 29. *D'Orbig.* v. 1. 54. t. 5. f. 1, 2.		
——— mucronatus, V.C. Tab. XXVII. f. 28. (*Schlotheim*) *Brongn. & Cuv. Env. de Paris,* 14 & 382. t. 3. f. 1. *De Blainville, Mém.* 64. t. 1. f. 12. *Min. Con.* t. 600. f. 1, 2, 4, 6 & 7. *Morris,* 177. B. electrinus, *Miller, Tr. Geol. Soc.* 2nd ser. v. 2. pt. 1. 61. t. 8. f. 18–21. t. 9. f. 1, 3. Belemnitella mucronata, *D'Orbig.* v. 1. 63. t. 7.	Sussex. Kent. Norfolk. Ireland, &c.	France. Sweden, &c.
TETRABRANCHIATA.		
Nautilus Archiacianus, R. 2. Tab. XXIX. f. 8. *D'Orbig.* v. 191. t. 21.	. . . .	Rouen.

	British localities.	*Foreign localities.*
Ammonites Prosperianus, R. 1. Tab. XXVII. f. 22. *D'Orbig.* v. 1. 335. t. 100. f. 3, 4.	Kent.	Near Orange.
———— Milletianus? R. 1. Tab. XXIX. f. 15. *D'Orbig.* v. 1. 263. t. 77.	. . . .	France.
————, species uncertain, Tab. XXVII. f. 18.		
Scaphites æqualis, C. Tab. XXVII. f. 37, 38. *Min. Con.* t. 18. f. 1–3. *D'Orbig.* v. 1. 518. t. 129. f. 1–7? *Morris,* 186, *in part.* Scaphites costatus, *Mantell, Geol. Suss.* 120. t. 22. f. 8, 12, 13.	Sussex.	Rouen.
———— obliquus, C. Tab. XXIX. f. 11. *Min. Con.* t. 18. f. 4–7. *Brongn. & Cuv. Env. de Paris,* 394. t. 6. f. 13. S. æqualis, *D'Orbig.* v. 1. 518. t. 129. f. 3. *Morris,* 186, *in part.*	Sussex.	France.
Turrilites Scheuchzerianus, C. Tab. XXIX. f. 17. (*Bosc.*) *D'Orbig.* v. 1. 602. t. 146. f. 2. Turrilites undulatus, *Min. Con.* t. 75. f. 1, 2. *Mantell, Geol. Suss.* 124. t. 23. f. 14, 16. t. 24. f. 8. *Morris,* 186.	Sussex.	France. Rouen, &c.
———— triplicatus, new, R. 1. Tab. XXIX. f. 16.		
Hamites angustus, new, R. 4. Tab. XXIX. f. 12.	Sussex.	
———— armatus, C. Tab. XXIX. f. 13. *Min. Con.* t. 168. & t. 234. f. 2. *Morris,* 181.	Sussex. Folkstone.	Rouen.
Baculites Faujasii, C. Tab. XXVII. f. 30. *Min. Con.* 592. f. 1. *Morris,* 177.	Sussex. Norwich.	Rouen, &c.

Subkingdom VERTEBRATA.

Class PISCES.

The remains of fishes occur in extraordinary preservation in the chalk formation. No one who has seen Dr. Mantell's superb collection, now in the British Museum, can ever forget the beautiful specimens which he collected in the vicinity of Lewes; palæontologists are much indebted to him for his great perseverance in developing and explaining the general characters of these magnificent fossils.

M. Agassiz has divided the class Pisces into four Orders, according to the characters of the external covering, a most useful arrangement to the palæontologist, who is often obliged to determine a species of fossil fish on the evidence of a few detached scales[1].

Fishes of all these orders are found in the cretaceous period, and most of their parts, not only the teeth, vertebræ, ribs and various bones of the head, but the fins, tail, and defensive bones, sometimes even the skin, are beautifully preserved[2]. The chalk fish have a nearer relationship to those of the tertiary period than to those of the oolite or older formations. The Edaphodontidæ of the chalk and eocene periods are very closely allied, as Sir Philip Egerton has pointed out.

[1] The first order he has denominated Placoid, from πλὰξ, *a broad plate.* These scales are sometimes of large size, though occasionally in small points, as in the Shark and Ray families.

The second order, Ganoid, from γάνος, *splendour*; these scales are usually of an angular form, strong, and covered with a thick layer of enamel: the Sturgeon is an example.

The third order, Ctenoid, from κτεὶς, *a comb*; these scales are toothed or pectinated on their posterior margin like a comb; they are sharp and disagreeable to the touch: the Perch belongs to this order.

The fourth order, Cycloid, from κύκλος, *a circle*; the edges of these scales are smooth; the external surface, like the Ctenoid, is often ornamented with markings. The Salmon and Herring are of this order.

[2] "Some fishes have teeth attached to all the bones that assist in forming the cavity of the mouth and pharynx, to the intermaxillary, maxillary and palatine bones, the vomer, the tongue, the branchial arches supporting the gills and the pharyngeal bones; sometimes the teeth are uniform in shape on the various bones, at others differing. One or more of these bones are sometimes without teeth of any sort, and there are fishes that have no teeth whatever on any of them. The teeth are named according to the bone upon which they are placed, and are referred to as maxillary, intermaxillary, palatine, vomerine, &c., depending upon their position."—*Yarrell's Introduction to Recent British Fishes*, pages 19 and 20.

Notes on the Order Placoidei.

Family CESTRACIONTIDÆ.

Genus *Ptychodus*[1], Agassiz.

The genus *Ptychodus*, formed by Agassiz, is very abundant in the chalk; he considers it more nearly allied to the *Cestraciontidæ* than to the *Raiidæ*. The teeth are beautifully preserved; the calcigerous tubes have the same arrangement as in *Acrodus*, but the medullary tubes are smaller and less straight. Professor Owen observes in his 'Odontography,' page 61, "*Ptychodus* differs from *Acrodus* in the greater number and more parallel course of the medullary canals, their fewer branches, and in the absence of an external layer of finer parallel tubes." The teeth of this genus are sometimes found in large groups. Mr. Catt had a mass containing 213 teeth of different sizes, and I have seen others with 150 or more. The engraved specimen, in sulphuret of iron from Mr. Catt's collection, of *Ptychodus decurrens*, is the only instance I have seen in which the teeth are preserved in their natural position[2]. The recent genus *Rhina* shows on a small scale the probable arrangement of the teeth of this gigantic extinct genus. The largest tooth in my cabinet measures 3¼ inches long by 2¼ broad, and the smallest not more than ⅛ of an inch; both are from the same individual of *Ptychodus latissimus*.

The teeth vary much in shape according to the period of growth and position in the jaw, consequently the species are difficult to define. Professor Agassiz told me he had only seen one or two large groups of these teeth in all his experience. The following species have been found in Kent and Sussex.

Ptychodus mammillaris, V.C. (Tab. XXX. fig. 6; Tab. XXXI. fig. 4.
Vol. iii. p. 151, Agassiz, Poissons Fossiles.)

This species is more common in the upper chalk formation than in the lower; the great folds of enamel do not extend to the edge of the tooth; the teeth look puckered, and often resemble a nipple; the anterior surface is sloping, the posterior almost perpendicular: I have a specimen of this species in the centre of a flint, which is rare. This species is found in England, France and Germany; Mr. Bass of Brighton has a mass containing 160 teeth. Mr. Catt has a singular

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[1] *πτυχὴ plicatura, ὀδοὺς dens.*

[2] Tab. XXXII. fig. 3.

variety of this species, in which the body of the tooth is unusually puckered and drawn in at the base; this character is common to all the teeth in the specimen, sixty in number.

Ptychodus decurrens, V.C. (Tab. XXX. figs. 7 & 8; Tab. XXXI. fig. 1; Tab. XXXII. fig. 3. Vol. iii. p. 154, Agassiz.)

This is a common species; I have only found it in the lower chalk and chalk-marl. The principal folds of enamel are straight, small and numerous, extending generally to the edge of the tooth, which on this account is easily distinguished. The larger specimens are somewhat convex, the smaller ones flat. It has been found in France, Italy and Germany: Captain Burgh residing at Brighton has a mass containing 120 teeth of this species.

Ptychodus altior, C. (Tab. XXX. fig. 10. Vol. iii. p. 155, Agassiz.)

This is a well-defined species; the great folds of enamel are confined to the apex of the tooth: the body of the tooth is smooth; its height is considerable, and it narrows towards the summit; the enamel is very thin at its base, and is more easily broken than in any other species; in other respects it resembles *P. mammillaris.*

This may be considered a rare species; it occurs in the upper chalk, and has been noticed by Agassiz in Germany, France and Italy.

Ptychodus rugosus, new, R. 4. (Tab. XXXI. fig. 5.)

The Earl of Enniskillen and Sir Philip Egerton have teeth of a species in their cabinets resembling in form those of *P. altior*, found in Kent, but they are larger and broader, and the great folds of enamel at the apex stronger, more rugose and crenated, and often worn away, showing the remains of calcigerous tubes beneath; the body of the tooth is traversed by small folds of enamel, which distinguish it from *P. altior*; it is also very different from *P. mammillaris.* I propose for it the specific name of *rugosus.*

Ptychodus latissimus, R. (Tab. XXX. fig. 1 & 2; Tab. XXXI. fig. 3. Vol. iii. p. 157, Agassiz.)

The folds of enamel in this species are larger and the edges more acute than in *P. polygyrus*, and the shape of the tooth is generally more oblong, though I have seen some nearly square; the sides are closely beset with coarse granulations; the teeth of this species are sometimes very large, but they vary exceedingly in size. The smaller ones are difficult to distinguish; the sharpness of the large folds of enamel is the most striking character. This species occurs both in the upper and lower chalk; the finest specimens I have seen are from Kent. I had a specimen from Kent containing eighty-four teeth of this species, many of them so different in their appearance, that if they had been found singly they would have been difficult to determine; I have now a group from Southeram-pit, near Lewes, of upwards of fifty teeth of this species; it is found also in France, Germany and Italy.

Ptychodus paucisulcatus, new, R. 2. (Tab. XXX. fig. 3.)

Having seen many well-marked teeth in which the great folds of enamel are large and very few in number, I am induced to form a new species, for which I propose the name of *paucisulcatus*. This tooth is nearly square; the great folds of enamel seldom exceed six or seven in number, and are larger and stronger than in *P. latissimus* or any other species; they do not extend to the margin; the accessory denticles, or small folds of enamel, are finer than in *P. latissimus* or *P. polygyrus*. Mr. Catt has a specimen of this species containing 147 teeth, none of them differing from the specific characters here given. The specimen figured by M. Agassiz, plate 25 *b*. fig. 26, appears to belong to this species.

Ptychodus polygyrus, C. (Tab. XXX. fig. 9; Tab. XXXI. fig. 10. Vol. iii. p. 155, Agassiz.)

I have found this species most frequently in the lower chalk. The principal folds of enamel are curved in a greater or less degree at their extremities, and in some specimens form complete circles. The small folds of enamel have a concentric arrangement. The furrows between the principal folds are more shallow than in *P. latissimus*, and the folds themselves smaller and not so elevated. Mr. Catt had a group found near Lewes containing 213 teeth of this species.

Ptychodus depressus, new, C. (Tab. XXXI. fig. 9.)

There is often seen in cabinets a large tooth somewhat resembling those of *P. polygyrus*, but the great folds of enamel are smaller and extend nearly to the edge of the tooth; it has no elevation in the centre, but is quite flat, this character not being attributable either to age or usage. I propose the name of *depressus* for this species. In the British Museum there are several examples of this tooth; it may also be seen in most collections of chalk fossils.

Ptychodus Mortoni, R. 4. (Tab. XXXI. figs. 6 & 7. Vol. iii. p. 158, Agassiz.)

The apex of this tooth presents ramifying folds, and its shape and appearance differ from all the other species; the specimen figured in M. Agassiz's work is from the greensand of North America, and from Dr. Mantell's collection: the tooth I have figured appears to me to agree in so many points with that from America, that I consider it the same species; it is from Mr. Catt's collection, and was found at Beeding chalk-pit, near Shoreham.

Ptychodus Oweni, new, R. 2. (Tab. XXXI. fig. 2.)

This is a beautiful species from the upper chalk of Kent. It differs from all its congeners in the great irregularity of the surface of the tooth. The folds of enamel are rarely parallel to any extent: they generally ramify in various directions from two or three principals, winding about, and sometimes bifurcating until they disappear at the margin of the tooth; their continuity is frequently interrupted. This species is in the Marquis of Northampton's collection, in Mr. Catt's and my own; the specimen figured belongs to Mr. Bowerbank, who has eight or ten others from one mass. It is a rare, but well-marked species: I have named it after my friend Professor Owen.

The specimens figured (Tab. XXX. figs. 4 & 5) were supposed by M. Agassiz to be young and not perfectly formed teeth of this genus.

Genus *Acrodus*[1], Agassiz.

This genus, according to M. Agassiz, presents the nearest affinity with the existing *Cestracion Philippi*, or Port Jackson Shark.

Acrodus Illingworthi, new, R. 3. (Tab. XXX. figs. 11 & 12; Tab. XXXII. fig. 9.)

I have dedicated this species to the Rev. Mr. Illingworth, who discovered the fine specimen (fig. 9, Tab. XXXII.) at Southeram chalk-pit.

It is a long tooth, the centre of which is considerably enlarged and elevated, having folds of enamel radiating from the apex; a well-marked ridge extends from the centre to the extremities, from which transverse folds pass off at right angles; the base of the tooth is very large.

Acrodus cretaceus, new, R. 4. (Tab. XXX. fig. 13.)

This tooth differs from the preceding in being shorter and broader; small

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[1] *ἄκρος summus, ὀδοὺς dens.*

lines of enamel diverge from the central ridge, more regularly on one side than the other; the shape is curved, and it has a thick base. In the centre of the jaw the teeth are probably larger; but it is a well-marked species. I have drawn this description from a small tooth in my own cabinet, found at Washington. Teeth of the same species are also preserved in Mr. Coombe's and Mr. Catt's collections.

Genus *Cestracion*[1], Cuvier.

Cestracion canaliculatus, Egerton, R. 4. (Tab. XXXII*. figs. 8 & 8^a.)

The discovery of a species of true *Cestracion* in the chalk is an event of much interest, since this genus has hitherto only been known from the recent *Cestracion Philippi* or Port Jackson Shark, a fish most valuable to palæontologists as being the only existing type of the family Cestraciontidæ, so extensively distributed through our fossiliferous strata, from the Silurian to the chalk both inclusive. The specimen proving the former existence of this genus in the cretaceous ocean belongs to the Marquis of Northampton, and was found in Kent. It fortunately shows both the anterior prehensile and posterior molar teeth; the former closely resemble those of the recent species in form, but they are longer in proportion as compared with the molars; the latter in the fossil are narrower, their surface rougher, and the central ridge higher, in the latter respect resembling the teeth of *Acrodus*. The most striking specific character occurs in the disposition of the medullary canals traversing the base of the teeth. These in the recent species are irregular in size, two or three being larger than the others. In the fossil one large canal is constant, traversing the base of each tooth, and forming, when they are in juxtaposition, a continuous passage through the entire range; the margin of one aperture of this canal in each tooth is produced, and corresponds with a depression on the adjoining tooth,—a mechanism very similar to the articulations of the scales in the Ganoid fishes. The arrangement of the teeth also differs from the recent species; in the latter the teeth before and behind the principal row diminish in size, but in the fossil we find a row of small teeth between two rows of larger ones. As far as the evidence of Lord Northampton's specimen goes, this species was much smaller than the *Cestracion Philippi*.

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[1] *κέστρα malleus, ὀδοὺς dens.*

Genus *Aulodus*[1], new, Agassiz.

Aulodus Agassizi, R. 4. (Tab. XXXII. fig. 6.)

This genus is nearly allied to *Strophodus* and *Psammodus*. The name *Aulodus* was proposed by M. Agassiz. The figured specimen from Mr. Catt's cabinet is the only example I have seen. It is a very thick, strong tooth, with large and distinct calcigerous tubes; the grinding surface is much worn and smooth.

Genus *Plethodus*[2], new, Dixon.

The name *Plethodus* is proposed for this genus, in reference to the multitude of calcigerous tubes of which the tooth is composed.

Plethodus expansus, R. 4. (Tab. XXXIII. fig. 2.)

This imperfect tooth from Mr. Catt's cabinet, of which the engraving is a good representation, is smooth and flat; it is not quite half an inch in thickness. It is a much-worn mass of calcigerous tubes, which in a horizontal section under the microscope have nearly the same arrangement as in *Ptychodus* and *Psammodus*. I have seen two or three other specimens not more than a quarter of an inch in thickness, showing the under surface to be concave and smooth as in *Cochliodus*[3].

Plethodus oblongus, R. 3. (Tab. XXXII*. fig. 4.)

In Mr. Coombe's and Mr. Catt's cabinets there are specimens of a tooth apparently belonging to this genus, but differing from those of the preceding species in their small size and oblong contour; they measure one inch in length by half an inch in breadth at the widest part; the surface is pitted or marked with small depressions varying in size and depth. The calcigerous tubes are very distinct.

Family SQUALIDÆ.

Genus *Corax*[4], Agassiz.

Corax maximus, new, R. 2. (Tab. XXX. fig. 17.)

A strong, thick tooth, from the upper chalk, much larger than *C. falcatus*,

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[1] αὐλὸς *fistula*, ὀδοὺς *dens*.

[2] πλῆθος *multitudo*, ὀδοὺς *dens*.

[3] A Cestraciont genus named by M. Agassiz from the mountain limestone.

[4] κόραξ *corvus*.

and differing in shape by being much less oblique and attenuated ; the notch on the posterior margin is smaller, and the accessory denticle not so prominent. The serrations surrounding the margin of the tooth are remarkable for their neatness and regularity ; they are smaller in proportion to the size of the tooth, than in any other species of the genus. I have observed it in the cabinets of the Rev. T. Image and Mr. Fitch, from Norfolk and Suffolk ; also in Captain Burgh's collection from Sussex. The figured specimen was procured at Houghton.

Genus *Oxyrhina*[1], Agassiz.

Oxyrhina crassidens, new, R. 3. (Tab. XXXI. figs. 13 & 13^{a}.)

This large and thick tooth I discovered at Houghton ; it differs from *O. Mantelli* by being shorter and more obtuse. The shoulders are deeply corrugated, almost to give the appearance of the lateral denticles of an *Otodus*.

Notes on the Order Ganoidei.

Family SAUROIDEI.

Genus *Pomognathus*[2], new, Agassiz.

Pomognathus eupterygius, R. 2. (Tab. XXXV. figs. 6 & 7.)

The name *Pomognathus* was proposed by M. Agassiz, from the lower jaw extending so far back towards the opercular bones. The teeth in the anterior portion of the jaws are exceedingly numerous, small, round and very pointed, sloping backwards towards the gullet. In the posterior extremities of the jaws, the teeth are few in number, considerably larger, flat and wide at their base. The pectoral, dorsal and ventral fins are displayed ; they are of large dimensions. It is allied to the genus *Caturus* of M. Agassiz. This beautiful fish forms a distinguished ornament in Mr. Catt's collection, and is faithfully represented by M. Dinkel. Detached upper and lower jaws are occasionally discovered[3].

Genus *Belonostomus*[4], Agassiz.

Belonostomus cinctus, R. 2. (Tab. XXXV. figs. 3 & 3*.)

This magnificent specimen agrees in most of its characters with the genus

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[1] *ὀξὺς acutus, ῥὶν nasus.*

[2] *πῶμα operculum, γνάθος maxilla.*

[3] The tail is reversed in fig. 6.

[4] *βελόνη acumen, στόμα os.*

Belonostomus, but it must have belonged to a larger fish than the jaw figured in the 'Poissons Fossiles'; the large teeth are most numerous in the anterior part of the jaw; they are conical, the apices being very sharp and solid, but the centres hollow.

Belonostomus attenuatus, R. 3. (Tab. XXXV. figs. 4 & 4*.)

Mr. Catt has also two specimens of the jaws of a *Belonostomus*, smaller and of far more delicate proportions than the preceding species, for which I propose the name *attenuatus*; the jaws are remarkably slender, and the teeth minute.

Genus *Prionolepis*[1], Egerton.

Prionolepis angustus, R. 4. (Tab. XXXII*. fig. 3.)

This genus is founded on a specimen from the cabinet of the Rev. Thomas Image, which was found at Burwell, near Newmarket: its nearest affinity is with the genus *Aspidorhynchus*, from which however it differs in the arrangement and articulations of the scales. The flanks of the fish were protected by a single series of long, narrow scales, deeply serrated on their posterior margins. In place of the broad elevated band, which occurs on the inner surface of the scales of *Aspidorhynchus*, the scales of this fish are furnished with a slight rib, defining the extent of the overlap; the perforation for the lateral line occurs near their upper extremities. The specimen only shows a small portion of the fish, the anterior and posterior extremities being deficient.

Family CŒLACANTHI[2].

Genus *Macropoma*[3], Agassiz.

Macropoma Mantelli, R. (Tab. XXXIV. fig. 2. Agassiz, vol. ii. p. 174.)

This fish is from 10 to 16 inches in length; it has two dorsal fins, the anterior one very large, with seven or eight strong rays; the two first have numerous spines; tail very broad and long; the teeth are small, conical and numerous, especially in the upper jaw. I have figured a fine head of this species, which shows the bones to be elegantly marked with a series of tuberculated lines radiating from the centres of ossification. I possess two specimens with coprolites in the

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[1] *πρίων serra, λεπὶς squama.*

[2] *κοῖλος cavus, ἄκανθα aculeus.*

[3] *μακρὸς extensus, πῶμα operculum.*

intestines. Southeram pit near Lewes and those near Amberley often produce good examples of this fish. It is certainly one of the finest fishes of the chalk formation.

Family Pycnodontidæ.

Genus *Pycnodus*[1], Agassiz.

Pycnodus parallelus, new, R. 4. (Tab. XXXIII. fig. 3.)

This fine specimen, from Mr. Catt's cabinet, has some resemblance to *Pycnodus gigas* of Agassiz, but the teeth are more elongated, and a distinct marginal ridge surrounds their base. The peculiar character of this species is the parallel arrangement of the teeth, which in other species is more or less oblique. The engraving is a good representation of the fossil.

Genus *Microdon*[2], Agassiz.

This genus very much resembles *Pycnodus*; the body is flat and nearly circular, the profile of the head almost vertical; the eye is placed high in the head, and the space between it and the mouth very considerable; the jaws are slightly prominent, and in the lower one there are four rows of teeth of uniform size; the fins are the same as in *Pycnodus*. The dentition forms a most essential character of the genus. The teeth are smaller than in *Pycnodus*, and more elongated.

Microdon nuchalis, new, R. 4. (Tab. XXXII. fig. 7.)

This small fish was found in a pit belonging to Sir Harry Goring, Bart., at Washington; it is on the opposite side of the road to the one I have mentioned as Washington chalk-pit. I have also procured from it a star-fish and other scarce fossils. The specimen shows little more than the head, but the form of the occipital region sufficiently distinguishes it from its nearest ally *Microdon radiatus*, from the Purbeck beds; this portion of the cranium is prolonged into a somewhat triangular crest, sloping backwards in the direction of the nape, whence its specific name.

Microdon occipitalis, R. 4. (Tab. XXXII*. fig. 2.)

Mr. Catt has a larger specimen of this genus, found at Lewes, which differs materially from the preceding species, not only in size, but in the larger di-

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[1] *πυκνὸς creber, ὀδοὺς dens.*

[2] *μικρὸς parvus, ὀδοὺς dens.*

mensions and coarser structure of the head-bones, for which I propose the name of *Microdon occipitalis*: Mr. Catt has also some teeth considerably larger than the two former, which indicate a third species (Tab. XXXII*. fig. 5).

Genus *Gyrodus*[1], Agassiz.

Gyrodus cretaceus, R. 3. (Tab. XXX. fig. 15. Vol. ii. part 2. pp. 233 & 246, Agassiz.)

The specimen from Dr. Mantell's collection, to which M. Agassiz has applied this name, is very much smaller than the one figured in this work; but as the latter resembles it closely, and was found at the same pit, near Lewes, I cannot but consider it a larger and more perfect example of the same species. From Mr. Bowerbank's cabinet.

Gyrodus angustus, R. 1. (Tab. XXX. fig. 14; and Tab. XXXIII. fig. 1. Vol. ii. part 2. pp. 235 & 246, Agassiz.)

M. Agassiz originally named this species from a few teeth found at Houghton; since then I have had the good fortune to find the magnificent and instructive figured specimen, which displays the two lower jaws and a great portion of the body with the scales. The structure of the teeth is described in Professor Owen's 'Odontography,' page 72; the larger teeth are smooth, and very much resemble a cucumber-seed; the smaller ones have a circular depression; the scales when first relieved from the chalk had a beautiful lustre; they are pitted, and have long processes which overlap each other. The scales along the nape of the neck terminate upwards in a row of projecting points, giving a highly ornamental finish to the outline of the fish.

Gyrodus conicus, new, R. 4. (Tab. XXXII. fig. 8.)

The conical character of these teeth sufficiently distinguishes them from those of *G. cretaceus*, and warrants a new specific name. The specimen is from Mr. Bass's collection at Brighton, and found at Malling.

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[1] *γῦρος gyrus, ὀδοὺς dens.*

Genus *Phacodus*[1], new, Dixon.

Phacodus punctatus, R. 4. (Tab. XXX. fig. 16.)

The name of the genus is taken from the kidneybean-shaped character of the teeth.

The teeth are smooth and worn down in the centre; they are easily distinguished from the *Pycnodontes*. They show the remains of calcigerous tubes in small dots and punctures. This is the only specimen I have seen. It forms part of my own cabinet, and was found near Lewes.

Notes on the Order Ctenoidei.

Family Percidæ.

Genus *Beryx*.

The genus *Beryx* was formed by Cuvier, and is allied to *Holocentrum* and *Myripristis*.

Beryx ornatus, V.C. (Tab. XXXVI. fig. 3; Tab. XXXIV. figs. 1, 4 & 5. Vol. iv. p. 115, Agassiz.)

Zeus Lewesiensis, Mantell.

This is a very common fish in the upper and lower chalk: it is found in great perfection in Kent and Sussex, and other counties of England, and on the Continent. I possess fine specimens from Houghton and the pits in that neighbourhood: the quarrymen at Lewes call this fish 'Johnny Dorey.'

Beryx radians, R. (Tab. XXXVI. fig. 4. Vol. iv. p. 118, Agassiz.)

This species is not so large as the former, but is longer in proportion; it is generally found in the lower chalk and chalk marl; the scales are particularly shining and pectinated, smaller than those of *B. ornatus* and of a dark colour. This fish is more rare than *B. ornatus*, but I have seen good specimens from the pits near Amberley, Steyning, Washington, Lewes and Clayton.

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[1] *φακὸς lens, ὀδοὺς dens.*

Beryx microcephalus, R. 2. (Tab. XXXIV. fig. 3. Vol. iv. p. 119, Agassiz.)

The head in this species (as its name implies) is small, and its form is more slender than *B. radians*. I have found this fish at Washington, but it is much rarer than the two preceding. The figured specimen is in the collection of Frederick Harford, Esq., obligingly procured for me by Dr. Mantell; it is from the chalk marl near Clayton, Sussex.

Beryx superbus, new, R. 2. (Tab. XXXVI. fig. 5.)

This very fine fish was pronounced to be new by M. Agassiz; it measures 18 inches long; the scales are particularly large and thick, slightly pectinated, and sculptured. The Rev. H. Hoper has a fine specimen of this fish: it is also in the collections of Lord Enniskillen, Sir Philip Egerton and Mr. Catt. I have described this fish from my own specimen, found at Southeram.

Genus *Berycopsis*[1], new, Agassiz.

This generic title was proposed by M. Agassiz for a fish in Mr. Catt's collection; having much resemblance to the genus *Beryx*, but differing from it in the absence of pectinations on the free margin of the scales.

Berycopsis elegans, R. 2. (Tab. XXXV. fig. 8.)

This fish in size and in its general character resembles *B. radians*, but the scales are smaller and more numerous, the body of the fish is also much deeper in proportion to its length: besides the beautiful specimen alluded to above, Sir P. Egerton and Lord Enniskillen have specimens in their cabinets.

Genus *Homonotus*[2], new, Agassiz.

Homonotus dorsalis, R. 2. (Tab. XXXV. fig. 2.)

This new fish, named by M. Agassiz, was found at Malling by Mr. Catt. In many of its characters it resembles the genus *Beryx*, but the vertebræ are more slender, the head smaller, and it has a longer and stronger dorsal fin, on which account I have proposed the specific name *dorsalis*; the scales are very delicate and rarely seen perfect. I have found it at Houghton and Brighton, and in Sir H. D. Goring's pit at Washington. It is in the collection of the Earl of Enniskillen and in that of Sir Philip Egerton, Bart.

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[1] beryx *beryx*, ὄψις *facies*.

[2] ὁμὸς *junctus*, νῶτος *dorsum*.

Genus *Stenostoma*[1], new, Agassiz.

Stenostoma pulchella, R. 4. (Tab. XXXVI. fig. 2.)

This well-preserved little fish is from Steyning chalk-pit. It has considerable affinities to the genus *Rhacolepis*, which is found in the chalk formation near Barra do Jardin, Serra de Araripe, N. Brazil, especially in the small size of the scales: this is the only example yet discovered, and forms part of my own cabinet. In shape it more resembles *Rhacolejus Brama* than *R. buccalis*.

Notes on the Order Cycloidei.

Family SCOMBEROIDEI.

Genus *Enchodus*[2], Agassiz.

Enchodus halocyon, R. 1. *Esox Lewesiensis*, Mantell. (Tab. XXX. fig. 27; Tab. XXXI. fig. 11. Agassiz, vol. v. p. 64.)

Single teeth and portions of the lower jaw of this fish are frequently discovered; the teeth are very brittle; they are not so numerous as in the Pike; the two anterior teeth are much longer than the rest. The jaws are beautifully granulated in longitudinal ridges; the scales are large and circular, marked with concentric lines; the vertebræ are longer than high. I procured a fine specimen of this fish from Balcombe pit, near Houghton; it shows the scales and vertebræ, and measures near a foot in length.

Tab. XXX. fig. 20. is a large specimen of the anterior tooth of an *Enchodus*, having serrated edges; this character is scarcely sufficient to warrant a second specific appellation.

Family SPHYRÆNIDÆ.

Genus *Saurodon*.

Saurodon Leanus, Agassiz, R. 2. (Tab. XXX. figs. 28 & 29; Tab. XXX1*. fig. 10.)

The specimen figured is of great interest; it shows the two lower jaws united at the symphysis, and a portion of the right palatine bone in its natural position.

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[1] στενὸς *angustus*, στόμα *os*.

[2] ἔγχος *gladius*, ὀδοὺς *dens*.

This fish must have had considerable resemblance to the Sphyræna or Baracuda Pike in the sharpness of its physiognomy, the length of the lower jaw, and the predatory character of its teeth. The barbed teeth described by M. Agassiz are those on the palatine bone, their edges are finely serrated; the teeth in the lower jaw are of an entirely different form, the base is broad and fluted, the blade compressed and recurved, with a sharp, finely-serrated edge; they are separated from each other by wide intervals, which are filled by innumerable, small, pointed teeth. It is from Malling pit near Lewes. I have several single, barbed teeth; all the specimens are from the upper chalk. I have found this tooth at Charlton near Woolwich, and at Gravesend.

Genus *Pachyrhizodus*[1], new, Agassiz.

Pachyrhizodus basalis, R. 4. (Tab. XXXIV. figs. 12 & 13.)

The fine and remarkably strong lower jaw of this fish, named by M. Agassiz, was found at Steyning. I have added the specific name of *basalis*, from the large size of the base of the tooth. The apex of the tooth is very brittle, slightly curved inwardly and solid; the base is hollow, and extends into the substance of the jaw. In Sir P. Egerton's cabinet there is a specimen of this fish, showing the humerus which is unusually thick and strong; it also shows the scales, which are large and circular, and covered with asperites so minute as to be indistinguishable without the aid of a glass.

Family SPHYRÆNIDÆ.

Genus *Saurocephalus*[2], Agassiz.

The teeth of this genus were first discovered in the chalk of America, and considered by R. Harlan to have belonged to reptiles. M. Agassiz placed them among the fishes of the family Sphyrænidæ, which has been proved to be correct by Professor Owen's microscopical investigations.

Saurocephalus lanciformis, R. (Tab. XXXIV. fig. 14; Tab. XXX. fig. 21; Tab. XXXI. fig. 12. Vol. v. p. 102, Agassiz.)

The finest specimen of this species hitherto discovered belongs to Mr. Bowerbank; it shows the extremities of the two rami of the lower jaw; the dentary

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[1] *παχὺς crassus, ῥίζα radix, ὀδοὺς dens.*

[2] *σαῦρος lacerta, κεφαλὴ caput.*

bones thicken out as they converge to the symphysis to give space for the implantation of six large lanciform teeth, which project forwards nearly in a horizontal direction ; the dentary bone immediately behind the symphysis is armed on its inner edge with strong laniary teeth ; the two hinder ones being on either side considerably larger than those that precede them ; the specimen is broken off a short distance from the commencement of the outer row, the anterior teeth of which are small.

The other specimen figured belongs to the valuable collection of Mrs. Smith ; and was found, as was the preceding one, in Kent. I have a portion of an upper jaw bone, with two teeth, from Amberley, Sussex, and have found single teeth in a perfect and beautiful state at Washington, Sussex ; these teeth are not hollow like those of the genus *Hypsodon*[1].

Saurocephalus striatus, R. 3. (Tab. XXXV. fig. 5. Vol. v. p. 102, Agassiz.)

The lower jaw of this species differs from the preceding one in its more delicate proportions, and in the absence of the thickened symphysis : in this respect it has a greater resemblance to *Saurodon* ; all the teeth are fixed on the outer edge of the dentary bone ; those near the symphysis have their points directed forwards, the remainder rake to the rear ; they are lanciform and striated. The engraved specimen is from Mr. Catt's cabinet, and was found at Southeram.

Family MUGILIDÆ.

Genus *Calamopleurus*[2], Agassiz.

Calamopleurus Anglicus, new, R. 4. (Tab. XXXII. fig. 12.)

This beautiful fish, from the collection of Sir Philip Egerton, was found in Kent, and is the only example of the genus yet discovered in England. M. Agassiz named the genus from a specimen in the British Museum, procured by Dr. Gardener in South America, from the cretaceous formation at the Villa de Barra do Jardin, about fourteen leagues south of Brazil, which he called *Calamopleurus cylindricus*. This species is larger than the Brazilian one, being when

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[1] Since this description was in type, Sir P. Egerton has obtained a specimen of *Saurocephalus lanciformis*, showing that the premaxillary bones were prolonged into a rostrum, as in the Xiphioids. Tab. XXXII*. fig. 1.

[2] *κάλαμος calamus, πλευρὰ latus.*

perfect about 16 inches in length; the caudal extremity is wanting in the fossil. The head was small, the body cylindrical, and the scales large and smooth; when seen under the microscope, they exhibit fine radiating lines as shown in the magnified view at fig. 11; the mouth was capable of great distention; the teeth are minute; the dorsal fin is placed about the middle of the back. This fish is assigned to the family Mugilidæ on the authority of M. Agassiz.

Family HALECOIDEI.

Genus *Osmeroides*, Agassiz.

Osmeroides Lewesiensis, *Salmo Lewesiensis*, Mantell R. 2. (Tab. XXXIII. fig. 4. Agassiz, vol. v. part 2, p. 105.)

These beautiful fish, formerly the ornaments of Dr. Mantell's collection, and now in the British Museum, are found in a more perfect state than any other fish in the chalk formation; they have hitherto only been met with in the lower chalk of Lewes. The figured specimen of *O. Lewesiensis*, if entire, would measure more than 12 inches in length. In developing these fish from the chalk Dr. Mantell has shown much ingenuity and perseverance, and they will ever remain as monuments of his anatomical knowledge and industry.

Osmeroides crassus.

Mr. Catt has in his collection a magnificent specimen of a head and shoulders of this genus, found at Southeram-pit. This fish has more resemblance to *O. Mantelli* than to *O. Lewesiensis;* it was however more massive in its proportions, and at least double its size. The lower jaws and the intermaxillary bones were furnished with thick, strong, conical teeth; the maxillary bones also carried a series of teeth of smaller size. This may be considered one of the finest ichthyolites that has been discovered in the chalk formation.

Genus *Tomognathus*[1], new, Agassiz.

The affinities of this genus are unknown; the only portions hitherto discovered have been jaws and portions of the cranium.

Tomognathus mordax, R. 1. (Tab. XXXV. fig. 1.)

The lower jaws of this genus are thick and strong; the anterior portion is

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[1] τόμος *incisio*, γνάθος *maxilla.*

furnished with eight or nine long hooked teeth on each side, ornamented with deep parallel grooves; the bone rises abruptly at the termination of the dental portion; and the remainder, amounting to more than half of the entire length, is edentulous; the teeth in the anterior portion of the upper jaw are larger and straighter than those in the lower.

Tomognathus leiodus, R. 1. (Tab. XXX. fig. 31.)

Mr. Catt has a specimen of this genus which appears to be distinct from the preceding; the most appreciable character is the absence of grooves on the teeth. The upper jaw appears to have been more prominent, and the teeth more attenuated. I discovered a lower jaw of this fish many years ago at Washington, Sussex. Mr. Catt has since found more perfect specimens with both jaws: the engraving is taken from a specimen in his cabinet. This species is in the collections of Lord Enniskillen, Sir Philip Egerton, Mr. Bowerbank, Mr. Coombe, and Mrs. Smith of Tonbridge Wells.

Description of the Fossil Reptiles of the Chalk Formation.

By PROFESSOR OWEN, F.R.S.

Class REPTILIA.

Order CROCODILIA.

Genus POLYPTYCHODON.

Species. *Polyptychodon interruptus* (Tab. XXXVII. figs. 16 & 17, and Tab. XXXVIII. fig. 3).

It appears from the evidence of detached teeth that a Saurian reptile as large as, if not identical with, the one whose massive remains were discovered by Mr. Mackeson in the greensand near Hythe, and to which I have given the generic name *Polyptychodon* *, existed during the period of the deposition of the chalk.

The fine crown of one of these teeth, which was found near Valmer in cutting the Lewes railway, and is now in the museum of Henry Catt, Esq., of Brighton, is represented of the natural size in Tab. XXXVII. figs. 16 & 17. It shows that alternate and interrupted character of the longitudinal ridges of the enameled surface which distinguishes the species called *Polyptychodon interruptus* † ; but the ridges have been more worn down, especially towards the apex, in Mr. Catt's specimen, than in the one originally figured in my 'Odontography.' The body of the crown consists of a hard compact dentine, partly resolved in the specimen by incipient decomposition into superimposed hollow cones, like the similarly-sized tooth of the *Polyptychodon continuus* from Mr. Bensted's greensand 'Iguanodon' quarry at Maidstone ‡. The cylindrical base of the tooth is excavated by a wide conical pulp-cavity with an obtuse summit, into which a small central process projects from the base of the crown (fig. 17). The enamel is very thin at the base of the crown.

The affinities of the remarkable Saurian genus *Polyptychodon*, on which the

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* Report on British Fossil Reptiles, p. 157.

† Odontography, pl. 72. figs. 4, 4′.

‡ *Ib.* fig. 3, and 'Report on British Fossil Reptiles,' p. 156.

detached teeth and the bones discovered at Hythe did not throw sufficient light, at the period of the publication of my 'Report on British Fossil Reptiles,' have received some additional elucidation through the unique example of a portion of the jaw with one entire tooth *in situ* and the socket of a second, which was discovered in the lower chalk-deposits of Kent, and now forms part of the valuable and instructive collection of Mrs. Smith of Tonbridge Wells.

On the hypothesis that the series of Saurian bones from the lower greensand quarry at Hythe, described in my 'Report on British Fossil Reptiles' (1841, p. 157), belonged to the same genus as that founded on the large Saurian teeth from the greensand and chalk formations, there was a probability that such genus had belonged to the Crocodilian order; the tibia and fibula and the metatarsal bones would favour such a reference, or at least would negative the ascription of the *Polyptychodon* to the Enaliosaurian order. There was a possibility, however, that the structure of the head and the mode of fixation of the teeth to the jaws might be found to be such as to show the *Polyptychodon* to have belonged to the Lacertian rather than to the Crocodilian order, and to have been, like *Mosasaurus*, the type of an extinct genus of gigantic marine Lizards. The specimen fig. 3. Tab. XXXVIII. inclines the balance in favour of the Crocodilian affinities of the remarkable Reptile in question, by showing that the teeth were implanted in distinct sockets, not anchylosed to the summits of processes of the jaw: the *Polyptychodon* is thus proved to be a 'thecodont' saurian, not an 'acrodont' lizard, like the *Mosasaurus*: the teeth are also separated by interspaces. In fig. 3, the letter *b* shows the smooth, cement-covered cylindrical base, and *c* the enameled conical crown, with the unequal ridges characteristic of the species *Polyptychodon interruptus*: *s* is an adjoining vacant alveolus, filled by the chalk matrix.

Order LACERTILIA, *Owen.*

Tribe NATANTIA.

Genus MOSASAURUS, *Conybeare.*

The *Mosasaurus* was a gigantic reptile, which in some respects more resembled the lizard than the crocodile, but had the feet shorter and more adapted for swimming. The largest species of *Mosasaurus*, and that which was first discovered, exceeded twenty-five feet in length, and derives its name from the circumstance of the locality on the banks of the *Meuse*, near Maëstricht, where the cretaceous deposits abound in which its remains occur. The most perfect skull of the animal hitherto obtained was here found; and it was for a long time the boast of the town of Maëstricht, until the capture of that place by the French, when it was removed to Paris, where it has since remained. A fine cast of this unique specimen may be seen in the Royal College of Surgeons in London. The teeth resemble in their form those of the Monitor lizard; but the presence of teeth on the bones of the palate, called ‘pterygoids,’ is a character by which the *Mosasaurus* more resembled the Iguana. The vertebræ have a convexity at one end and a concavity at the other, and are reckoned at upwards of 130 in number: the tail was very long, deep, and flattened from side to side, so as to form a powerful organ for swimming. From which characters, together with the number, size and shape of the teeth, it is plain that the *Mosasaurus* was an aquatic carnivorous reptile, most probably marine, and a formidable enemy to the fishes of the ancient ocean in which the deposits of the chalk were formed.

Mosasaurus gracilis, Owen (Tab. XXXVII. figs. 1–5; Tab. XXXIX. figs. 7, 8, 9).

Cuvier[*] says of the great *Mosasaurus* of Maëstricht, which is entered in the catalogues of M. v. Meyer and M. Pictet under the synonyms *M. Camperi* and *M. Hofmanni*, that "all the teeth are pyramidal, a little curved, with their external surface flat (‘plane’) and divided by two sharp ridges from the internal surface, which is round or rather semi-conical." Messrs. Von Meyer[†] and Pictet[‡] repeat Cuvier's description of the external characters of the crowns of the teeth; the one says, "ihre Aussenseite ist eben"—their outer side is flat or level; the other, "leur face externe est plane." My description[§], that "their outer side is nearly plane, or slightly convex," was founded on an examination of the magnificent fossil skull in the Parisian Museum, the original of Cuvier's description;—and the contour of the base of the crown of a maxillary tooth of the *Mosasaurus Hofmanni* given in fig. 1, is taken by accurate admeasurement from a perfect specimen from the Maëstricht chalk: the enameled crown of this tooth was 2 inches (5 centimeters) in length; the rest of the tooth was formed by the enlarged coarse osseous fang; the total length of the tooth being 4 inches 10 lines (12½ centimeters). Dr. A. Goldfuss, in his highly interesting and instructive account[||] of the skull and teeth of the *Mosasaurus*

Fig. 1.

Section of tooth, *Mosasaurus Hofmanni.*

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[*] Ossemens Fossiles, 4to, v. pt. 2. p. 322.

[†] Palæologica, p. 219.

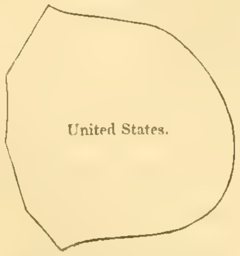
[‡] Traité élémentaire de Paléontologie, ii. p. 63.

[§] Odontography, 4to, p. 258.

[||] Nova Acta Acad. Nat. Cur. t. xxi. pt. 1. p. 175.

Maximiliani, accurately describes and figures the finely dentated character of the two opposite longitudinal ridges of the crown; but the feeble indications of angles observable in some of the teeth, those of the upper jaw chiefly, of the *Mosasaurus Hofmanni*, do not bear out the term 'polygonal' which he applies to the crowns of the teeth of that species, as well as to those of his *Mosasaurus Maximiliani* (fig. 2); still less can I find these angles so constant and regular as to divide the outer surface of the crown into five, and the inner surface into seven facets: nor have I seen in any maxillary or mandibular tooth of *Mosasaurus Hofmanni* that near equality of extent and convexity between the inner and outer surfaces of the crown, which Dr. A. Goldfuss describes (p. 178) and figures in tab. 9. fig. 4 of the memoir above-cited. If that figure accurately represents a maxillary tooth of the same species of *Mosasaurus* as the one described by Cuvier and recorded by V. Meyer and Pictet under the name of *M. Camperi* and *Hofmanni*; and if the outer surface of the crown is ever flat or level, the range of variety between the two extremes of flatness and convexity is greater than I have yet found in any of the equally well-marked forms of teeth in other fossil reptiles.

Fig. 2.



Section of tooth,
Mosasaurus Maximiliani.

The teeth in the specimens of upper and lower jaw of the species of Mosasaur from the chalk-pit at Offham, Sussex, now in the Museum of Henry Catt, Esq. of Brighton, and figured of the natural size in Pl. XXXVII. fig. 1 & 1 *a*, equally differ from the typical form of tooth of the *Mosasaurus Hofmanni* and from those of the *Mosasaurus Maximiliani*: the outer surface of the crowns of the mandibular teeth of *Mosasaurus gracilis* are more convex than those of *Mos. Hofmanni*, and are less convex than in *Mos. Maximiliani*: not any of the teeth of *Mosasaurus gracilis* present that angular disposition of the enamel which gives the polygonal form to the pyramidal crowns of the teeth of the *Mos. Maximiliani* (fig. 2). The lower jaw is more slender, less deep in proportion to its length, than in the great Maëstricht Mosasaur, and the hinder teeth are relatively smaller and closer together; I propose, therefore, to indicate the species by the name of *Mosasaurus gracilis*. The general form of the crown of the teeth in *Mos. gracilis* is shown at *a* and *b*, fig. 1. Pl. XXXVII.; an exact contour of the crown a little above its base is given at *c*, fig. 1. The smooth and polished enamel; the inequality of the outer and inner sides of the crown, such as it is; the implanted fang of the tooth thickly coated by a coarse osseous cement; the anchylosis of the general fang to the bony walls of the socket, which rise in a pyramidal form from the alveolar border of the jaw; manifest the peculiar generic characters of the great acrodont marine lizard, *Mosasaurus*. The maturity of the individual from which the present specimen (Pl. XXXVII. fig. 1) has been derived, cannot be inferred from the solidification and complete development of the anchylosed fangs of the teeth in a class of animals in which those organs are repeatedly shed and renewed: the worn-out teeth, in course of displacement, of the young Crocodile, with their alveoli, present in miniature all the senile characters of the corresponding teeth of the mature and aged animal. If, however, the specimen of Mosasaur in question should be adult, it would derive a well-marked specific character from its diminutive size as compared with the *Mosasaurus Hofmanni* or *Mos. Maximiliani*; being only one-half the size of the latter, and one-fourth that of the former species. But the characters of immaturity are not manifested by the cold-blooded animals in their osseous and dental systems as they are in the warm-blooded and higher organized mammalia*.

In all the teeth of the *Mosasaurus gracilis* in which the crown is broken, the remains of the pulp-cavity are exposed in the centre of its base: but the immaturity of the specimen is not demonstrated by this character; for, in the largest-sized teeth of the *Mosasaurus Hofmanni*, even in one with a completely developed fang, measuring with the crown nearly five inches in length, I have found a pulp-cavity extending from the base of the crown into the expanded fang, but becoming almost obliterated at the base of the fang. The cast of the crown of a still larger tooth of a Mosasaurus from the greensand of New Jersey, U.S., also shows the remains of a pulp-cavity at its base. This cavity becomes filled in the fossil specimens with the matrix, which is usually chalk; but sometimes the cavity, like the air-chambers of polythalamous shells, is filled with silex.

The number of teeth in each ramus of the lower jaw of *Mosasaurus gracilis* seems not to have exceeded twelve. In *Mosasaurus Maximiliani* they are reckoned at eleven†; in *Mosasaurus Hofmanni* at fourteen‡. The posterior teeth are rather smaller than the others in *Mosasaurus gracilis*. At the fore-part of the jaw the implanted and anchylosed base of the teeth extends through about

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* Dr. Goldfuss infers the maturity of his *Mosasaurus Maximiliani* from the characters, of which the inadequacy is explained above. "Die vollständige Verknöcherung aller Theile, so wie die häufige bemerkbare Aussfullung der Zähne beweisen, dass das Individuum seine vollständige Ausbildung und mit dieser nur die halbe länge des *Mosasaurus Hofmanni* erreicht hatte." (*l. c.* p. 177.)

† Goldfuss, *loc. cit.* p. 178.

‡ Cuvier, *loc. cit.* p. 320.

half the vertical diameter of the jaw; at the posterior part of the series the fangs sink into one-third or one-fourth the depth of the jaw. The canal, which, as in the Crocodile, extends below and along the inner side of the bases of the sockets and anchylosed fangs, is shown, filled by chalk, at *d*, fig. 1. Pl. XXXVII. Traces of the vascular foramina along the outer side of the jaw are visible in the right dentary piece whose outer side is exposed: the 'splenial' ('opercular,' Cuvier) element is shown at fig. 1, on the left ramus.

In the portion of the left superior maxillary bone (Pl. XXXVII. fig. 1 *a*) all the teeth are, unluckily, too much broken or abraded to give an idea of the precise form of their crowns; they are rather more compressed at their base than in *Mosasaurus Hofmanni*: the posterior ridge is much less developed, and the whole of the posterior longitudinally concave border is more transversely convex than in *Mosasaurus Hofmanni* or *Mos. Maximiliani*. There is as little indication of the angular or polygonal structure in these teeth as in those of the lower jaw; but the enamel shows some longitudinal striations.

All the vertebræ of the *Mosasaurus*, according to Cuvier, are concave at the fore-part, convex at the hind-part of their bodies; the convexity and concavity being greatest on the anterior vertebræ. The foremost of these are characterized by an inferior spinous process developed from the middle of the lower surface of the centrum: they have two transverse and four articular processes, and a long compressed upper spine. The centrum is longer than it is broad, and broader than it is high: the terminal articular surfaces are transversely oval or reniform. Such are the characters of the last cervical or first dorsal vertebræ. The middle dorsal vertebræ are like these, but have no inferior spinous process. Then follow vertebræ which have no articular or oblique processes (zygapophyses), but have longer and flatter transverse processes (diapophyses), and terminal articular surfaces of a triangular form with the base downwards. Next come vertebræ with transverse processes and inferior processes (parapophyses) for the articulation of chevron-bones (hæmapophyses): afterwards vertebræ without transverse processes and with large anchylosed chevron-bones (hæmapophyses); and finally vertebræ devoid of all processes whatever.

The vertebræ discovered in the Kentish chalk with the jaws and teeth above described, and of corresponding proportions with the vertebræ of the *Mosasaurus Hofmanni*, present all the generic characters of these parts of the skeleton of that Lacertian genus, and correspond with the third and sixth kind, or with the posterior dorsal and the anterior caudal vertebræ, as defined by Cuvier. But the terminal articulations of the centrum of the dorsal vertebræ of *Mosasaurus gracilis* present a full oval (not elliptical) form, the long axis of which is vertical and the great end downwards (Pl. XXXVII. fig. 4). The length of the centrum (*ib.* fig. 3), which is 3½ centimeters, or 1 inch 5 lines, exceeds the breadth ; but this is equalled by the height of the centrum. The diapophyses in fig. 2, *d*, are broken away ; in fig. 3 it is uncertain whether the surface be a fractured one, or whether it is a natural articular cavity for the rib ; the analogy of *Mosasaurus Hofmanni* favours the former view of it. The neural arch (fig. 3, *n*) is anchylosed to the centrum, as in the larger species of *Mosasaurus*. I can perceive only a feeble indication of zygapophyses, which shows that the vertebræ (figs. 2, 3 & 4) come from the posterior region of the back. The neural canal (fig. 4, *n*) is small and triangular : a sharp longitudinal ridge rises from the middle of its floor, and on each side of this there is a vascular canal descending vertically into the substance of the centrum : this substance presents a coarse fibro-cancellous texture ; the areolæ extended longitudinally, and decreasing much in size at the ends of the centrum. The outer surface of the vertebra is smooth : the margins of the anterior articular concavity are sharp.

The vertebra (Pl. XXXVII. fig. 2) shows, by the lower position of the diapophysis (*d*), that it comes from a more posterior position of the spine than that represented in fig. 3. Figs. 4 & 5 give two views of the same vertebra, but in a reversed position, the hæmal canal *h* being upwards ; they demonstrate another Mosasaurian character in the anchylosis of the hæmapophyses or chevron-bones to the centrum, as in the posterior caudal vertebræ of *Mosasaurus Hofmanni* : but the hæmal canal (fig. 4, *h*) is relatively wider, and the entire centrum is much longer than in the corresponding kind of vertebra figured by Cuvier*.

Three views of the body of a vertebra of the *Mosasaurus gracilis*, discovered by the Rev. H. Hooper, M.A., distinguished by his geological researches in the neighbourhood of Lewes and Brighton, are given in Tab. XXXIX. figs. 5, 6, & 7. This specimen is from the Sotheram Pit near Lewes. In the rich collection of Mrs. Smith are preserved some of the bones of a fin or paddle of the *Mosasaurus*.

From the genus *Leiodon*† the *Mosasaurus gracilis* differs, like the *Mosasaurus Hofmanni*, in the inequality of the two sides of the crown of the teeth, which are bounded or divided by the anterior and posterior ridges. The *Mosasaurus Maximiliani* differs from the genus *Leiodon* in the polygonal character of the crowns of the teeth.

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* *Loc. cit.* pl. 19. fig. 6, *A*, *B*.

† Odontography, 4to, p. 261, pl. 72. figs. 1 & 2.

Genus Leiodon.

(Tab. XXXVII. figs. 10, 11 & 12; Tab. XXXVIII. figs. 8 & 9.)

Of three teeth which, by the equality of the two sides, and consequent elliptic transverse section of the crown, are referable to the genus *Leiodon*, one, from the chalk of Norfolk (Pl. XXXVII. fig. 12*), presents the size of the specimens figured in my 'Odontography' (pl. 72. figs. 1 & 2), on which the genus was originally founded, and belongs, therefore, to the *Leiodon anceps*. The other specimen, Pl. XXXVII. fig. 11, from the chalk of Sussex, presents only half the size of this; and the third specimen (fig. 10), from the same locality, is still smaller.

These specimens, now in the museum of Henry Catt, Esq., may belong to the pterygoid bones of the larger species of *Leiodon*; or possibly even to those bones in the *Mosasaurus gracilis*, since the pterygoid teeth of the *Mosasaurus Hofmanni* approach the characteristic form of the teeth of the genus *Leiodon*: but that genus of Mosasauroid Lizards is founded on specimens attached to the mandibular, not the pterygoid bones.

A fine and characteristic tooth of the *Leiodon anceps*, found in the chalk in cutting the Brighton and Lewes railway, and which is also in the collection of Mr. Catt, is figured in Pl. XXXVIII. figs. 8 & 9.

Fig. 14. Pl. XXXVII. represents the crown of a conical curved tooth with a full elliptical base which is excavated in the middle by the apex of the pulp-cavity; two principal, but not quite opposite longitudinal ridges divide the surface of the crown into an outer longitudinally convex, and an inner longitudinally concave surface: the latter, transversely, forms three-fourths of a circle, and the same proportion of the circumference of the tooth: the outer facet is less convex transversely. All the outer surface of the tooth is finely grooved or striated longitudinally; but the outer surface also shows four or five longitudinal ridges or angles of the enamel at unequal intervals, and there is one similar ridge the inner side near one of the larger boundary ridges. This tooth belongs most probably to some member of the Mosasauroid family. It is from the chalk formation near Norwich.

Tribe Repentia.

Genus Raphiosaurus.

Species. *Raphiosaurus Lucius*. (Tab. XXXIX. figs. 1, 2 & 3.)

In a Memoir communicated to the Geological Society of London in 1840, and in my 'Report on British Fossil Reptiles,' published in the volume of 'Reports of the British Association' for 1841, p. 145, I proposed the name of *Raphiosaurus** for a genus of small extinct lacertine *Sauria*, characterized by slender awl-shaped teeth, attached by anchylosis in a single series to the bottom of a shallow alveolar groove, and to the inner side of an outer wall or parapet of the same groove; thus corresponding with that type of saurian dentition called 'pleurodont' amongst modern Lizards†.

The specimen figured in Pl. XXXIX. figs. 1, 2 & 3, was discovered in the lower chalk near Cambridge; it consists of a considerable portion of the dentary part of the lower jaw, and contains twenty-two of the above-described teeth, arranged in a close series: *a*, fig. 3, is a tooth in place; *b*, a tooth with the crown broken off; and *c*, the groove or incomplete socket of a shed tooth.

At the period when this fossil was described‡, the only vertebræ of a lacertine Saurian, which at all approximated to the proportions of the species indicated by the jaw and teeth of the *Raphiosaurus*, were those which Sir Philip de M. Grey Egerton had kindly submitted to my inspection, and which are figured in the volume of the Geological Society's Transactions already cited. That chain of vertebræ was discovered in the lower chalk of Kent, and manifested specific distinctions from the vertebræ of the existing genera of Lacertians with which I was able to compare them in 1840; and at that time I could only suggest, when pressed for a closer determination, that, on the hypothesis of their having belonged to the same species as the fossil Lacertian from the Cambridge chalk, they must be referred to a Lizard generically distinct from any known existing species. Other specimens with which Mr. Dixon afterwards supplied me, have rendered it highly probable that the vertebræ (figured in Pl. XXXIX. fig. 4) belonged to an extinct Lizard, distinct from the Cambridge *Raphiosaurus Lucius*, with the vertebral characters of which species we are still, therefore, unacquainted.

Genus CONIASAURUS.

Species. *Coniasaurus crassidens*. (Tab. XXXVII. figs. 18, 19, 19 *a* & 20.)

Two genera of Lizards of the cretaceous period, with procælian cup-and-ball vertebræ, similar in size and form to those of the series figured and described in the 'Geological Transactions§,' are now no longer hypothetical, but have been

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* From *ῥαφίον* an awl, *σαύρος* a lizard.

† Odontography, 4to, p. 182.

‡ Transactions of the Geological Society, 2nd Series, vol. vi. p. 412, pl. 39. fig. 3.

§ *Ib.* p. 413.

satisfactorily established by the discovery of portions of jaws and teeth associated with such vertebræ. The first of these specimens, which discloses a small extinct Lacertian, distinct from *Raphiosaurus*, and characteristic of the chalk formation, was obtained from the lower chalk at Clayton, Sussex, and forms part of the choice and instructive collection of Henry Catt, Esq., of Brighton. It is figured in Pl. XXXVII. figs. 19 & 20, and a group of vertebræ of apparently the same species is represented in fig. 18.

These vertebræ are represented of the natural size. Like those first figured in the ' Geological Transactions,' tom. cit., pl. 39, they present an anterior concavity or cup, and a posterior ball upon the bodies for their reciprocal articulation; and a tubercle is developed from each side of the vertebral body near its anterior end for the articulation of the rib. The non-articular surface of the vertebra is smooth; its under part is concave in the axis of the body, convex transversely. On the very probable supposition, however, that the vertebræ, *v*, fig. 19, belonged to the same animal as the jaw which is imbedded in the same portion of chalk, such vertebræ must be smaller in proportion to the head than in the extinct species of lacertine Saurian, likewise from the chalk (Pl. XXXVIII. fig. 1), and to which there will be adduced reasons for believing that the fine specimen in the collection of Sir P. de M. Grey Egerton, Bart. (Pl. XXXIX. fig. 4) belongs. The fossil jaw and teeth in Pl. XXXVII. fig. 19. determine the distinctness of the *Coniasaurus* from the above-named fossil as well as from all known recent Lizards.

The dentary bone contains from 18 to 20 teeth; the anterior five or six teeth are slender, slightly recurved, pointed or laniariform; the rest progressively increase in thickness as they are placed further back; expanding above the neck, slightly compressed laterally, most convex inwardly, with an anterior border which is more prominent and curved than the posterior one: the anterior margin is further characterized by a longitudinal groove on its outer side. Some of the posterior teeth show a slight longitudinal indent near the posterior obtuse border; on the last molar is smaller and more obtuse than the others. The enamel is very finely wrinkled.. The teeth are closely and rather obliquely arranged; the long simple roots are anchylosed to the bottom of the shallow alveolar groove and to the inner side of the outer wall, and their excavations indicate the usual mode of succession and displacement: a few alternate teeth have been shed.

The mode of attachment more resembles that which characterises the teeth in *Lacerta* proper and other *Cœlodont* genera of the Lacertian tribe; but in the number, proportions, and general shape of the teeth, the present species more resembles some of the Iguanian tribe. The anterior coronal groove is continued to the anterior margin of the crown, which it slightly indents in the larger teeth; but this is the only approach to that complex structure which characterises the teeth of the typical *Iguanidæ*. Fig. 19 *a* is a magnified view of the crown of one of the anterior teeth; and fig. 19 *a'* of one of the posterior teeth.

There is no existing species of the Iguanian or other herbivorous family, nor of any of the pleurodont Saurians, with which the present chalk-fossil is identical; nor can I refer it to any of the established genera of *Lacertia*. The absence of the cranium and bones of the extremities does not allow of any closer comparison with the Monitors, Iguanas or Scinks; but the characters of the teeth justify the consideration of the fossil as the type of a hitherto undescribed genus and species, which I therefore propose to call *Coniasaurus crassidens*, or the thick-toothed Lizard of the Chalk formation.

The specimens represented in figs. 18, 19 & 20 are from the Clayton chalk-pit near Brighton: a smaller portion of a lower jaw and a few teeth have been obtained by Mr. Dixon from the Washington chalk-pit near Worthing: and vertebræ have been found by Mr. Catt in the upper chalk near Falmer, during the cutting of the railroad from Brighton to Lewes. These are the only specimens of the genus and species that have yet been discovered.

Genus Dolichosaurus.

Species. *Dolichosaurus longicollis.* (Tab. XXXVIII. figs. 1 & 2; Tab. XXXIX. fig. 4.)

Mr. Dixon has obtained such information relative to the beautiful specimen of the mutilated head and anterior thirty-six vertebræ of the fossil Lizard from the lower chalk of Kent, in the admirable collection of Mrs. Smith of Tunbridge, and figured in Pl. XXXVIII. fig. 1, as leaves no doubt in his mind that it formed part of the same skeleton with the chain of posterior abdominal and sacral vertebræ in the collection of Sir P. de M. Grey Egerton, Bart., M.P., F.G.S., and which is figured in the 'Geological Transactions,' 2nd Series, vol. vi. pl. 39; and in the present work at Pl. XXXIX. fig. 4.

Both specimens are from the same quarry or pit at Burham in Kent, were found at the same time, and there is good reason to suppose in the same block of chalk. It appears, however, that they were disposed of by the quarrymen to different persons, and ultimately found their way to the two collections of which they are now respectively the ornaments.

Assuming then the two groups of vertebræ to have belonged to the same skeleton, and the conformity in shape, and size of the vertebræ and ribs, favour the conclusion which Mr. Dixon has drawn from the historical evidence, we may then enumerate fifty-seven vertebræ between the skull and the pelvis, supposing that none have been lost between the end of the specimen in Pl. XXXVIII. and the beginning of that in Pl. XXXIX. Amongst existing Lacertians this number of abdominal (cervical and dorsal) vertebræ is equalled only by those snake-like species (*Pseudopus*, *Bipes*, *Ophisaurus*) which seem to make the transition from the Lacertian to the Ophidian Reptiles: but not any of such genera manifest so well-developed a humerus and scapular arch as are indicated in fig. 1. Pl. XXXVIII., at 51 & 53, or so complete a sacrum and pelvic bones as are shown in fig. 4. Pl. XXXIX. Of those existing Lacertians which had the hinder extremities as well developed as in the extinct species under consideration, the greatest recorded number of vertebræ between the skull and the sacrum is forty-one*.

Although the evidence relating to the discovery of the specimens (fig. 4. Pl. XXXIX. and fig. 1. Pl. XXXVIII.) is such as to lead me to deem it highly probable that they form the anterior and posterior moieties of the vertebræ of the trunk of the same individual; yet, as it does not amount to absolute demonstration, the characters of the Saurian in question must for the present be rigorously deduced from those parts which are unaffected by such uncertainty. In this fit condition for scientific comparison must be regarded the fragment of skull, and the chain of thirty-six vertebræ imbedded in one block of chalk and represented in Pl. XXXVIII. fig. 1. The most cautious and sceptical Palæontologist must admit, after scrupulous examination of the specimen, that the jaws and the portion of vertebral column, which are accurately figured in the plate, have belonged to one and the same animal, having been subject to no greater amount of dislocation than is represented at the twenty-fifth vertebra for example, and in the position of some of the ribs. Viewing the slight extent of displacement of any of these parts in the fossil, it is very improbable that the scapular arch (51) should have been subjected to any considerably greater degree of displacement; and taking, also, into consideration the gradual diminution of the

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* According to the table in Cuvier, Leçons d'Anat. Comp. i. (1836) p. 221, *e.g.* in the *Scincus ocellatus*.

vertebræ, as they extend forwards from the place of the scapular arch in the fossil, at the eighteenth or twentieth vertebræ, to the cranium, and the remarkable and striking difference in the shape and size of the pleurapophyses (vertebral ribs, *pl*, *pl*) in those anterior vertebræ, I am led to conclude that the position of the remains of the scapular arch (51) in the fossil was, in relation to the vertebral column, its true position in the skeleton of the living reptile, and that the vertebræ anterior to it answer to those which are called cervical by Cuvier, in those existing Lizards which have four well-developed extremities.

The artificial character of the 'cervical' vertebræ of anatomy is more obvious in the Lacertine Sauria than in most other vertebrates. Cuvier, who has assigned a given number of such vertebræ to several species of Lacertians in his 'Table of the Vertebræ of Reptiles*,' does not define their characters. He merely observes that "they have inferior crests like the anterior dorsal vertebræ†."

With regard to the *Monitor* (*Varanus*) Cuvier affirms, in another work‡, that the "inferior crest distinguishes the cervical from the dorsal vertebræ;" but he admits that the first three of these dorsal vertebræ have an inferior tubercle. Proceeding next to speak of the American Monitor (*Monitor* proper, or *Tejus*), he says,—"Les vertèbres cervicales, déterminées par les fausses côtes antérieures, sont au nombre de huit, c'est-à-dire qu'il y a six paires de ces fausses côtes§." This number of so-defined cervicals is found in the Iguanians, Basiliscs, true Lizards, Geckos, Anolises, Agamians and Stellios. But Cuvier avows that two if not three of the last of these cervical vertebræ, although their false ribs (pleurapophyses) do not reach the sternum, are embraced by the scapular arch, and concur in the formation of the chest: if these be accordingly subtracted, the number of cervicals will be reduced, Cuvier says, to five. In the 'Table of Vertebræ' above-cited only four cervicals are allowed to the Iguana, Basilisc, the banded Gecko, Anolis, Agama, and Levantine Stellio. There is a difference, however, in the number assigned to some of these species in the table in the 'Ossemens Fossiles‖.' But all these discrepances depend on the arbitrary and inconsistent characters that have been assigned to the cervical vertebræ of Lizards.

Recognizing the artificial nature of such a group of vertebræ, I believe that that character would be most easily determined, and, therefore, most convenient in its application, which should be founded on the absence of sternal ribs

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[*] Leçons d'Anat. Comp. i. (1835) p. 220.

[†] *Ib.* p. 215.

[‡] Ossemens Fossiles, 4to, v. pt. ii. p. 284.

[§] *Ib.* p. 285.

[‖] Tom. cit. p. 288

(hæmapophyses): according to which the vertebra that first was joined to the sternum by sternal ribs would be reckoned as the first 'dorsal,' and all anterior to it as 'cervical vertebræ.' This arbitrary character would agree with that by which the cervical vertebræ are, in point of fact, defined in the Human subject and mammalia generally.

In the fossil Lacertian, however, which forms the more immediate subject of this description, there is no indication of a junction of the vertebral rib (pleurapophysis) by a sternal rib (hæmapophysis) with a sternum (hæmal spine), and I can only compare the cervical region of the spine with that in existing Lacertians, insofar as relates to the vertebræ situated between the skull and the scapular arch. The number of vertebræ so situated in modern Lacertians is usually five, and rarely exceeds six: in the *Dolichosaurus* it was seventeen. In modern Lacertians the bodies and neural arches of such cervicals are scarcely inferior in breadth to the succeeding vertebræ, and commonly surpass them in depth by reason of the largely developed inferior spinous processes. The short anterior pleurapophyses are usually thick, broad, and expanded at their extremities, or are 'hatchet-shaped' (*Cyclodus*, *Tiliqua*, *Scincus*). Besides the superior number of the cervicals in the *Dolichosaurus*, they exhibit a more decided decrease of size as they approach the head: the pleurapophysis of the third or fourth vertebra is short, almost straight, and very slender: that of the eighth or ninth vertebra is also very slender, and but a little longer: those of the three succeeding vertebræ progressively though slightly increase in length, but the vertebral ribs do not exhibit their normal length until the seventeenth or eighteenth vertebra: the pleurapophysial character of these eighteen or twenty anterior vertebræ is much more like that of the same vertebræ in the Ophidian than in the existing Lacertian reptiles: and there is no trace of any of the vertebral ribs having supported sternal ribs, or having been attached by these to a sternum. The slender anterior ribs increase in length, however, more gradually in the *Dolichosaurus* than in Serpents.

The parietal and occipital regions of the fossil skull, with the atlas and dentata, have been too much crushed to allow of their structure being accurately determined and compared: the first tolerably entire vertebra appears to be the fourth from the head: the expanded back-part of the neural arch receives the contracted fore-part of that arch of the fifth vertebra: the base of the neural spine is slightly expanded posteriorly. In the fifth and succeeding vertebræ the anterior articular processes look upwards, the posterior ones downwards, and they are simple as in ordinary Lizards, but rather longer and more slender. The thin base of the neural spine extends along the middle of the summit of the entire arch; the sides of which slope downwards and outwards more gradually, *i.e.* do not curve outwards so suddenly as in the *Iguana* and *Cyclodus*. The short convex diapophysis (*d*) supporting the rib is developed from the side of the fore-part of the centrum beneath and a little behind the anterior zygapophysis. I excavated the chalk beneath the seventh vertebra, and exposed a short compressed inferior spine projecting downwards from the middle of the hinder half of the centrum. The ribs are hollow, as in the *Cyclodus** and in Ophidians. The long pleurapophyses of the twentieth and succeeding vertebræ are more compressed than in the *Iguana* and *Cyclodus*: they are less regularly or gradually curved: the comparatively straight middle portion after the first slight bend is too constant in the ribs of the fossil not to be natural: this shape of the ribs indicates the abdomen to have been more compressed, as the number of vertebræ shows it to have been longer than in the *Iguana* or *Cyclodus*. The twenty-sixth vertebra is dislocated: the two following are turned upon their side and expose the under part: here the inferior spine has disappeared: the surface is smooth, slightly punctate, gently concave lengthwise, convex transversely. Figure 2 gives a direct side-view, magnified, of the best-preserved ramus (the left) of the jaw: below, in outline, of the natural size; above, magnified. The extent and upward curve of the coronoid piece (*c*) most resembles that in the *Varanus* (Cuvier, loc. cit. pl. 16. fig. 8, *c*); but in this genus it is relatively shorter than in the *Dolichosaurus*, and in other recent Lacertians it is still shorter and more pyramidal in shape. The extent of the surangular (30), and its length behind the coronoid, are lacertian characters: but the outer surface is divided by a longitudinal ridge or angle into an upper and a lower facet, the upper one being slightly excavated: the enameled crowns of the last four teeth show a simple obtuse shape; they are chiefly remarkable for their small proportional size. The two dentary bones meet at an acute angle; that on the right side joins a supra-angular piece which is continued back to near the articular surface. Allowing a symphysis of the ordinary lacertian proportions, the length of the under jaw may be estimated to have been four centimeters (1 inch 7 lines), or equal to between four and five dorsal vertebræ.

Parallel with the eighteenth, nineteenth and twentieth vertebræ lie the remains

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* The vertebral ribs (pleurapophyses) are probably hollow in other Lacertians, but I cite only the genus in which I have found them so in the present comparison.

of a broad, thin and flat bone (51), with a smooth emargination, and a rough or slightly granulated surface. As the broad, thin and anteriorly emarginate scapula of the Iguana presents a similar surface, I conclude the part in the fossil marked 51 to be the scapula; and the short, thick, subcylindrical, hollow bone (53), slightly twisted and expanded at both ends, to be the shaft of the humerus: it is shorter in proportion to its breadth than in the existing Lizards, and probably supported a shorter fore-arm and fore-foot; the whole limb being therefore, perhaps, more formed for swimming than in the Monitors and Iguanæ.

The ball-and-socket structure of the vertebræ is better adapted to sustain the body on dry land than the biconcave structure; but the modern Crocodiles, the Amblyrhynchus, and the rare instance of the Lepidosteus amongst fishes, prove it not to be incompatible with aquatic habits. The *Dolichosaurus*, with a procœlian type of vertebrate structure, and amongst the earliest reptiles that manifested such structure, may well have been a good swimmer and frequenter of the ancient ocean of its epoch, as well as a crawler on dry land. Although the articulations of the vertebræ must have limited if not prohibited the bending of the spine in the vertical direction, the extent of lateral flexuosity is considerable; the double curve of the fore-part of the vertebral column, preserved in fig. 1, being evidently the natural one assumed in the last struggles of the dying animal.

Assuming that the specimens fig. 1. Pl. XXXVIII. and fig. 4. Pl. XXXIX. give the natural length of the neck and trunk of the *Dolichosaurus*, to which trunk the size of the anterior caudal vertebræ indicate a long and strong tail to have been appended, the progress of the long and slender *Dolichosaurus* through the water would be by flexuous and undulatory lateral movements of the entire body, like those of a water-snake or eel.

The specimen fig. 1. Pl. XXXVIII. demonstrates that this procœlian Lizard of the cretaceous period had a smaller head and a longer, more slender and tapering neck than any known existing species of the Lacertian order of Reptiles.

The hinder moiety of the trunk-vertebræ, with part of the pelvis and root of the tail,—which, from the correspondence of size, shape and structure of the vertebræ, I refer to the *Dolichosaurus*, and from the evidence above given, corroborated by the disposition of the parts in the chalk-matrix, I believe to be part of the same skeleton as the anterior moiety, fig. 1. Pl. XXXVIII.—includes twenty-one abdominal, two sacral, and five caudal vertebræ. They have been exposed by the removal of the chalk from their inferior or ventral surfaces, the operation having been commenced from the opposite side of the block from that at which the exposure of the part of the skeleton in the other portion of the same block of chalk has been effected. The bodies of the vertebræ and the ribs show the same disposition and slight degree of dislocation as in the specimen. The ribs have been pressed by the weight of the surrounding chalk, as the soft parts yielded and became decomposed, close to the sides of the vertebræ, but with scarcely any further dislocation; and the vertebræ, maintaining the close articulations of their cup-and-ball surfaces, continue, with not more deviation from the straight line than a slight flexuosity, like that shown by the last six vertebræ in the moiety of the skeleton in Pl. XXXVIII.

The under surfaces of the vertebræ exhibit the same smooth, imperforate, longitudinally concave, transversely convex surfaces, as in the anterior dorsals of the last-described specimen: as in that specimen, also, they are longer in proportion to their breadth than in the Monitor (*Varanus* ?) figured by Cuvier*, or than in the *Iguana*, *Cyclodus* and *Tiliqua*: the diapophyses rise by a shorter base than in the *Iguana*: in an Australian *Tiliqua* I find the under surface of the centrum with two vascular perforations towards its fore-part, which are not present in the *Dolichosaurus*, nor in many of the existing Lacertians. Each diapophysis forms a short rounded tubercle, immediately below the base of the anterior zygapophysis; and the simple, slightly expanded head of the rib is excavated to fit the tubercle. In the degree of compression and expansion of the proximal portions of the ribs, and in their curvature, the present precisely corresponds with the preceding portion of the skeleton of the *Dolichosaurus*; and it is obvious that the natural form of the abdomen must have been deep and narrow, like that of the Water-Snakes (*Hydrophides*).

The length of the last two abdominal vertebræ slightly decreases: a short, slender, nearly straight and pointed pleurapophysis projects outwards from the diapophysis of the last abdominal (lumbar) vertebra with which it has become anchylosed. The pleurapophyses of the next two vertebræ are equally confluent with the diapophyses, but are rather longer and much thicker than those of the preceding vertebra: they are also slightly expanded and truncate at their ends; they determine by these proportions the 'sacral vertebræ,' which thus agree in number, as in general structure, in the *Dolichosaurus* with those in existing Lacertians.

Part of the bodies of the two sacral vertebræ has been destroyed, but evident

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* Ossem. Foss. v. pt. ii. pl. 17. fig. 23.

traces of the persistent cup-and-ball articulation between them remain. In the Scincoids the bodies of the sacral vertebræ become anchylosed together. The extremities of the sacral pleurapophyses come into contact in the *Dolichosaurus*, but do not coalesce: the second sacral vertebra presents a ball to the first caudal, as in existing Lacertians, not a cup, as in the modern *Crocodilia*. On the right side of the specimen the hinder half of the iliac bone extends backwards, projecting freely a short way behind the second sacral pleurapophysis, as in some modern Lacertians (*Cyclodus*, e. g.). On the left side a part of the ilium is preserved, which extends to the acetabulum. A portion of the expanded ischium is likewise preserved, and the distal half of the left femur extends back in a right line from the position of the hip-joint. The length of the entire femur could not have exceeded three centimeters (14 lines); it thus agrees in its relative shortness with the humerus in Pl. XXXVIII. fig. 1, 53, and accords with the idea that the *Dolichosaurus* was more aquatic in its habits than the modern Lacertians, most of which have longer proportional humeri and femora. The femur of the *Dolichosaurus* had a medullary cavity. The under surface of the first two caudal vertebræ is impressed by a median, longitudinal, shallow canal, bounded by two slight ridges, diverging posteriorly in the second caudal to the tubercles that have supported the hæmal arch; these tubercles are close to the posterior articulation. A part of the spine of this hæmal arch is preserved nearly in its true position.

The foregoing comparisons show that all the general characters of the Lacertian type of the vertebrate skeleton are presented by the *Dolichosaurus*: they are most modified in the cervical region, where the Ophidian type is rather followed, in the number and size of the vertebræ, and in the size and shape of the ribs: a less decided approach, but one still indicating an affinity to the Ophidians, is made by the unusual length of the slender trunk, which includes, from the skull to the sacrum, not fewer than fifty-seven vertebræ, and is not less than eighteen inches in length. The smallness of the head accords with the long and slender proportions of the neck, and must have added to the snake-like appearance of this early example of procœlian lizard. But the complete and typically Lacertian organization of the scapular and pelvic arches, and of their locomotive appendages, proves that the *Dolichosaurus* was more strictly a lacertine Saurian than the existing genera, *Pseudopus*, *Bipes* and *Ophisaurus*, which effect the transition from the Lizards to the Snakes, or typical Ophidian reptiles.

Order CHELONIA.

Family MARINA.

Genus CHELONE. (Tab. XXXIX. figs. 5 & 6.)

Of several fragmentary specimens of fossil remains from the chalk, referable to the Chelonian order, in the Museum of Mr. Dixon, the most characteristic is the series of five marginal plates represented of the natural size at figures 5 & 6, Tab. XXXIX. The inner surface of these plates being excavated by the cavities for receiving the pointed ends of the ribs, as shown in figure 5, such indication of that articulation by gomphosis enables one to refer the specimens to a large species of Turtle (*Chelone*).

Order ENALIOSAURIA.

Family PLESIOSAUROIDEA.

Genus PLESIOSAURUS.

Of all existing Reptiles the Chelonians make the nearest approach to the present remarkable extinct genus in the length and flexibility of the neck, in the size of the true body of the atlas (*processus dentatus*, Auct.), which resumes its normal relations with the neural arch of that vertebra in *Chelys* and *Chelodina*; in the natatory form of the extremities as exemplified in the paddles of the Turtle; and in the great expanse of the ischium and pubis; whilst the Plesiosauri exhibit, next to the Turtles, the greatest development of the abdominal ribs (hæmapophyses and their spines), which form a kind of interwoven flexible ‘plastron’ beneath the abdomen. I pass therefore in the present catalogue of British Reptilian Fossils from the aquatic Turtles to the extinct marine Saurians.

Species. *Plesiosaurus Bernardi*, Owen. (Tab. XL.)

In my ‘Report on British Fossil Reptiles,’ one species of *Plesiosaurus*, viz. *Plesiosaurus pachyomus*, was defined from remains discovered in the greensand division of the Cretaceous series*; and the existence of the genus *Plesiosaurus*, at the period of the deposition of the latest member of that series, was inferred from the discovery of the femur of a large species in the chalk which forms the well-known ‘Shakespeare's Cliff’ near Dover†.

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* ‘Report on British Fossil Reptiles,’ Trans. Brit. Association (1839), p. 74.

† *Ibid.* p. 193.

This indication has been since confirmed by the discovery of both teeth and vertebræ of the *Plesiosaurus* in the same formation; and the cervical vertebra figured in Tab. XL., which was obtained from the upper chalk-pit, at Houghton, near Arundel, Sussex, indicates a species nearly allied to the *Plesiosaurus pachyomus* from the greensand of Cambridge.

The following are the dimensions of the vertebra from Houghton and of the most perfect of those of the above-cited species from the greensand:—

	Pl. pachyomus.		*Pl. Bernardi.*	
	In.	Lines.	In.	Lines.
Longitudinal diameter of centrum	1	7	1	9
Transverse diameter	2	3	3	0
Vertical diameter	1	9	2	0

The breadth of the centrum is proportionally greater in the vertebra from the chalk, which further differs from that from the greensand in the anchylosis of the pleurapophyses, *pl* (hatchet-bones or cervical ribs); which, if they presented the characteristic expansion of their extremities, must have supported the hatchet-shaped head on an unusually long body or pedicle. The articular surfaces of the centrum are more concave than in most *Plesiosauri*, and deepen to a central pit, in which they resemble those of the *Plesiosaurus pachyomus*; but they differ inasmuch as the circumference of the surface is convex, and appears at *c a*, *c p*, upon a side view of the vertebra, fig. 3, Tab. XL. The central pit is transversely elongated in *Pl. pachyomus*, but is circular in *Pl. Bernardi.*

Both neurapophyses (*n*) and pleurapophyses (*pl*) are anchylosed to the centrum. The neurapophyses coalesce together, and send almost vertically upwards a spinous process which exceeds in length the whole vertical diameter of the vertebra below it, and is more than twice its own antero-posterior diameter; it is compressed, and gradually decreases in thickness as it rises; it presents a rough shallow tract along its fore-part (fig. 1), and a deeper and smoother excavation behind (fig. 2, *s*). Two small zygapophyses (*z*, *z'*) are developed from both the fore-part (*z*) and back-part (*z'*) of the neural arch. The pleurapophyses are long, subdepressed, slightly expanded as they extend downwards, outwards and backwards; but the fractured ends do not show how far they have extended forwards and backwards into a hatchet-shaped extremity. They have coalesced with the lower part of the sides of the centrum, an extent more than their own vertical diameter intervening between them and the base of the anchylosed neurapophyses. The articulated cervical ribs in the *Pl. pachyomus* have a similar low position on the centrum.

The under part of the centrum presents two deep pits from which the vascular canals ascend, divided by a moderately thick convex longitudinal bar (fig. 4). The non-articular surface of the centrum is smooth, and the sides of the centrum slightly concave.

A very interesting and well-marked additional species of the singular genus *Plesiosaurus* is thus indicated by the present unusually perfect fossil vertebra. As it was discovered on one of the estates of his Grace the Duke of Norfolk, I avail myself of the opportunity of fulfilling a request of my lamented friend Mr. Dixon, and of gratifying my own wishes, by dedicating this new species to the memory of LORD BERNARD HOWARD, a young nobleman of great promise and most amiable disposition, and who had given much attention to the science of geology: he died suddenly in Egypt at the early age of twenty-one years, whilst pursuing his travels in order to acquire a knowledge of the antiquities, the arts, and policy of distant countries.

Plesiosaurus constrictus, Owen. (Tab. XXXVII. figs. 6 & 7.)

The species of *Plesiosaurus* from the chalk-pit at Steyning, Sussex, indicated by the centrum of a middle cervical vertebra, which is figured in Tab. XXXVII. figs. 6 & 7, differs from that of the *Plesiosaurus Bernardi*, Tab. VI., in its great length as compared with the height and breadth of the articular surfaces of the centrum, and in the small size of the costal articulation, the pleurapophyses having been unanchylosed to the centrum; it also differs from all the species of Plesiosaur hitherto defined in the degree of lateral constriction of the centrum between those surfaces, if this be natural. The free or non-articular surface of the centrum is rugose, showing the coarsely fibrous texture of the bone. The under surface is slightly concave, both transversely and longitudinally, is subquadrate and oblong, with two approximated vascular orifices at its centre, separated by a slight rising, which is not developed into a ridge. The small costal surfaces, *pl*, are elliptic, situated at the middle of the ridge dividing the under from the lateral surfaces of the centrum; twice their own vertical diameter below the neurapophysial surfaces, and equidistant from the two ends of the centrum. The articular surfaces here are slightly convex at their circumference, slightly concave in the rest of their extent, with a feeble longitudinal rising at the centre interrupted by a transverse linear groove.

The neurapophysis terminates below in a very open angle. The vertebra appears to have been subject to pressure, and is slightly distorted; but it is difficult to conceive how this could have operated partially as to have produced the compressed character of the middle of the centrum and have left the two articular ends of their natural form.

	In.	Lines.
Antero-posterior diameter of centrum	2	4
Transverse diameter of articular surface of ditto. . . .	2	2
Vertical diameter of ditto	1	7½
Distance between the neurapophysial and costal pits . .	1	0
Transverse diameter of middle of centrum above the costal pits	1	7

TEETH OF PLESIOSAURI.

Plesiosaurus Bernardi.

Two teeth with enameled crowns 1½ inch in length when perfect, and half an inch in diameter at their circular base, slightly curved and gradually tapering to a point, with a few longitudinal enamel ridges of different lengths, and none extending to the apex, belong by these characters to the genus *Plesiosaurus*, and are referable by their size to the *Pl. Bernardi.* The fang or root is cylindrical, smooth, and devoid of enamel. One of these teeth, which is figured in Tab. XXXVII. fig. 8, was obtained from the Scaddlescombe chalk-pit, near Lewes, Sussex. The other specimen, Tab. XXXVII. fig. 9, is from Southeram, Sussex.

Plesiosaurus constrictus.

A smaller tooth of a *Plesiosaurus* with more numerous longitudinal ridges (Tab. XXXVII. fig. 13), may probably have belonged to the *Plesiosaurus constrictus.* This tooth is also from Southeram.

Plesiosaurus (?).

A much-fractured tooth (Tab. XXXVII. fig. 15), as thick as those of figs. 9 & 18, but diminishing more rapidly to the apex, shows similar unequal but more numerous ridges all round the enameled surface; its crown is composed of the same kind of hard dentine as in the Crocodiles and Plesiosaurs, with a moderately thick covering of enamel.

The tooth may be a variety of the Plesiosaurian type, or it may have belonged to a Steneosauroid Crocodilian. It was obtained from the same chalk-pit, at Houghton, near Arundel, as the vertebra of the *Plesiosaurus Bernardi.*

Genus ICHTHYOSAURUS *.

Species. *Ich. communis?* (Tab. XXXIX. fig. 10.)

These teeth were found in Kent, and are now in the museum of William Harris, Esq., F.G.S. Other teeth of the same species are preserved in the well-arranged and instructive cabinet of the Rev. Thomas Image, M.A., rector of Whepstead, Suffolk: these were discovered in the chalk near Cambridge. Mr. Dixon had informed me that he was not aware of any specimen of *Ichthyosaurus* having been found in Sussex.

The group of teeth figured in Tab. XXXIX. fig. 10. belong unquestionably to the genus *Ichthyosaurus*, and so closely correspond in form and size with those of the *Ichthyosaurus communis*, that I cannot presume, in the absence of any knowledge of the characters of the vertebræ or paddles, to pronounce them to belong to a distinct species.

Order PTEROSAURIA, *Owen.*

Genus PTERODACTYLUS.

Within the last few years several new species of 'Pterodactyle' have been discovered in the secondary strata from the lias to the chalk inclusive. The form of these extinct flying Lizards is so extraordinary as to have given rise to different conjectures or theories respecting their nature and affinities; some palæontologists supposing them to have been a kind of Bat, others a modified Bird; but the conclusions to which Cuvier finally arrived are those now generally adopted, viz. that, on account of the construction of the skull, the compound lower jaw supported by tympanic pedicles, and the teeth inserted into distinct sockets, the Pterodactyle was a Saurian reptile or Lizard; but with the bones of the fore-arm and hand singularly elongated like those in the bat, and the bones light and hollow, as in the bird, thus adapting the creature to powerful and rapid flight, with probably the power of swimming. Remains of specimens equalling

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* The reader who may desire to be made acquainted with the general characters of this extinct Sea-lizard is referred to the excellent 'Bridgewater Treatise' by Dr. Buckland.

in size the raven or cormorant have been discovered ; but no satisfactory determination has yet been made of any larger species : the only unequivocal examples from the chalk of Kent that I have hitherto inspected, do not exceed in size those of the *Pterodactylus macronyx* of the Oxford oolite. As the marine lizards called *Plesiosaurus* and *Polyptychodon* are supposed to have frequented estuaries, or to have swum near the shore, and as the *Pterodactylus* cannot be supposed to have flown far out to sea, the discovery of their remains in the chalk indicates the proximity of that formation to the land: and it may be remembered that the Iguanodon has been discovered in one division of the Cretaceous group.

Species. *Pter. conirostris*, Owen. (Tab. XXXVIII. figs. 4, 5, 6 & 7.)

The specimens of the anterior part of the upper and lower jaws of a Pterodactyle (Tab. XXXVIII. figs. 4 & 5), and of the conjoined extremities of the scapula and coracoid (fig. 6), both from Burham chalk-pit in Kent; and the portion of one of the long bones of the wing (metacarpus of fifth digit, fig. 7), from a chalk-pit at Halling in the same county, have previously been figured in the 'Quarterly Geological Journal,' vol. ii. pl. 1, and are there referred to a species which Mr. Bowerbank states that he has described (*ib.* p. 8), and which he proposes to call *Pterodactylus giganteus*. The figures with which Mr. Dixon's plate is illustrated are originals of the natural size, from the specimens cited. That of the fractured scapular arch (fig. 6) corresponds in size with the same part in the *Pterodactylus* (*Ramphorhynchus*) *Gemmingi*, Von Meyer*: the length of the head of the *Pter. Gemmingi*, from the nasal aperture to the end of the beak, is 7 centimeters or 2 inches 9 lines; the length of the same part in the cranium from the chalk (fig. 6) is 5 centimeters or 2 inches; but the *Pterodactylus Gemmingi* belongs to the section of the *Pterosauria* with long and slender beaks. In the *Pterodactylus macronyx* found in the lias of Lyme Regis, and now in the British Museum, the scapular arch rather exceeds in size that from the chalk of Kent figured in Tab. XXXVIII. fig. 6. The metacarpal bone of the fifth or elongated digit of the *Pterodactylus Bucklandi*, from Stonesfield, now in the museum of the Earl of Enniskillen, exceeds in size the largest of those from the chalk figured in the 'Quarterly Geological Journal,' vol. ii. pl. 1. fig. 6, and in Tab. XXXVIII. fig. 7 of the present work : at the same time it is to be observed, that this bone, as well as the scapular arch (fig. 6), accords in proportion with the jaws (figs. 4 & 5), and together, if of a full-grown individual, indicate the inferiority of size

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* Palæontographica, 4to, 1846, taf. v.

of this species of Pterodactyle from the chalk to that of which numerous remains have been found in the oolitic slate at Stonesfield*.

So far as I have been favoured by the opportunity of making observations on true and indubitable remains of the Pterodactyle from the Kentish chalk, it appears to have been a smaller species than the *Pterodactylus Bucklandi*, and not to have exceeded, to say the most, the *Pter. macronyx* and *Pter. Gemmingi.*

The idea of the gigantic proportions of the Pterodactyle of our chalk-deposits has, in fact, been founded on the assumption that the fossil bones of the *Cimoliornis* figured in my 'British Fossil Mammals and Birds,' pp. 545, 546, figs. 230, 231, and in Tab. XXXIX. figs. 11 & 12 of the present work, belong to the genus *Pterodactylus*, and to the same species as the portion of cranium (Tab. XXXVIII. figs. 4 & 5) and the scapular arch (fig. 6). The disproportion of the long bone (Tab. XXXIX. fig. 11) to the scapular arch (Tab. XXXVIII. fig. 6) is such as to need only to be glanced at to form a judgement of the improbability of their belonging to the same species of Pterodactyle; admitting, for the sake of the comparison, Mr. Bowerbank's hypothesis that the long bone formed part of the skeleton of a gigantic Pterodactyle. But, if we further admit it to have belonged to the same species as the scapular arch, this idea of Mr. Bowerbank's must of necessity involve the assumption that the scapular arch (Tab. XXXVIII. fig. 6) has belonged to a very young individual of the species, which assumption is negatived by the anchylosis that has taken place between the scapula (51) and the coracoid (52), where they contribute to form the glenoid cavity *g* for the humerus. I have yet obtained no evidence which shakes my original conclusion that the bone (Tab. XXXIX. fig. 11) is part of the shaft of a humerus of a longi-pennate bird, like the Albatros. It is unnecessary to repeat here the reasons and comparisons that have led me to view in the distal extremity of the tibia of the Albatros the nearest approximation to the form of the well-defined trochlear articular extremity of the long bone figured in Tab. XXXIX. figs. 12 & 13.

Until the part of the skeleton of the Pterodactyle be shown to which that portion of bone can be demonstrated to be more closely conformed than it does to the part of the bird's skeleton which I have pointed out (British Fossil Mammals and Birds, p. 545), its reference to the genus *Pterodactylus* will be held to be gratuitous, at least by all those practised and cautious microscopical observers

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* Lord Enniskillen possesses cervical vertebræ of the *Pterodactylus Bucklandi* upwards of an inch in length.

who may be of opinion with me, that the statements that have been made (Quart. Journ. Geol. Soc. No. 13, p. 2) in proof of the Reptilian and Pterodactylian character of the fossil remains of *Cimoliornis*, and especially of the shaft of the wing-bone (Tab. XXXIX. fig. 11), are not sufficiently supported by the evidence adduced from the application of an otherwise valuable instrument in aid of palæontological research *.

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* It will be seen that the arguments from the microscopical observation are omitted in the allusion to the 'comparative substance' of the bones in the paper in the 'Quarterly Geological Journal,' vol. ii. The author limits himself to the following:—

"From a comparison of the specimens Nos. 5 and 6 with the figure in the 'Transactions,' and from my recollection of the original, I am very much disposed, with due deference to Professor Owen, to believe that it may ultimately prove to be the bone of a Pterodactylus instead of a bird." (p. 7.)

Mr. Bowerbank states that his belief "is the more probable, as the bone in question (Tab. XXXIX. fig. 11), and the head (pl. 2, fig. 4) and bones (*ib.* fig. 6) of the animal now produced, are from the same pit at Burham." As soon as I became aware that Mr. Bowerbank had undertaken the determination and description of these fossil bones from the chalk, I obtained permission from the Earl of Enniskillen to submit to Mr. Bowerbank those which I had described, and to furnish him with portions for microscopical examination. He took such portions from the shaft of the wing-bone of the longi-pennate bird (fig. 11), and he has given the following results of his comparisons in a supplementary note to his original paper:—"Although the two specimens (fig. 11. Tab. XXXIX. and fig. 7. Tab. XXXVIII) differ greatly in size, there is so strong a resemblance between them in the form and degree of angularity of the shaft, and in the comparative substance of the bony structure, as to render it exceedingly probable that they belong to the same class of animals."

Mr. Bowerbank is silent as to the nature or points of resemblance of the 'comparative substance.' He cannot affirm that the resemblance of form and degree of angularity is less in the humerus of a longi-pennate bird to the bone, Tab. XXXIX. fig. 11, than it is in the bone which he compares: he admits that "the two specimens differ greatly in size;" and he also admits that "the flat side of the bone described by Prof. Owen is rather more rounded at that portion exhibited by cutting away the chalk beneath it, but it gradually becomes less convex as we pass towards the same relative portion that is exposed in my specimen," *i.e.* fig. 7. Tab. XXXVIII. And Mr. Bowerbank might have added, that the obvious points of difference which he here acknowledges to exist between the large bone (fig. 11. Pl. XXXIX.) and the small bone (fig. 7. Pl. XXXVIII.) are precisely those by which the large bone so much more resembles the humerus of the Albatros.

When such obvious ornithic characters as these, and especially those of the trochlear end of the bone, fig. 12, determine their nature, the microscopist must have earned due confidence in his judgement as well as his zeal, before the conclusions from those broad anatomical characters can be abandoned on the ground of an alleged non-ornithic character of the microscopic radiated bone-cell. Now it needs only to compare the range of difference in the length and breadth of the radiated cells figured in Quart. Geol. Journ. vol. iv. pl. 1. fig. 1, and the range of difference in the length and breadth of the radiated cells in fig. 9 of the same plate, and to know that Mr. Bowerbank affirms

With regard to the specific name of the unquestionable species of Pterodactyle from the chalk (Tab. XXXVIII. figs. 6 & 7): this being equalled in size by some other species of true Pterodactyle, and surpassed by one, the term 'giganteus' or 'gigantic' is obviously a misnomer. Must that 'nomen triviale,' then, be retained for the new deep-jawed and cone-beaked Pterodactyle of the chalk, because certain bones of another and larger animal of a different species have been erroneously referred to it? This is a question for the Committee of the British Association for the Advancement of Science, who have undertaken the difficult but desirable duty of establishing the Rules of Nomenclature in Zoology. The mere coining of names for things glanced at and imperfectly understood,—the fabrication of signs without due comprehension of the thing signified,—becomes a hindrance instead of a furtherance of true knowledge.

fig. 1 to determine the characters of the Pterodactyle, and fig. 9 those of the Bird, in order to form a conclusion as to the grounds for determining fossil bones that have influenced this able and indefatigable microscopical observer.

CATALOGUE
OF THE
REMAINS OF VERTEBRATE ANIMALS
FROM
THE CHALK FORMATION.

Class PISCES.

Order PLACOIDEI.

CESTRACIONTIDÆ.

	British localities.	*Foreign localities.*
Ptychodus mammillaris, V.C. Tab. XXX. f. 6, XXXI. f. 4.	Brighton.	France and Germany.
——— decurrens, V.C. Tab. XXX. f. 7, 8, XXXI. f. 1, and XXXII. f. 3.	Brighton.	France. Italy. Germany.
——— altior, C. Tab. XXX. f. 10.	Sussex. Kent.	France. Italy.
——— rugosus, new, R. 4. Tab. XXXI. f. 5.	Sussex?	[Germany.
——— latissimus, R. Tab. XXX. f. 1, 2, and XXXI. f. 3.	Southeram. Kent.	France. Italy. Germany.
——— paucisulcatus, new, R. 2. Tab. XXX. f. 3.		
——— polygyrus, C. Tab. XXX. f. 9, and XXXI. f. 10.	Lewes.	
——— depressus, new, C. Tab. XXXI. f. 9.	England.	
——— Mortoni, R. 4. Tab. XXXI. f. 6, 7.	Shoreham.	N. America, Green-S.
——— Oweni, new, R. 2. Tab. XXXI. f. 2, and XXX. f. 4, 5.	Kent.	
Acrodus Illingworthi, new, R. 3. Tab. XXX. f. 11 & 12, and XXXII. f. 9.	Southeram.	
——— cretaceus, new, R. 4. Tab. XXX. f. 13.	Washington.	
Cestracion canaliculatus, R. 4. Tab. XXXII*. f. 8, 8ª.	Kent.	
Aulodus Agassizi, R. 4. Tab. XXXII. f. 6.	Sussex.	
Plethodus expansus, R. 4. Tab. XXXIII. f. 2.	Sussex.	
——— oblongus, R. 3. Tab. XXXII*. f. 4.	Sussex.	

SQUALIDÆ.

	British localities.
Corax maximus, new, R. 2. Tab. XXX. f. 17.	Norfolk. Sussex. Suffolk.
Oxyrhina crassidens, new, R. 3. Tab. XXXI. f. 13 & 13^a.	Houghton.

Order GANOIDEI.

SAUROIDEI.

Pomognathus eupterygius, R. 2. Tab. XXXV. f. 6 & 7.	Sussex.
Belonostomus cinctus, R. 2. Tab. XXXV. f. 3 & 3*.	
——— attenuatus, new, R. 3. Tab. XXXV. f. 4 & 4*.	
Prionolepis angustus, R. 4. Tab. XXXII*. f. 3.	Newmarket.

CŒLACANTHI.

Macropoma Mantelli, R. Tab. XXXIV. f. 2.	Lewes. Amberley.

PYCNODONTIDÆ.

Pycnodus parallelus, new, R. 4. Tab. XXXIII. f. 3.	Sussex.
Microdon nuchalis, new, R. 4. Tab. XXXII. f. 7.	Washington.
——— occipitalis, new, R. 4. Tab. XXXII*. f. 2.	Lewes.
———, sp. new, Tab. XXXII*. f. 5.	
Gyrodus cretaceus, R. 3. Tab. XXX. f. 15.	Lewes.
——— angustus, R. 1. Tab. XXX. f. 14, and XXXIII. f. 1.	Houghton.
——— conicus, new, R. 4. Tab. XXXII. f. 8.	Malling.
Phacodus punctatus, R. 4. Tab. XXX. f. 16.	Lewes.

Order CTENOIDEI.

PERCIDÆ.

Beryx ornatus, V.C. Tab. XXXVI. f. 3, and XXXIV. f. 1, 4 & 5.	Sussex. Kent, &c.
——— radians, R. Tab. XXXVI. f. 4.	Amberley, &c.
——— microcephalus, R. 2. Tab. XXXIV. f. 3.	Clayton. Washington.
——— superbus, new, R. 2. Tab. XXXVI. f. 5.	Southeram.
Berycopsis elegans, R. 2. Tab. XXXV. f. 8.	Sussex.
Homonotus dorsalis, R. 2. Tab. XXXV. f. 2.	Malling. Brighton, &c.
Stenostoma pulchellum, R. 4. Tab. XXXVI. f. 2.	Steyning.

Order CYCLOIDEI.

SCOMBEROIDEI.

	British localities.
Enchodus halocyon, R. 1. Tab. XXX. f. 27, and XXXI. f. 11. (Tab. XXX. f. 20?)	Houghton.

SPHYRÆNIDÆ.

Saurodon Leanus, R. 2. Tab. XXX. f. 28 & 29, and XXXI*. f. 10.	Malling. Kent.
Pachyrhizodus basalis, R. 4. Tab. XXXIV. f. 12 & 13.	Steyning.
Saurocephalus lanciformis, R. Tab. XXX. f. 21, XXXI. f. 12, and XXXIV. f. 14.	Sussex. Kent.
———— striatus, R. 3. Tab. XXXV. f. 5.	Southeram.

MUGILIDÆ.

Calamopleurus Anglicus, new, R. 4. Tab. XXXII. f. 12.	Kent.

HALECOIDEI.

Osmeroides Lewesiensis, R. 2. Tab. XXXIII. f. 4.	Sussex.
———— crassus, R. 4.	Southeram.
Tomognathus mordax, R. 1. Tab. XXXV. f. 1.	
———— leiodus, R. 1. Tab. XXX. f. 31.	Washington.

Class REPTILIA.

Order CROCODILIA.

Polyptychodon interruptus, R. 4. Tab. XXXVII. f. 16 & 17, and XXXVIII. f. 3.	Valmer. Hythe.

Order LACERTILIA.

NATANTIA.

Mosasaurus gracilis, new, R. 4. Tab. XXXVII. f. 1-5, and XXXIX. f. 7-9.	Southeram. Offham.

	British localities.
Leiodon anceps, R. 3. Tab. XXXVII. f. 12*, and XXXVIII. f. 8 & 9.	Sussex. Norfolk.
———? Tab. XXXVII. f. 14.	Norwich.
———? Tab. XXXVII. f. 10 & 11.	Sussex.

REPENTIA.

Raphiosaurus Lucius, R. 4. Tab. XXXIX. f. 1, 2 & 3.	Cambridge.
Coniasaurus crassidens, R. 4. Tab. XXXVII. f. 18, 19, 19^a & 20.	Clayton. Washington. Falmer.
Dolichosaurus longicollis, R. 4. Tab. XXXVIII. f. 1 & 2, and XXXIX. f. 4.	Kent.

Order CHELONIA.

MARINA.

Chelone, R. 3. Tab. XXXIX. f. 5 & 6.

Order ENALIOSAURIA.

PLESIOSAUROIDEA.

Plesiosaurus Bernardi, new, R. 4. Tab. XL., and XXXVII. f. 8 & 9.	Southeram. Dover. Houghton.
——— constrictus, R. 4. Tab. XXXVII. f. 6, 7 & 13.	Steyning. Southeram.
———? Tab. XXXVII. f. 15.	Houghton.
Ichthyosaurus communis? R. 3. Tab. XXXIX. f. 10.	Kent. Cambridge.

Order PTEROSAURIA.

Pterodactylus conirostris, R. 4. Tab. XXXVIII. f. 4–7.	Burham. Halling.

Class AVES.

Cimoliornis, R. 4. Tab. XXXIX. f. 11–13.	Burham.

GENERAL INDEX.

Names of Places and Formations in Capitals; Synonyms in Italics; and the Tables in Roman Numerals.

CORRIGENDA.

Page 10, line 1, *for* Milliolite *read* Miliolite.
... 13, ... 2, *for* Milliolite *read* Miliolite.
... 25, ... 10 *from bottom, for* Milliolite *read* Miliolite.
... 89, ... 3 *from bottom, insert* Tab. II. f. 3.
... 90, ... *under* Tellina lunulata, *transf.* "Donax lunulata, *Lam.*, *&c.*" after "*Edw. loc. cit.*, *&c.*"
... 94, ... 3, *for* Tab. XIII. *read* Tab. XIV.
... 94, ... 8, *for* t. 28 *read* t. 38.
... 95, ... 6 *from the bottom, after* Tab. VII. f. 3 *dele* & 3^a.
... 96, ... 2, *after* Tab. VII. f. 1 *insert* 3^a.
... 98, ... 13, *insert* Tab. VI. f. 20.
... 98, ... 11 *from bottom, for* Tab. XIII. *read* Tab. XIV.
... 100, ... 15 *from bottom, for* Turbo sulcata *read* Turbo sulcatus.
... 101, ... 12, *for* Tab. VI. f. 5 *read* Tab. VI. f. 8.
... 102, ... 14, *after* Tab. VI. f. 4, 6 *dele* & 16.
... 103, ... 20, *for* t. 96^{bis} *read* t. 94^{bis}.
... 106, ... *last line, for* Tab. VII. *read* Tab. V.
... 111, ... 15 *from bottom, after* R. 2. *insert* Tab. XI.
... 113, ... 4, *after* Tab. XIII. *insert* f. 1.
... 118, ... 17, *for* Globulus patulus *read* Ampullina patula.
... 118, ... 12 *from bottom, for* Globulus sigaretinus *read* Ampullina sigaretina.
... 119, ... 2, *for* Tab. XIV. f. 22 *read* Tab. VI. f. 20.
... 119, ... 16 *from bottom, for* Turbo sulcata *read* Turbo sulcatus.
... 120, ... *after* Cassidaria nodosa, &c. *insert* Cassidaria coronata, Tab. VI. f. 22, 30, &c.
... 165, ... 4, *for* Tab. I. f. 2 *read* Tab. XIV. f. 9.
... 167, ... 6, *after* Tab. III. fig. *insert* 12.
... 170, ... 8 *from bottom,* for *granulata* read *granulatus.*
... 182, ... 14 *from bottom, for* Tab. VI. f. 4, 5 *read* Tab. VI. f. 4, 6.
... 201, ... 3, *insert* Tab. XI. f. 7.
... 227, ... *between* 2 & 3, insert *Genus* Globulus.
... 228, ... 13, *insert* Tab. XIV. f. 15.
... 228, ... 16, *insert* Tab. XIV. f. 28.
... 341, ... 2 *from bottom,* for *pillula* read *Pilula.*
... 343, ... 13 *from bottom, for* f. 39 *read* f. 38.
... 352, ... 4 *from bottom, for* ——— pustulosa *read* Pustulopora pustulosa.
... 373, ... 2, for *pulchella* read *pulchellum.*
... 374, ... 11, *dele* Family Sphyrænidæ.
... 398, ... 16 *from bottom, for* Tab. VI. *read* Tab. XL.
Plate XVI. f. 5 *transpose letters b & c.*

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TAB I

Eocene Corals of Bracklesham

TAB. II.

Eocene Shells of Bracklesham.

J De C S fecit

TAB. III.

Eocene Shells of Bracklesham

J. De C. S. fecit

TAB. IV.

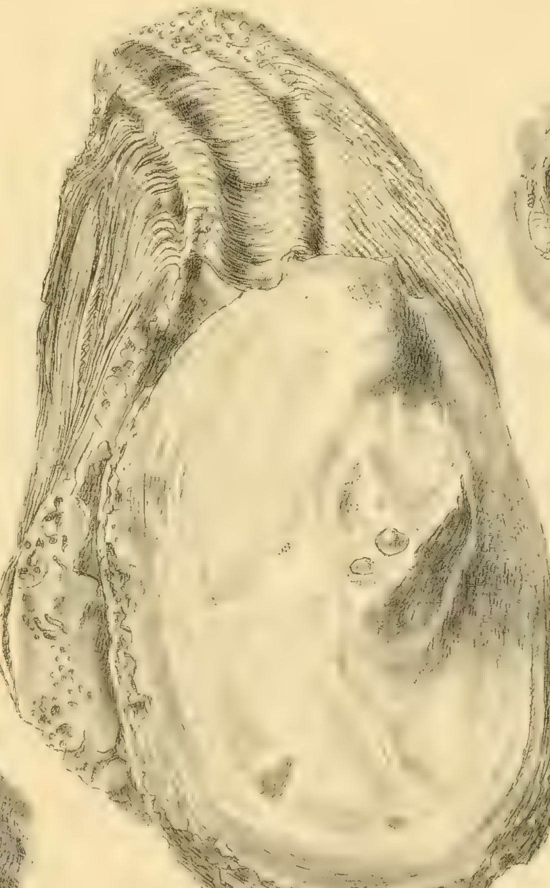
2

1

3

6

4



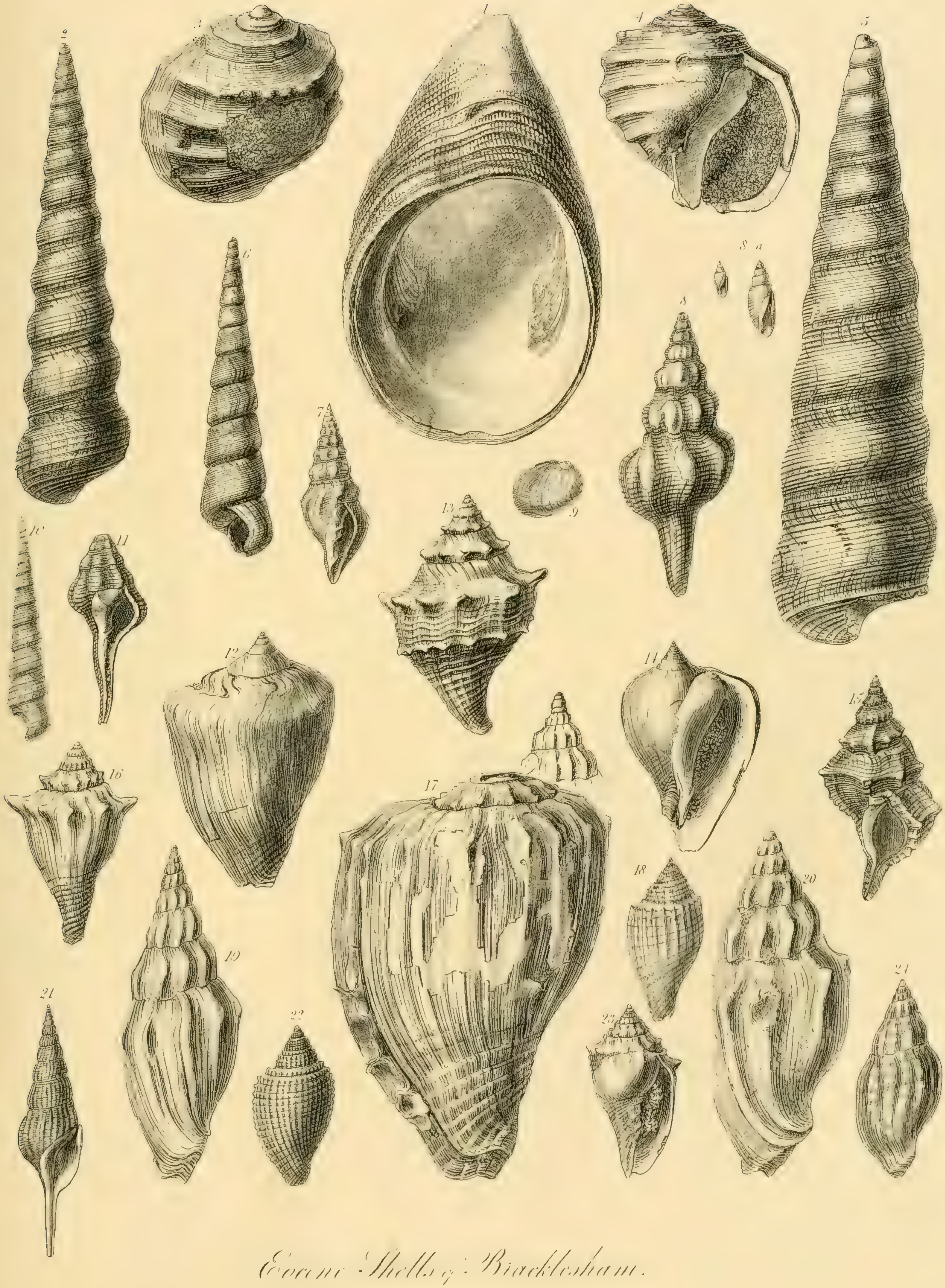
5

7

8

Eocene Shells of Bracklesham.

J.De C.S. fecit



Eocene Shells of Bracklesham.

J. De C. S. fecit

TAB. VI.

Eocene Shells of Bracklesham

J. De C. S. del.

TAB. VII.

Eocene Shells of Bracklesham.

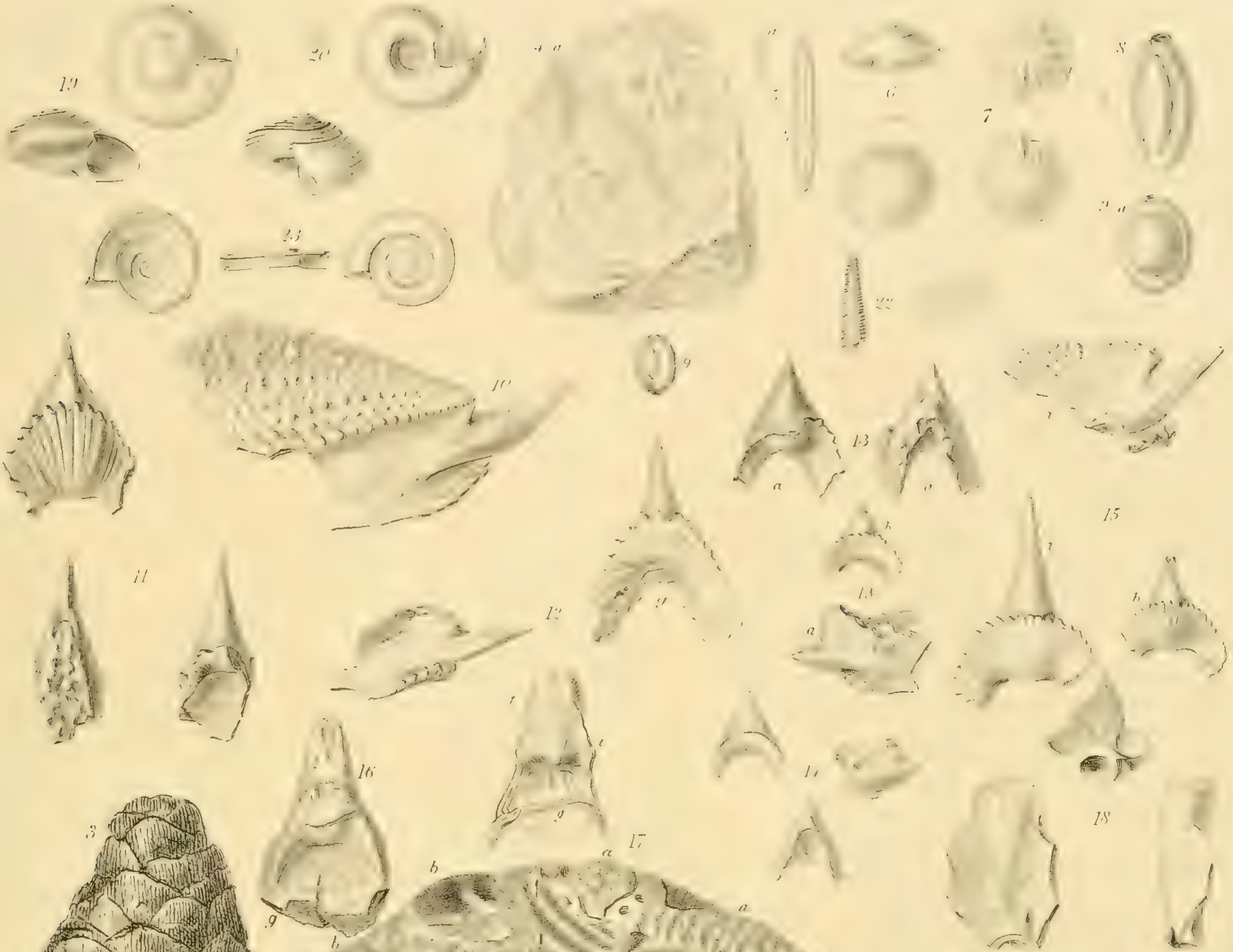
J. De C. S. fecit

TAB. VIII.

Eocene Shells of Bracklesham.

J De C.S. sc.

TAB. IX.



Eocene Fossils of Bracklesham

J.De C.S. fecit

[illegible]

6, 7, 8, [illegible] fragments of vertebrae

1[illegible] Some of the caudal spines of a [illegible]

[illegible]

[illegible]

18 Upper maxillaries and teeth of Edaphodon eurygnathus.

19 The right premaxillary of Edaphodon eurygnathus.

20 The right upper maxillary of Edaphodon Bucklandi

[illegible] Edaphodon Bucklandi.

[illegible] Chimaeroid teeth

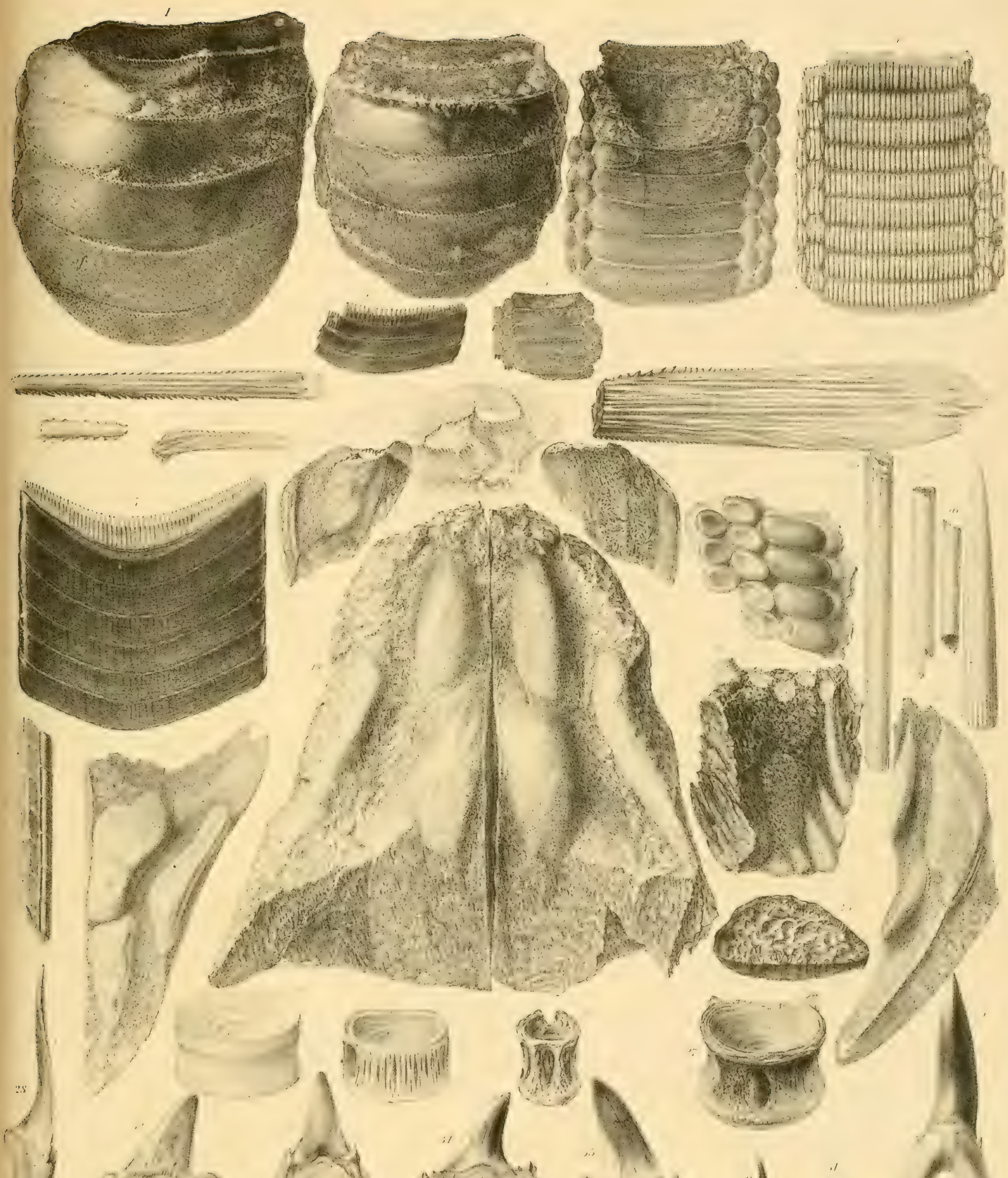
[illegible] Sphyraena teeth

2[illegible], 27, Vertebrae of various fishes,

28, 31 Teeth of Lamna elegans,

32, 35 " " Otodus obliquus.

TAB X



Eocene Fishes of Bracklesham.

[illegible]

1 Part of the lower dental plate of a recent Sting-Ray, Myliobatis.
2, 4 Aetobatis irregularis.
5, —— —— convexus.
6 [illegible]
7 [illegible]
8 [illegible]
9. [illegible] jaw and teeth of a recent [illegible]
10. Section of upper and lower jaw of Aetobatis.
11, 13 Defensive spines of a Siluroid fish.
14, Myliobatis Dixoni.
15, ———— irregularis.
16, — —— Edwardsii.
17, ———— contractus.
18. [illegible]
19. [illegible]
[illegible]
[illegible]
[illegible] latidens.
24, 25, Teeth of fossil fishes.
26 Prolonged premaxillary [illegible] (Cœlorhynchus.)

[illegible]

1_26. Eocene Fishes of Bracklesham.

[illegible] Lithrs to the Queen

[illegible]

Fig. [illegible]

" [illegible] — — [illegible].

" 3. — — Dixoni.

" 4. — Toliapicus.

" 5. Premaxillary bone of Edaphodon leptognathus.

" 6, 7 Teeth of Pristis.

" 8 Portion of fossil skin of a Placoid fish.

" 9, 10, Pristis contortus.

" 11, 12, 13, Dental plates of Platylaemus.

Eocene Fossils of Bracklesham.

TAB. XIII

From Nature on Zinc by J. Erxleben

Day & Son Lith. to the Queen

Eocene Chelonia of Bracklesham.

TAB. XIV.

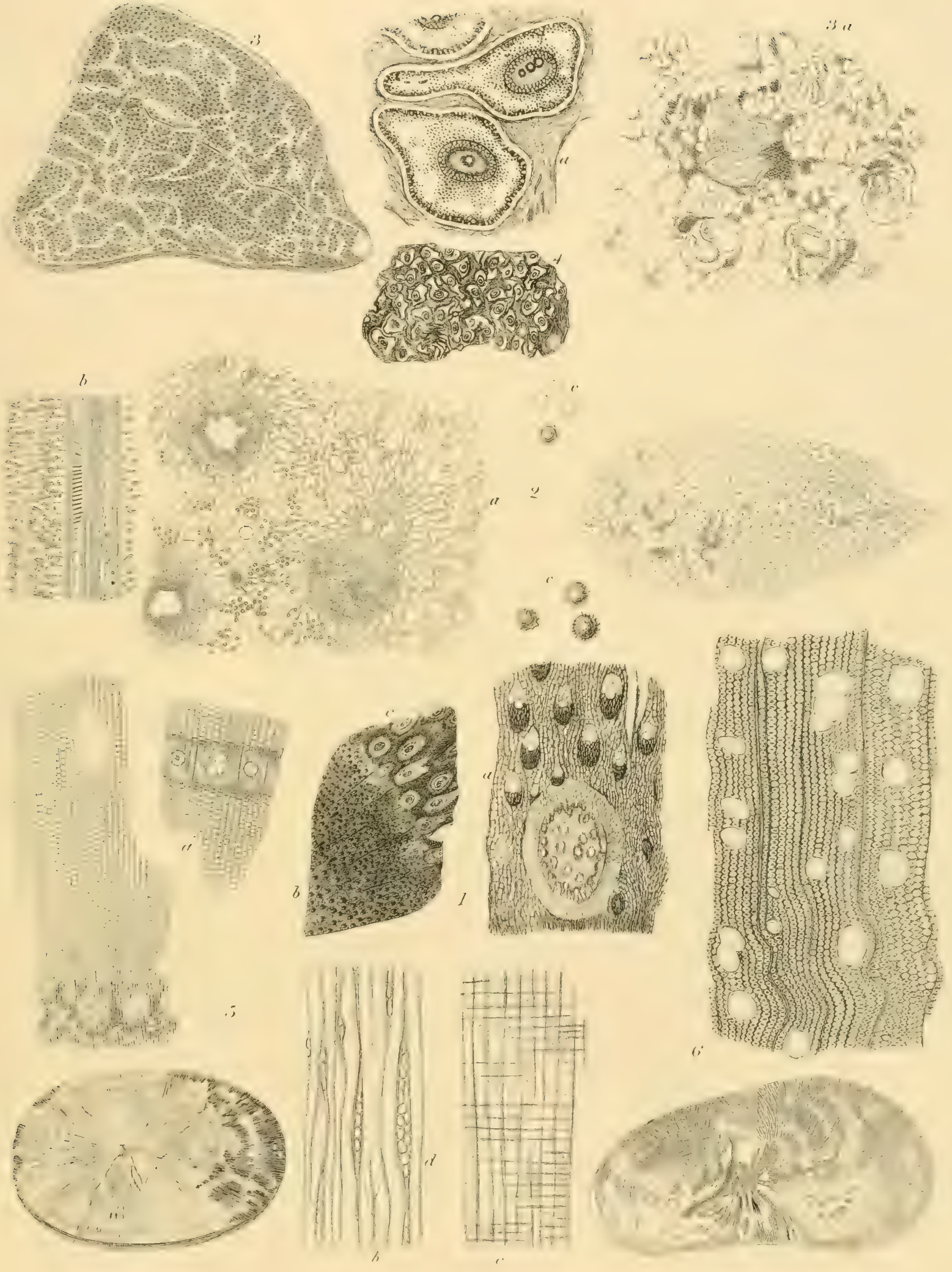
Eocene Shells of Bognor.

J De C.S. fecit

TAB. XV.

Eocene fossils of Bognor.

TAB. XVI.



Palm Stems & Wood; from the Coast of Sussex.

Maria Dixon del.

J. De C.S. Sc.

TAB. XVII.

Choanites &c. in Flints from the Coast of Sussex.

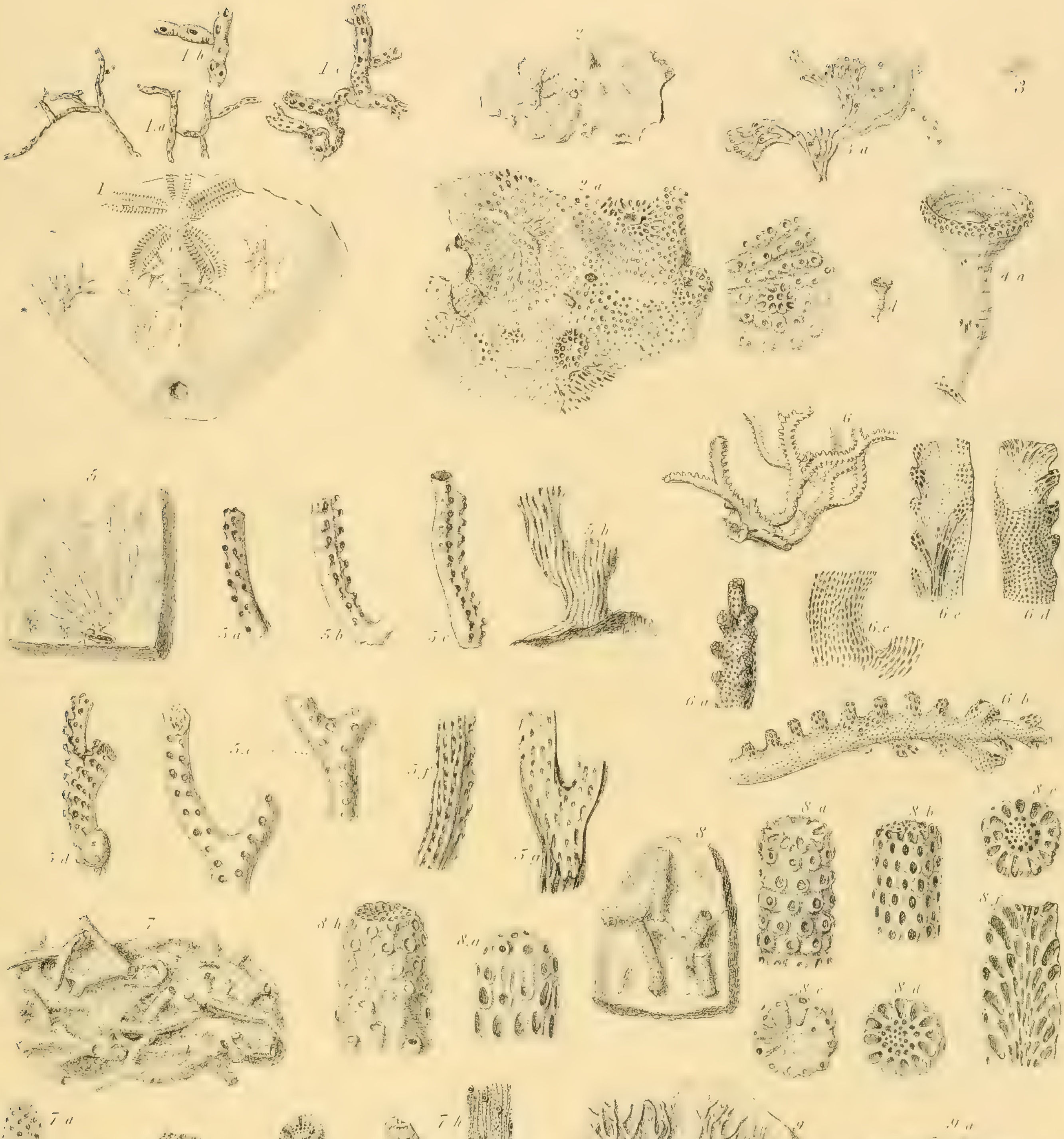
Maria Dixon del. J. De C. S. sc

TAB. XVIII.

Corals of the Chalk.

J.De C.S. fecit

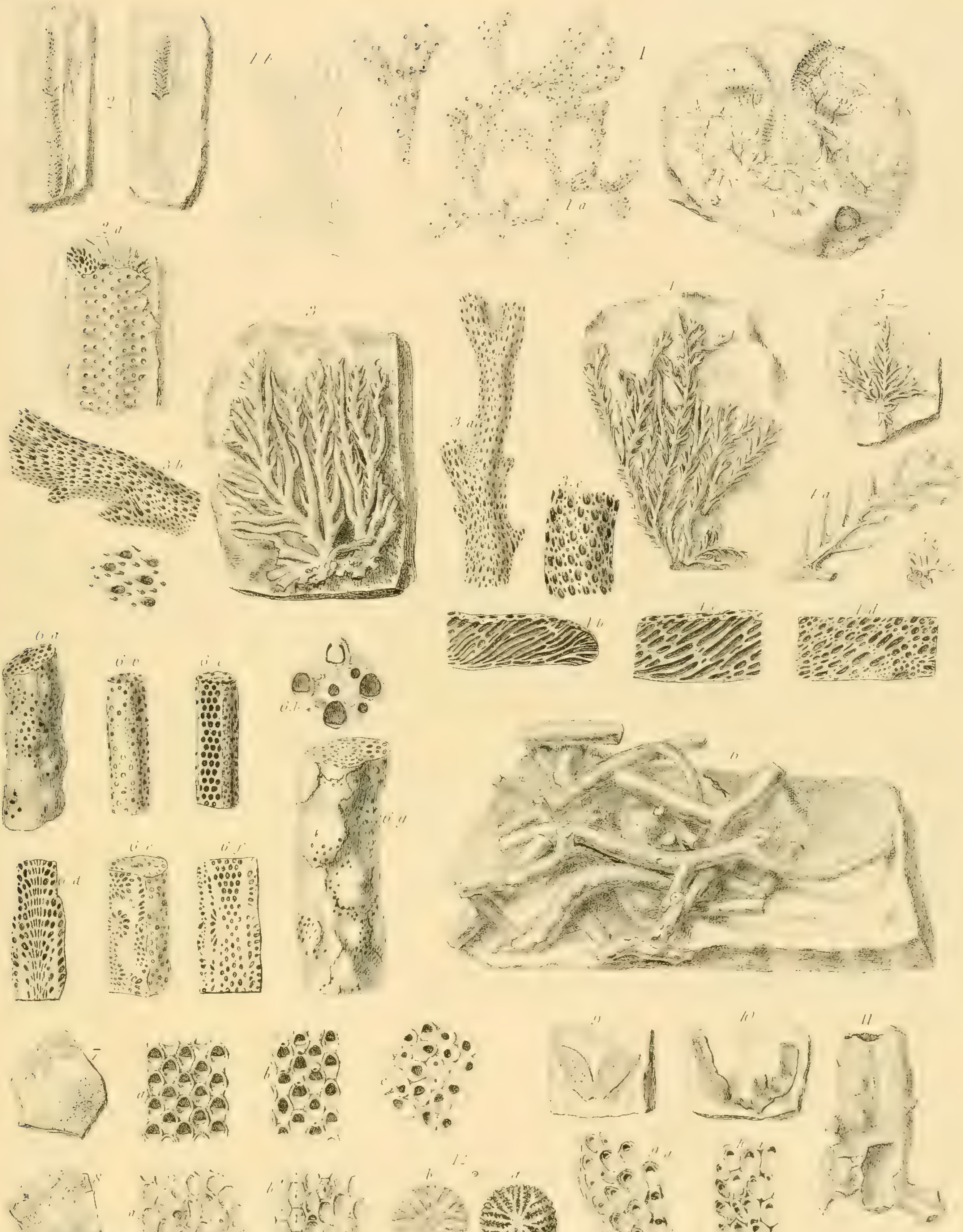
TAB. XVIII. A.



Corals of the Chalk.

J. De C. Sowerby fecit.

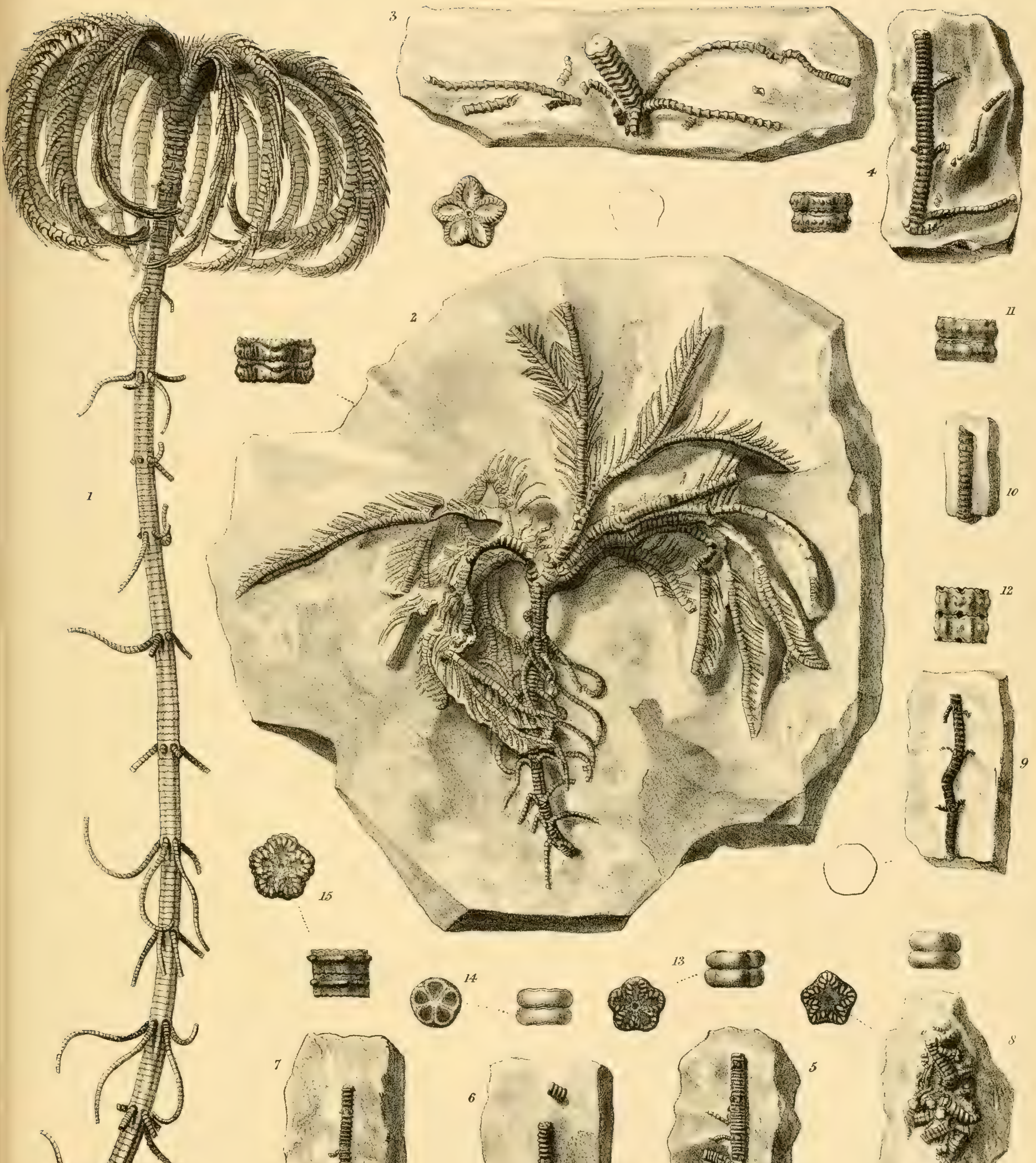
TAB. XVIII B



Chalk Corals.

J. De C. S. fec.

TAB. XIX.

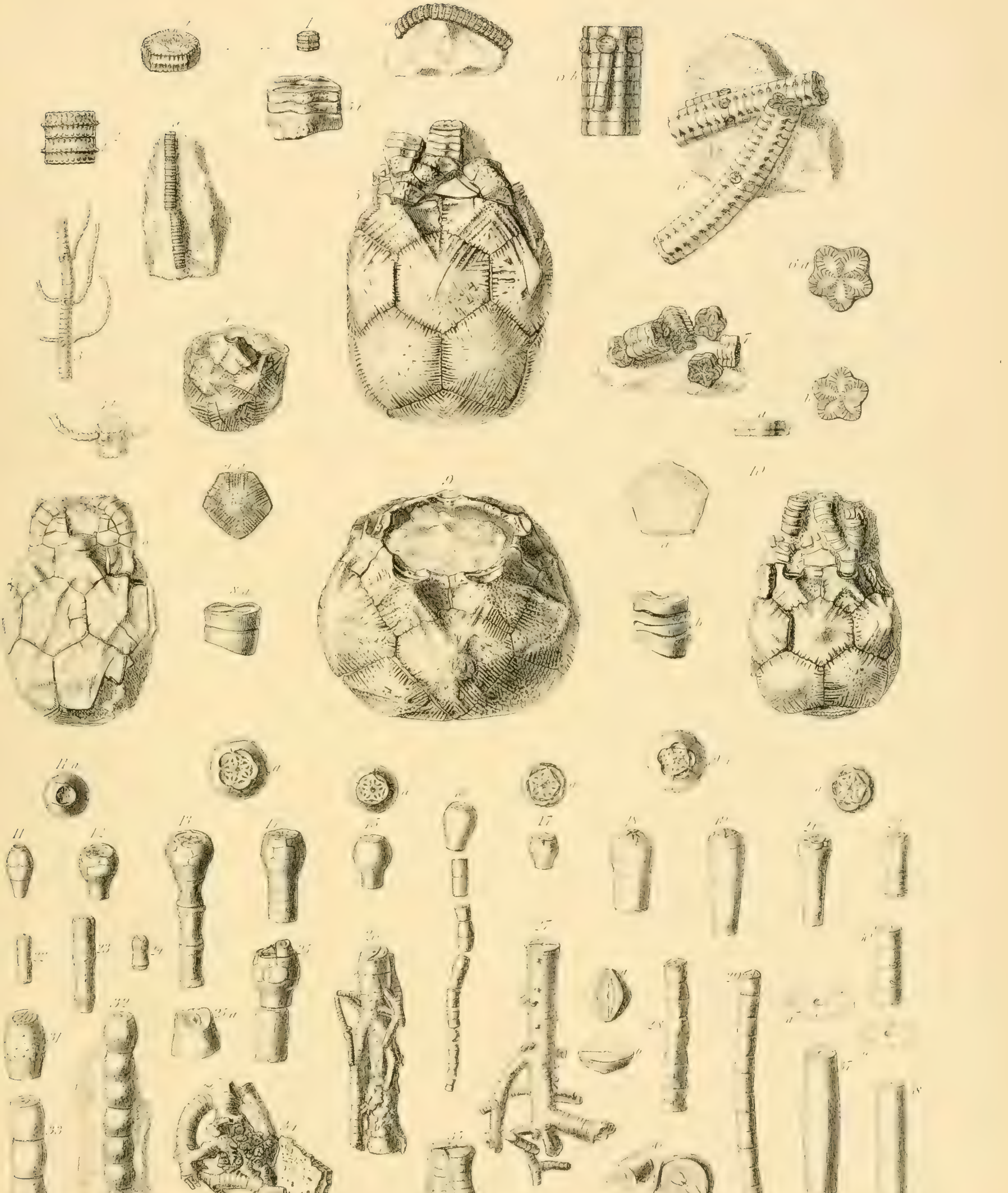


Dinkel del. et lith

Hay & Son, Lith^rs to The Queen

Encrinites of the Chalk.

TAB. XX.



Chalk Crinoïdea?

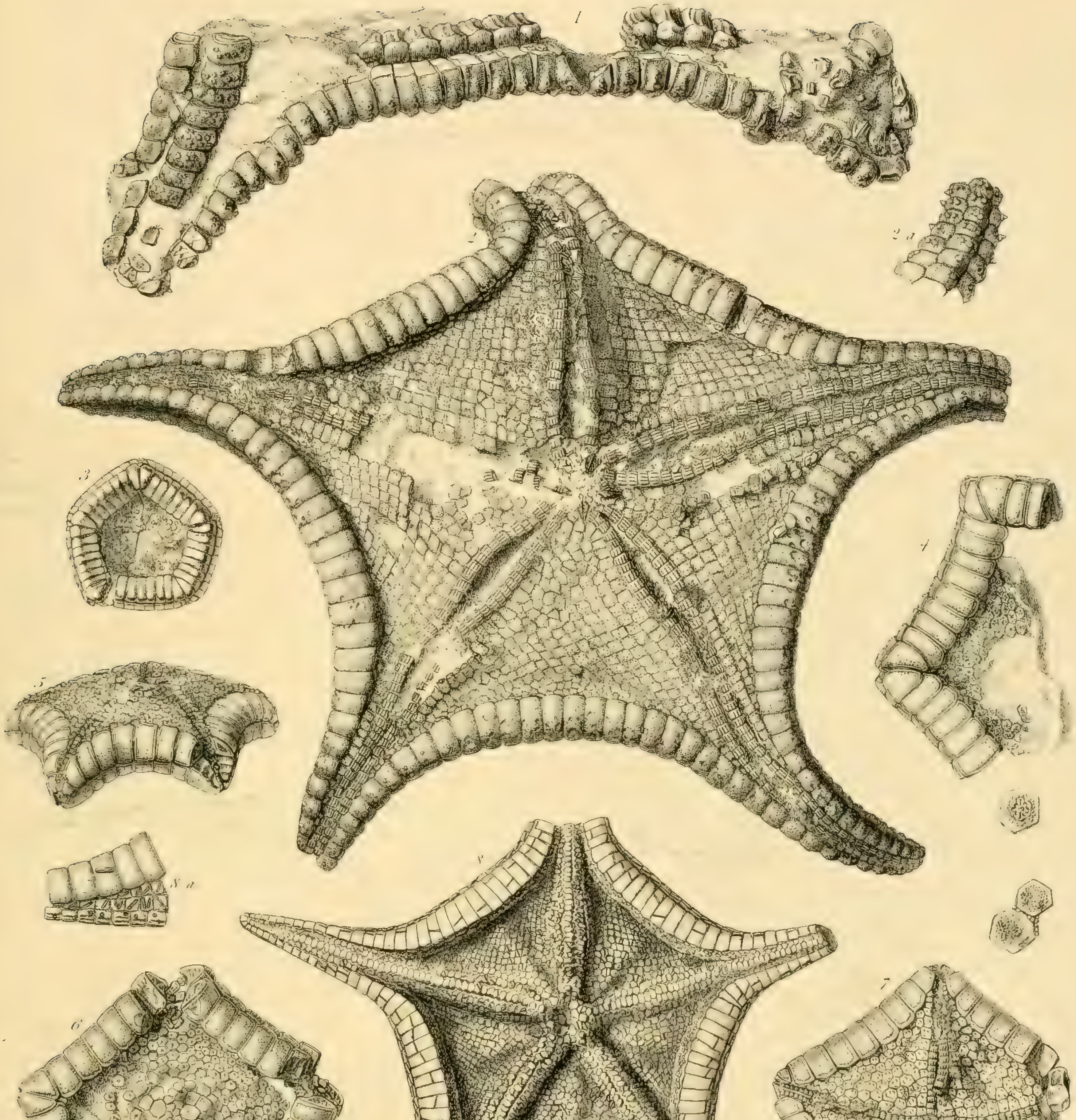
J De C.S. fecit

TAB. XXI.

Chalk Asteriadæ.

J.De C.S. fecit.

TAB. XXII.



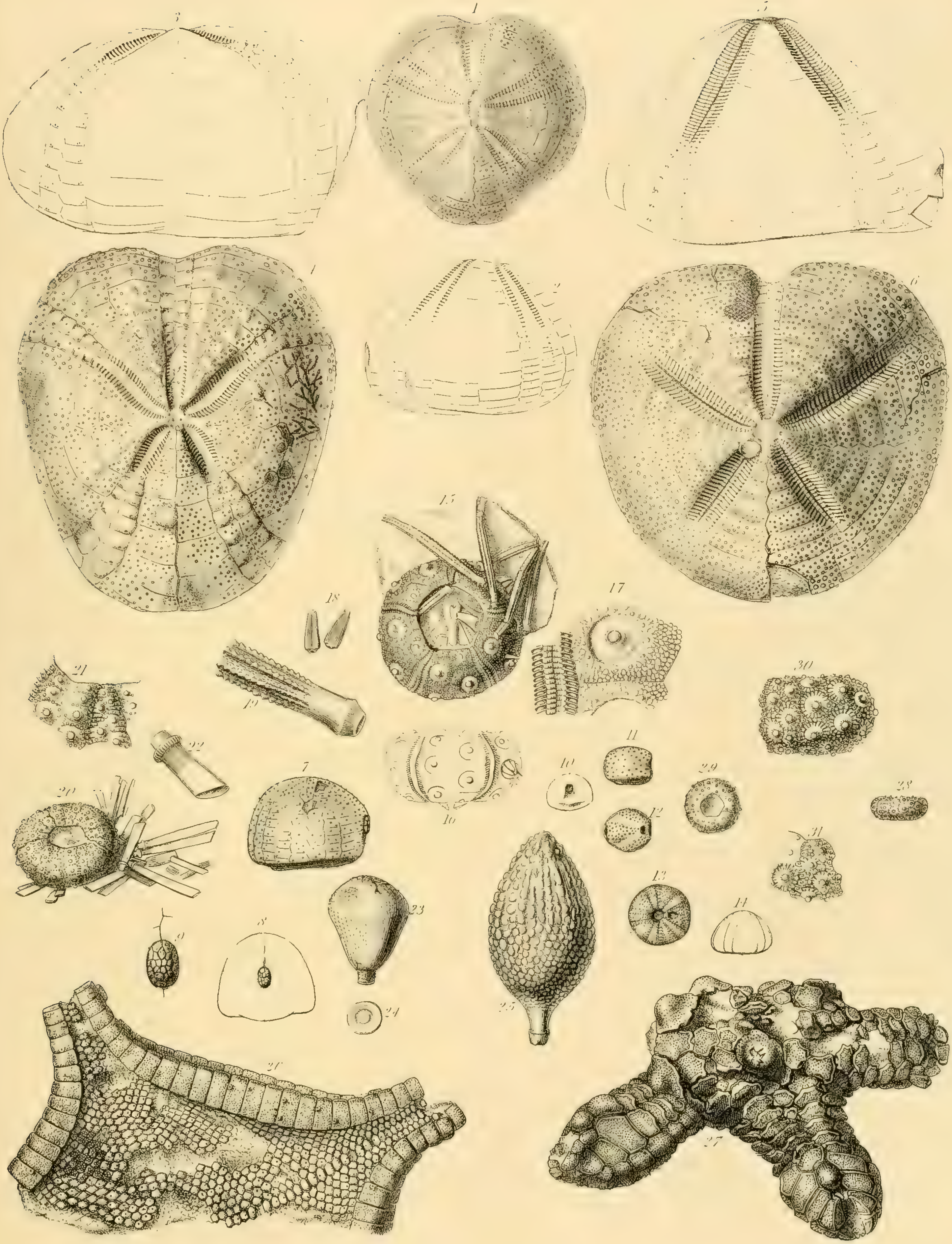
Chalk Asteriadæ.

J. De C. S. fecit

TAB. XXIII.

Chalk Asteriadæ

J.De C.S. fecit



Fossils of the Chalk.

J. De C. S. fecit

TAB. XXV.

Chalk Echinidæ.

J.De C.S. fecit

TAB. XXVI

Hippurites Mortoni

TAB XXVII

Fossil Shells of the Chalk.

J. De C. S. fecit

TAB. XXVIII.

Fossil Shells of the Chalk.

J. De C. S. fecit

TAB. XXIX.

Fossils of the Chalk.

J. De C. S. fecit

TAB. XXX.

Chalk Fishes

J.De C.S. fecit

TAB. XXXI.

Chalk Fishes

J. De C. S. fecit

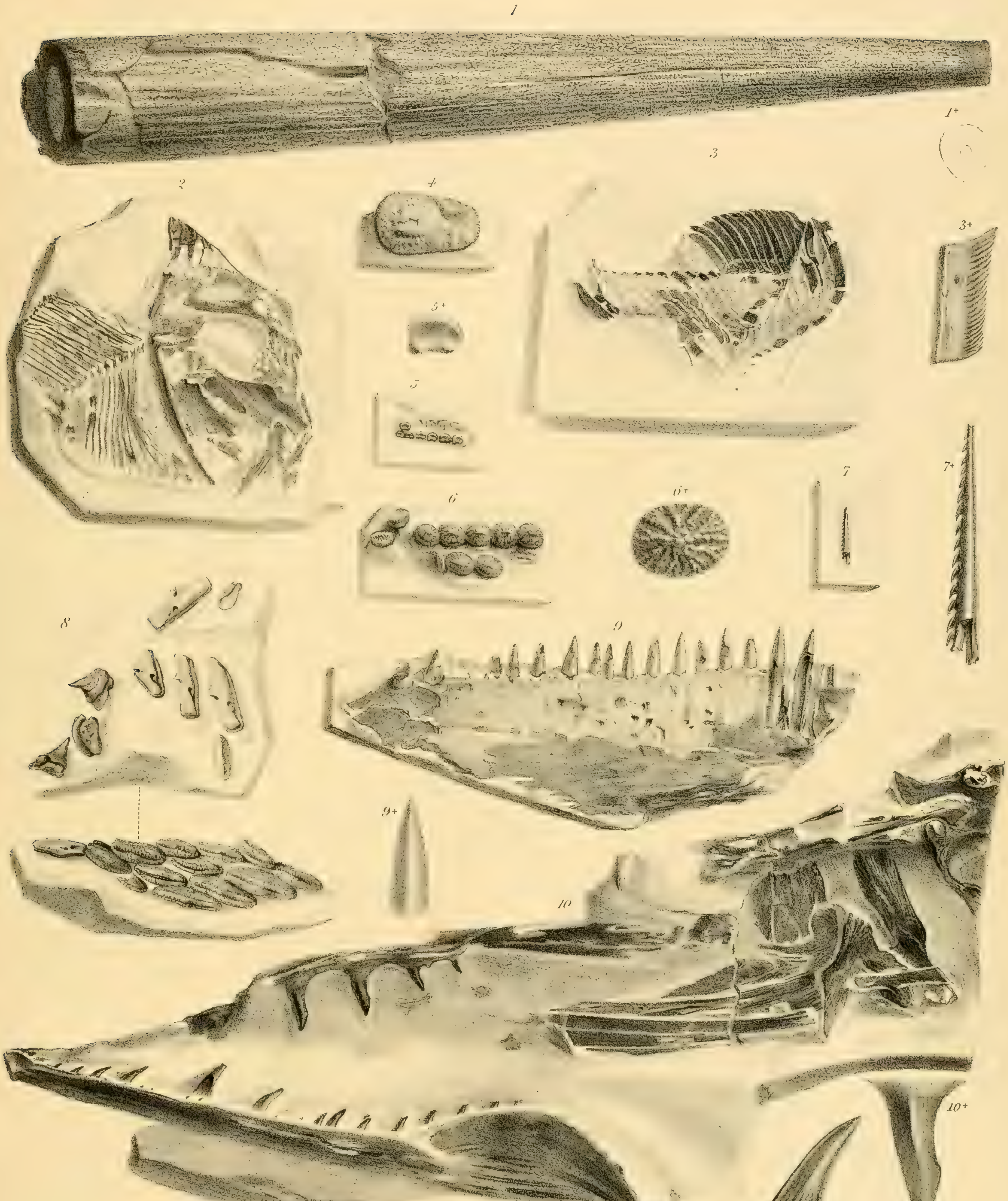
[illegible]

Fig. 1, 2, Upper maxillary bone, left side, Edaphodon Mantelli.
" 3, 4. Mandible of Ichthyosaurus

TAB. XXXII.

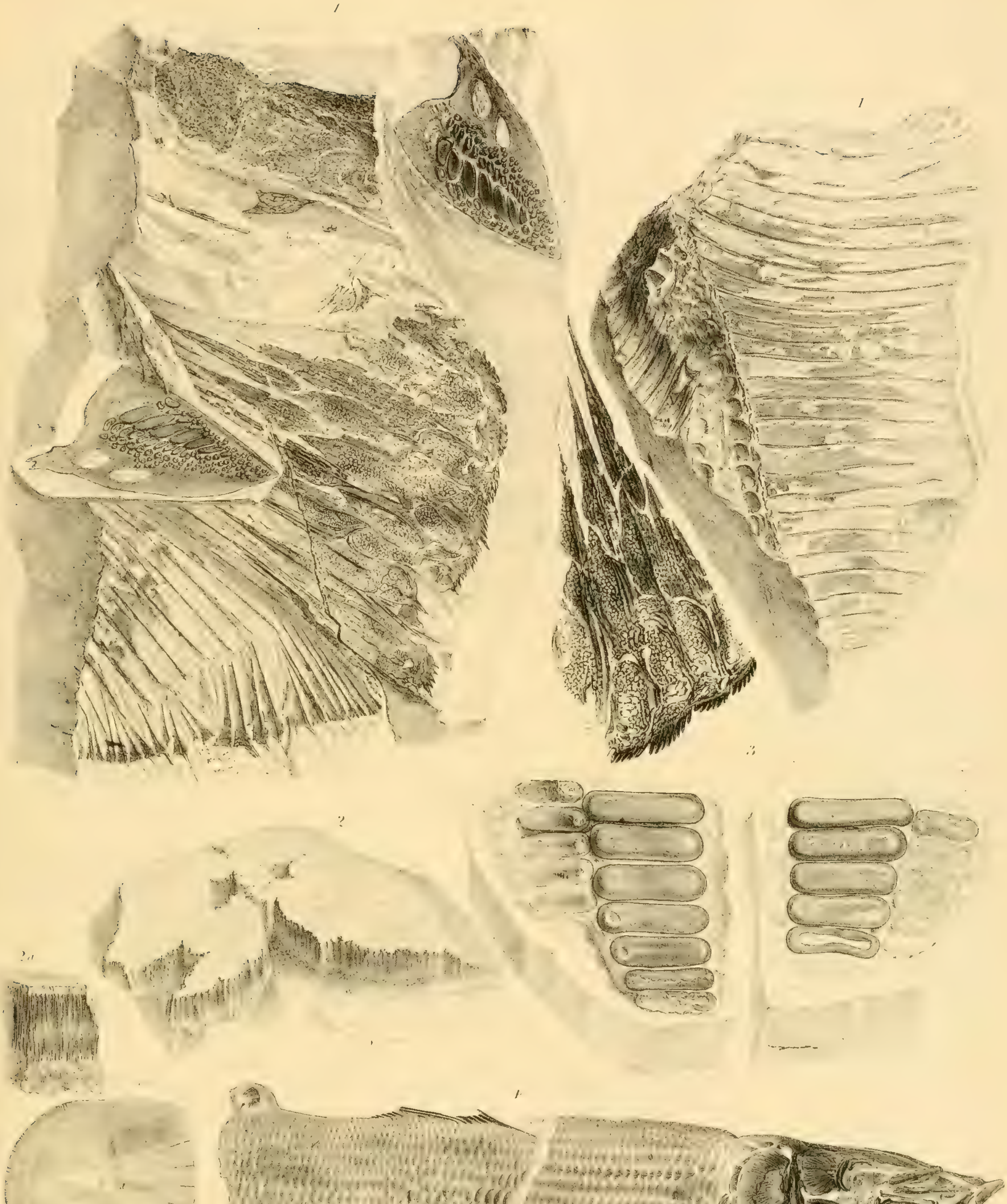
Fossil Fishes of the Chalk.

TAB. XXXII *



Dinkel del. et lith

Fossil Fishes of the Chalk



Dinkel del. Lens Aldous Zn. [illegible]

Fossil Fishes of the Chalk.

TAB. XXXIV.

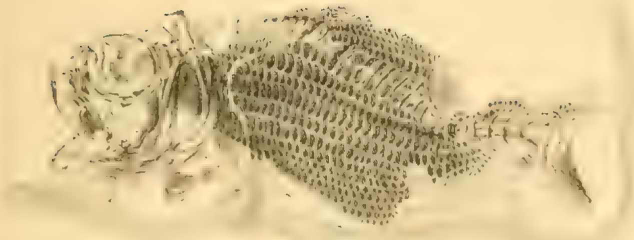
Fossil Fishes of the Chalk.

Dinkel del.

Fossil Fishes of the Chalk

1

2



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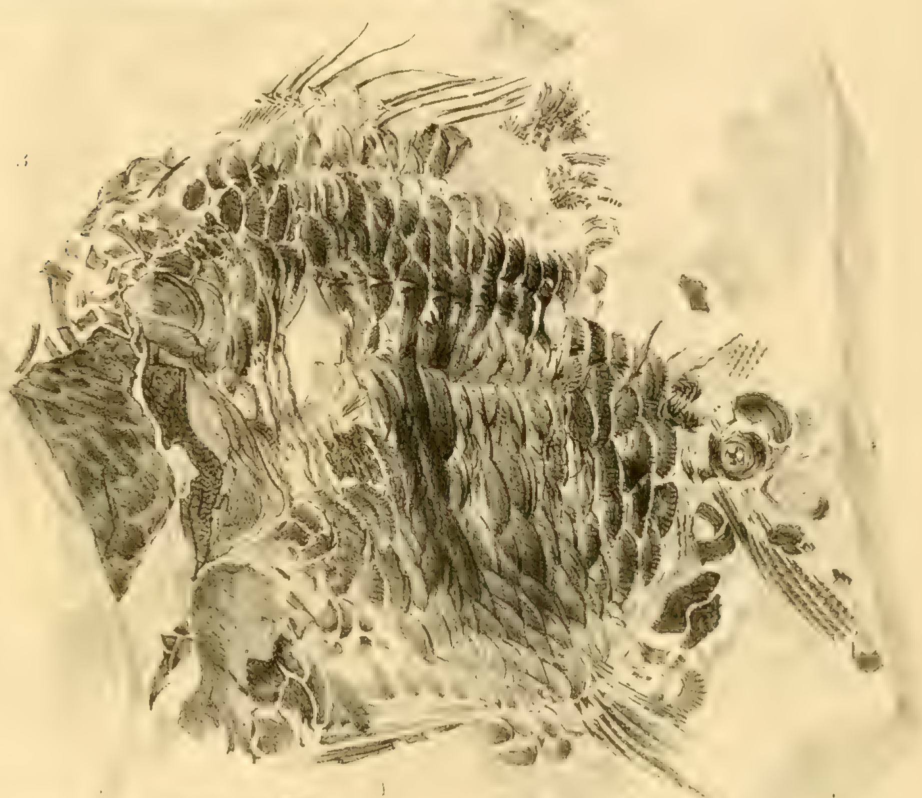

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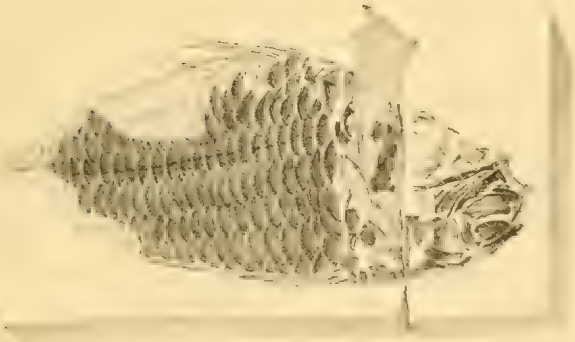

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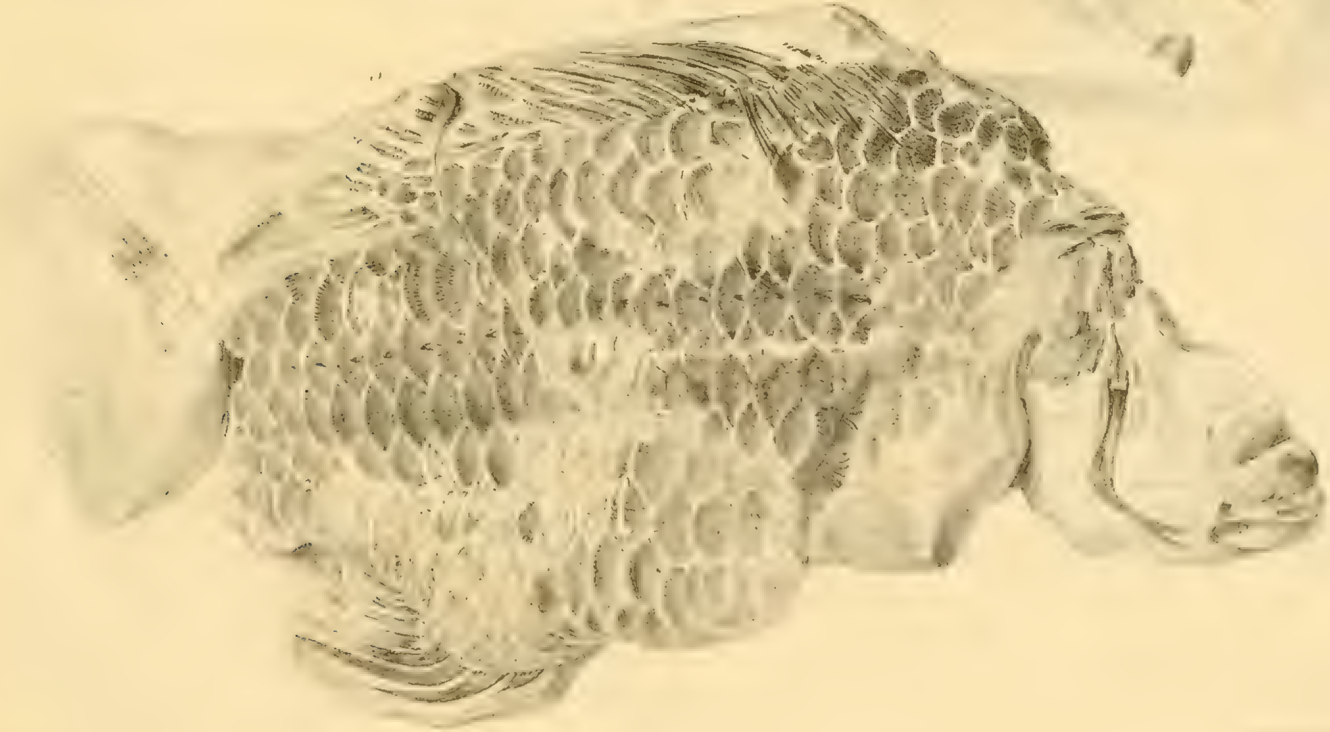


Fossil Fishes of the Chalk.

TAB. XXXVII.

J Erxleben from nat on Zinc.

Day & Son Lithogrs to the Queen

Foſsil Reptilia from the Chalk.

TAB. XXXVIII.

From nat. on zinc by J. Erxleben.

Day & Son Lithogrs. to the Queen

Fossil Reptilia from the Chalk.

TAB XXXVIII.

Day & Son, lith^rs to the Queen

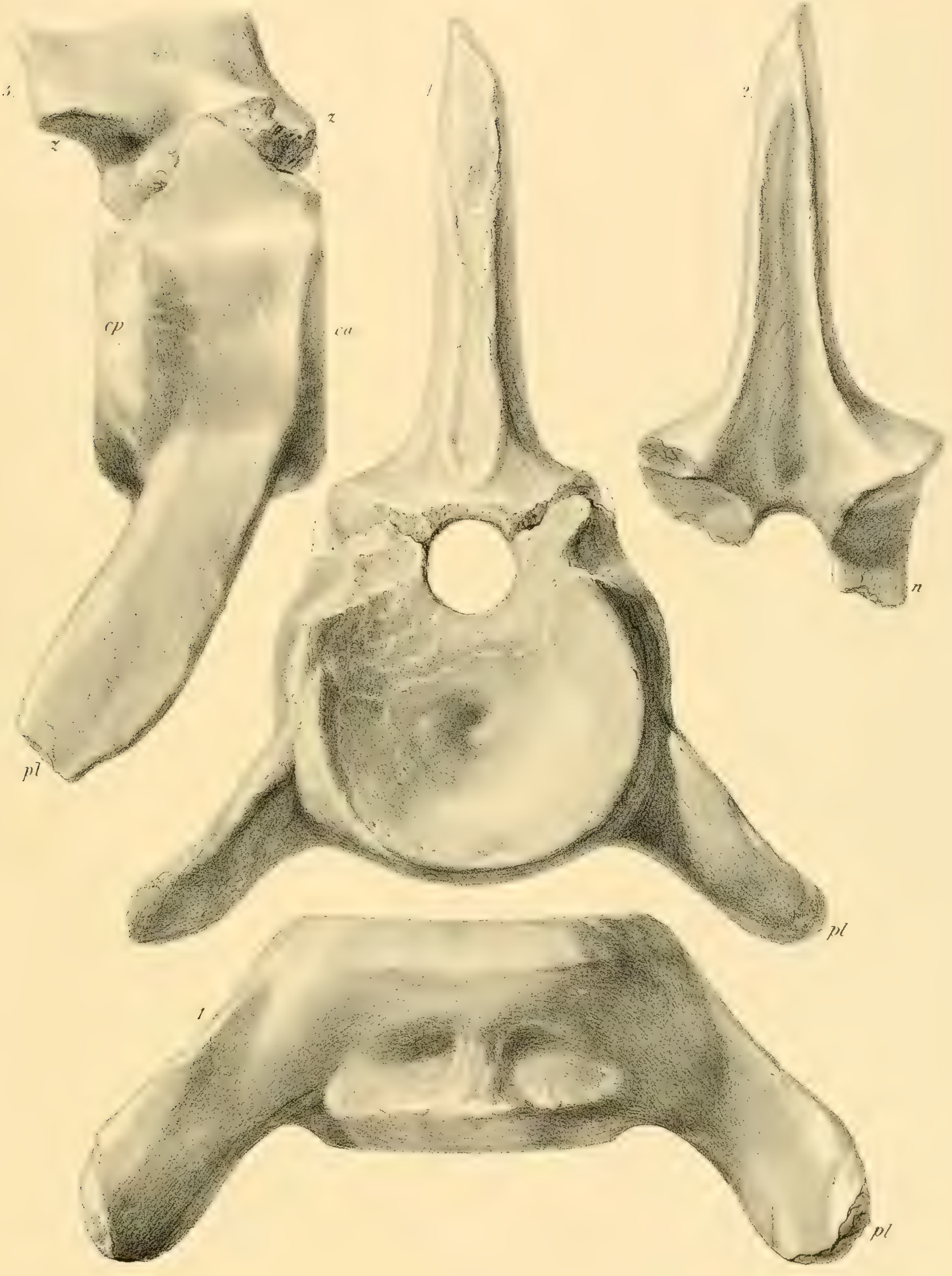
Crustacea from the Chalk.

TAB. XXXIX

On Zinc by Lens Aldous

Fossil Reptilia from the Chalk.

Day & Son, Lith^rs to the Queen



Drawn on Stone by J. Scharf

Fossil Reptilia from the Chalk.

Day & Haghe Lith^rs to the Queen